

Thom Hogan's

Complete Guide to the Nikon D90

1st Edition

By Thom Hogan
by Thom Press

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1st Edition, version 1.00: 11/29/2008

Acknowledgements

Several Web sites proved useful in researching aspects of this book. While I mention several at appropriate points in the eBook, three need to be singled out for D90 users:

- Phil Askey's <http://www.dpreview.com> not only has some of the most thorough reviews of digital cameras (yes, even more thorough than the ones on my own site), but also has an ongoing forum that's useful for getting answers to tough questions (select **Nikon D90 - D40** from the **Discussion Forums** pop-up in the left navigation panel).
- Nikonians <http://www.nikonians.org> is another of the "well-attended" public forums that are useful for Nikon D90 users. Click on **Forums**, and then click on the **D70/D80/D90 Users Group** link.
- Nikon Café <http://www.nikoncafe.com> is a relatively new moderated forum and has had a discussion for Nikon DSLR users. Click on **Lighting and Flash, Cameras, and gear**, and then click on the **Nikon D90** forum link.

About this eBook

This eBook was created using Adobe Acrobat directly from my original files. I've tried to retain as many of the navigational features as Acrobat allows (for example, the **Bookmarks** section at the left is derived from the Table of Contents and is fully active—click on an entry and you'll be taken to it). Curiously, trying to create a fully functional eBook using Adobe's tools is worthy of an eBook itself (most of the chapters would be centered on trying to get promised features to work, and how they keep changing between Acrobat Professional versions, sometimes going backwards in ability).

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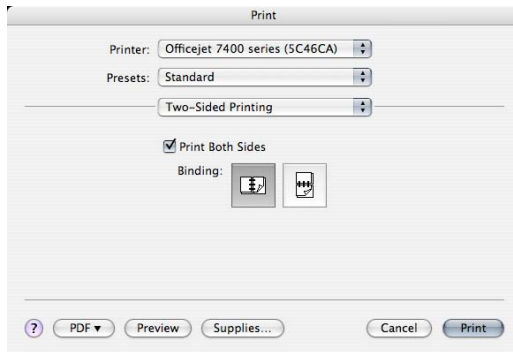
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It's possible to print on both sides of the paper and get a real book-like experience by using the **Print: Odd Pages Only** and **Print: Even Pages Only** options on the **Print** dialog, but I don't recommend this unless you're good at keeping track of paper, know how to properly re-orient the paper for the second pass, and are sure that your printer won't choke on a page somewhere. With some HP printer drivers, for example, you can print the odd pages, put the pages generated back into the printer correctly oriented, then select **Print: Even Pages Only** and **Print Back to Front**, saving you the step of reordering the pages before the second pass.

Some recent printers offer something called "duplex printing," where the printer itself handles flipping the paper. That's how I print my eBooks for myself on my HP OfficeJet, which

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supports duplex printing. Here's the relevant dialog on my Mac filled out correctly for this eBook:



Since there are so many printers available and their dialog boxes all allow different printing options, I can't help you figure out the most economical or convenient way to print your eBook². Yes, it even took me a few minutes to figure out how to create front and back copies on my laser printer, so I know it's a hassle. A complete set of step-by-step instructions that work for the three printers I have available are included on the CD in a separate file, called **PRINTING.PDF**.

Take the resulting pages to your copy shop, have them trim the edges (the final page size is 5.5 x 8.5" unless you've let Acrobat rescale the book to fit the full page) and bind. This eBook is actually in three specific sections that could be bound separately ("Before You Take Pictures," "Shooting Pictures with Your D90," and "After You've Taken Pictures and Videos with Your D90"); I've tried to keep the instructions you'd want while out shooting in the middle section.

²Since I get the occasional question as to *why* I don't publish a paper version, I'll explain: paper versions turn out to be more expensive to produce in the small quantities at which a niche publication like this sells. Producing this eBook electronically allows me to create it on demand, reducing waste and cost, and to keep it up to date as I learn new things about the camera. It also gives me a chance to correct the inevitable minor typos that somehow creep into every major production. On that last point: I keep a current errata list on my Web site. You'll find the one for this version of the eBook (1.00) at <http://www.bythom.com/d90guideerrata.htm>.

If you're really the type that doesn't like to struggle through the paper handling idiosyncrasies of your printer, most Kinko's and similar copy shops can print, collate, and bind a nice portable version of this book for you (show them the statement on the back cover or on the previous page if they balk at printing a Copyrighted work). Make sure they know that the final page size is 5.5" x 8.5".

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Note: Some Kinko's now use a special piece of software to print from PDF files, such as the one for this eBook. Since that software first attempts to extract all text from the file and I have selected to block text extraction in Acrobat, this means that such software fails to work with this eBook. Kinko's can still print it by simply running Acrobat, but this limits some of the fancier options they can do.

This eBook is designed to help you get quality results from your Nikon D90. While I'll try to provide introductory material that should help even a photography novice get by, this eBook probably isn't the place to learn what an aperture or shutter speed is (check out <http://www.bythom.com/bookrecs.htm> if you want some recommendations for general photography books).

Nevertheless, I will try to explain the concepts and terminology that are necessary to understand how a D90 works. If you find something in this eBook unclear, or that I've assumed knowledge on your part that you don't have, don't hesitate to drop me an email asking for an explanation. Not only will I answer your question, but it will give me some insight on what I might want to change in future editions to make the eBook even clearer.

Besides dealing with the practical side of the camera and showing you how all the basic functions work, I'll also provide you with some tips on how to squeeze every last bit of image quality out of your camera as well as how to make up for some of its shortcomings.

Note on the First Edition

While this is a first edition, the D90 is enough like earlier Nikon DSLRs that I've been able to re-purpose and rewrite portions of earlier eBooks—specifically the D80 eBook, as the D90 shares a basic design and many options with that camera—which means that much of the information here has been previously vetted.

One thing I have done with this eBook, though, is restructure it from my previous ones, and augment it with more introductory material. The audience for the D90 includes more first-time SLR³ users, so I've worked very hard on making this work both more approachable and more understandable, even though my previous Nikon books have been highly regarded in that respect.

Since I mentioned the change in structure, let me point it out; this eBook is separated into three distinct sections:

- *Things you should know and consider before using the D90 (labeled “Before You Take Pictures” and starts on page <27>).* In this first major section I cover a lot about what a DSLR is, some of its critical components (like the sensor that captures images), how to set up your camera for shooting, and things you should do and know before you head out the door to take pictures. This section is up front because it's the background material you need to get up to speed with the unique aspects of your camera.
- *Things you need to know while using the D90 (labeled “Shooting Pictures with Your D90” and starts on page <220>).* This is the primary “how-to” section of the eBook. Here's where I walk you through each feature of the camera as you'd use it. I'll explain why you might use it, how to make that feature active, and what your options

³SLR stands for Single Lens Reflex, and I'll explain what that means on page <27>. You'll also see me use DSLR, or Digital Single Lens Reflex, to distinguish the digital bodies from the film bodies.

are. If you're going to print only one section of this eBook and carry it with your camera, this is the section you'll want. Yes, you may find a few things repeated in this section from the first, but in the interest of making for a complete "how-to" section, I've elected to repeat some set-up and other instructions.

- *Things you need to know about video (labeled "Shooting Video with Your D90" and starts on page <669>).* If you wish to take advantage of the video features of the D90, then you need a few additional explanations and how-tos that specifically deal with using the camera as a motion capture device. This is the section I deal with the video-specific information.
- *Things you need to know and do after you've taken your pictures (labeled "After You've Taken Pictures or Video with Your D90" and starts on page <683>).* When you come back from shooting with your camera you still have things you may want to do, like transfer, print, view, organize, or improve your images. In this revision, I've moved the information on software (both Nikon's and third party software) to my new *Introduction to Nikon Software* eBook, which you'll find on the CD I supplied. This helps make this manual a bit more manageable in size, plus allows me to update the software sections independently of the cameras).

That also mimics the order you'll want to follow as you master your new camera: initiation, use, and post production.

As I wrote earlier, this eBook incorporates bits and pieces from earlier eBooks I've written about Nikon equipment. It's not easy keeping up with all the changes Nikon keeps making to its DSLR lineup and software, though, so if you have any of my previous eBooks you'll find that my words and explanations may have changed, even for features that were common across many models. So don't skip over anything—read everything here as it stands, not as you think it might be.

As I receive comments from readers of this eBook, I *update* the original file. Since I generate this eBook directly from my files, this means that I am usually able to keep the text nearly error-free while adding or modifying sections to make a point more clearly. Every now and then I make a *full* pass through the manuscript, augmenting what I've previously written with knowledge I've learned from using the camera, teaching workshops, and from other sources. When I do that, I iterate the "edition number." And when I create a new edition, I offer low-cost updates to people that bought the original eBook from me.

So, if you do find an error or confusing wording, take a look at <http://www.bythom.com/d90guideerrata.htm> to make sure that the problem hasn't already been discovered; drop me an email telling me about it if it hasn't.

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Conventions Used in this eBook

In this eBook I occasionally make comparisons between the D90 and previous Nikon models. In general, whenever this eBook uses the term D1 or D1 series, I'm referring to the entire D1 *family* (i.e. the D1, D1h, and D1x). The same is true of the D2 family (D2h, D2hs, and D2x). Use of an individual model name in the text indicates a model-specific feature or characteristic. In tables, if there are differences between the cameras, I've either added columns for each camera, or separated the information into model-specific tables.

Why am I including some D1 and D2 information in this eBook? Many readers own multiple DSLRs or have experience with previous Nikon models. Moreover, many D90 purchasers followed the earlier camera developments but held off buying one until Nikon came out with a camera that was less expensive. The introduction of the D90 was what they were waiting for, though the resulting camera is a bit different than the earlier models they learned about. Finally, it is just good form to know how your camera compares against other Nikon DSLRs.

When software products are mentioned, including those that Nikon supplies with the camera, I try to identify the version I used for this eBook when I introduce the product, and note any significant differences between versions that I think you should be aware of. If I refer to a software program generically, as in “use the **Unsharp Mask** in Photoshop,” this usually applies to the entire range of Photoshop versions.

Specific instructions for software, as in “select **Remove Redeye** in the **JustDolt** menu,” are for the version current as of the publication of this eBook. Also, you'll note that I use a different font to distinguish menu items or messages that you'll see on the computer or camera screens—this makes it easier for you to differentiate what I'm writing about from what you should be seeing on your equipment.

Instructions that apply to using the camera are marked starting with a 📷. Anywhere you see that symbol, grab your D90 and follow along!

As I have with all my previous books and eBooks, I use my Web site (<http://www.bythom.com/d90guideerrata.htm>) to report any corrections or clarifications of information or instructions (you'll also find some helpful product reviews and general articles). Write me at thom_hogan@msn.com if you have any questions or comments.

Thom Hogan
Emmaus, PA

Introduction

You've purchased a Nikon D90 camera and are looking for help in getting the best possible pictures from it. Or perhaps you're considering purchasing a D90 and want to know how it works and what it is capable of. Welcome. You've come to the right place.

First a little background for the newcomers: I've been using Nikon cameras most of my life and for the last dozen years have spent much of my time creating articles, books, and a Web site explaining the nuances of these cameras to others. Successfully, I think (I hope you'll agree by the time you finish reading this work).

You probably fall into one of three categories:

1. *You've never used an SLR⁴ type of camera before.*
Previously, you probably used either a 35mm or digital point-and-shoot type of camera. Those all-automatic, all-in-one cameras are small and convenient, but tend to be somewhat slower to shoot and limited in control. You probably decided to try a D90 to get away from one of these traits.

Specifically, you're hoping that the autofocus is fast and accurate, that there's no delay between pressing the shutter release and the time the picture is taken, and that you can buy accessories that allow you to take pictures you can't with your compact camera.

I'll cut to the chase: you'll be happy with your D90. But you've got a lot to learn, as SLRs tend to be more

⁴Again, SLR stands for *Single Lens Reflex*. That may not mean a lot to you yet; the key point is that an SLR uses a mirror relay system (the "reflex" portion of the name) to let you see exactly what the lens is zoomed and focused on. Yes, there used to be a TLR (Twin Lens Reflex), which is a system where you look through one lens via a mirror system, and a second lens is used for taking the picture. The old Rolleiflex and Yashicamats are examples of a TLR.

complex and sometimes require more decisions than do the automatic point and shoots.

If you fall in this category, you'll want to read this entire eBook very carefully—there's really no section you can skip over.

2. *You've used a film SLR before, but are just now switching to a digital SLR (DSLR).* You probably picked the D90 because it was modest in price but big in features and quality.

Your film SLR worked just fine, but you're looking for the advantages that digital brings: instant review, no wait for developing and processing, no per-image costs, and convenience for emailing and sharing pictures. You're probably a little worried about image quality—is a digital SLR like the D90 as good as 35mm film?

Again good news awaits you: yes, you'll get all the conveniences you seek and give nothing up in image quality.

If you fall into this category, you'll probably be able to skip over many of the early portions of this book (or read them as a refresher). But make sure that you start reading seriously with the section labeled "Camera Setup" on page <192>.

3. *You've used a digital SLR before, so the D90 is likely a backup or second body for you.* You may have picked the D90 because it looks like it might be a less expensive backup to a D300. And you'd be right—while a few features are missing and it's a little slower, the image quality of the D90 basically equals that of its older and more expensive brother, the D300.

Or perhaps you have a D40, D40x, D50, D70, D70s,

or D80 and picked up a D90 to get better image quality and a few new features (your older Nikon DSLR will become your backup body). Again, you'll find that you've made a good choice. Your only worry is whether you can get up to speed with your D90 as fast as possible.

Your good news is that you've already got a huge head start on the others—you need only to brush up on a few odds and ends.

If you fall into this category, you can probably skim through the “Before You Take Pictures” section or perhaps skip it entirely. You'll want to read and print out the section labeled “Shooting Pictures with the D90” (see page <220>), and depending upon your familiarity with Nikon's software, you may want to also read the *Introduction to Nikon Software eBook* on the CD carefully, as well.

But don't worry, it doesn't matter which of the categories I've just described you fit into, you'll find everything you need to know in this eBook.

Before I get deep into each of the areas just mentioned, let me tackle a few common questions that novice D90 users ask:

1. *What's an SLR?* If you're the first type of user I described earlier—moving up from a point-and-shoot—we need to cover some basics so that you know how an SLR works before we get to the details of how a D90 works. Don't worry, this isn't an engineering textbook—I'll hit just those things you need to know and keep the language in terms everyone can understand. We'll get to the detailed answer of this question in the next section (see “What's an SLR?” on page <27>). If you've used a film or digital SLR before, you can skip that section or read it quickly as a refresher.

2. *How is digital different?* Film was easy: you took your pictures and then handed your film to a lab. The lab performed “magic” and made your pictures into good-looking prints. Digital cameras can make great photos, too, but you’ll want to know how it is unlike film and what you might have to do differently. I cover this in various places in this eBook, but the big differences you need to know about are in the section that begins with “The D90 Sensor” on page <66>. There I’ll step you through everything you need to know about how digital works, which, thankfully, isn’t as much as you probably expect. If you’ve read any of my other books on Nikon DSLRs or have DSLR experience already, you can probably skip that section, too, or at least read it quickly as a refresher. Shooting digital also forces you to pay attention to camera settings, in particular things like white balance and color characteristics. I cover those at the end of the “Metering and Exposure” section that begins on page <232>.
3. *How do you use a D90?* That’s the question that probably drove you to this eBook. The bulk of this eBook is dedicated to answering this question. “Shooting Pictures with the D90” begins on page <220> and steps through every D90 feature telling you how it works and when you might want to use it. As I’ve noted before, this is the section of the eBook you want with you in the field if you’re going to print out any portion of the eBook as reference. “Shooting Movies with Your D90” begins on page <669> and covers the use of the D90 as a video camera. I’ve separated this section out because shooting videos is different and has different considerations to pay attention to.
4. *What do I do with the images I shoot?* In addition to the camera information in this eBook, the last major portion of this eBook (“After You’ve Taken Pictures or

Videos with Your D90” on page <683>) details some of the things you do after you’ve taken pictures. But the primary information about the software that comes with the camera and optional software you might want to consider is now in a second eBook entitled *Introduction to Nikon Software*, which you’ll find on the CD you received.

Finally, I should point out that something as complex as the D90 means that I can’t easily introduce every term and concept you’ll need to understand all at once. I also tend to make the assumption throughout this work that you know some basic photography terminology, such as “aperture” and “exposure.” If for some reason a term or concept confuses you, don’t hesitate to drop me an email asking for more explanation.

At the same time, if you’re completely new to controlling a camera (e.g., you’ve always just used an all-automatic camera), you might want to also pick up a general book on photography. For that, I normally recommend you start with the classic: *The Camera*, by Ansel Adams (updated by Robert Baker)⁵. While Adams didn’t use digital cameras, his explanations of the basic concepts are about as good as they get, and with the update, survive into the modern SLR world.

⁵If you’d like to help pay to maintain the content on my Web site <http://www.bythom.com>, go there and click on the Amazon support link at the bottom of the home page, then buy any of the other books recommended in this eBook from Amazon. A small portion of what you pay Amazon comes to me, and that’s the money I use to purchase Web space, services, and review equipment.

Before You Take Pictures

In this section I'll take the time to explain how an SLR body works, plus we'll look at the controls of the camera, how it's powered, how images are stored, and the important things you'll need to set up before you first use it.

I'll also present a short "what to do before you go out and shoot" section called "Camera Setup."

Overall, this is a section of the eBook that you'll tend to read once for the background and understanding that's necessary to use a sophisticated product like the D90.

What's an SLR?

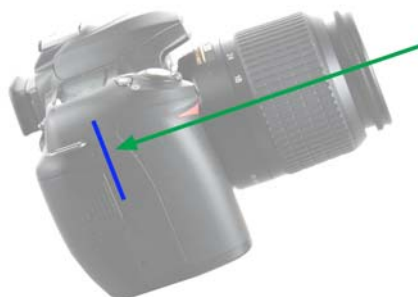
You're probably reading this because you haven't ever used an SLR type of camera before, or else you want a refresher course on the basic aspects of how your new camera works.

Most modern SLRs—including all the Nikon DSLRs—use a traditional mirror and prism system to move light to the places it needs to be for image preview. The mirror moves out of the way for the actual picture taking.

Light comes in through the lens and hits a large mirror that reflects most of the light up into a prism, which in turn reflects that light (and reorients it so that it's right side up) into your eye via the viewfinder eyepiece. When you press the shutter release, the mirror flips up out of the way, a shutter opens to reveal the sensor, and the light then goes directly to the digital sensor (or film in the case of a film SLR).

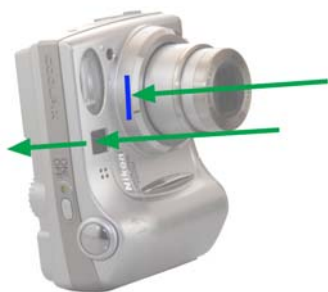


Before the shot, light (green arrows) takes a path through the camera that is reflected off mirrors (red) to get to your eye.



As the picture is taken, the main mirror moves out of the way and the light only goes to the sensor (blue). Thus, during the actual moment the picture is taken, the viewfinder “blacks out” for a moment, as no light gets to the prism.

By way of comparison, film point-and-shoot cameras have a separate viewfinder that you look through that *mimics* the view that the lens sees. Some such cameras have sophisticated viewfinders that zoom and move as you change settings on the lenses, but they're never perfectly aligned to the image. The most common problem is something called parallax, where what you see in the viewfinder is slightly offset from what the camera's lens sees.



In a compact camera, such as this Coolpix, light (the green arrows) goes separately to the sensor (blue line) and to your eye looking through a separate viewfinder (bottom set of green arrows).

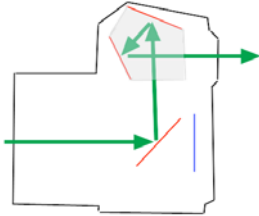
Digital point-and-shoot cameras often use this same technique, though most also show exactly what the digital imaging sensor is seeing by displaying it on an LCD as a “live preview” of the eventual image. A few now only have the LCD preview and skip an optical viewfinder entirely. The only problems with LCD preview are: it slows down the image capture (the camera has to switch from image preview to image capture, which isn’t as simple as it seems); the color LCD is difficult to see in bright light; the user tends to move the camera away from their body in order to see the LCD and thus compromises stability; and the color LCD doesn’t have a great deal of detail in it making it difficult to verify focus and even composition with really wide angle lenses.

So let’s look more closely at the SLR design:

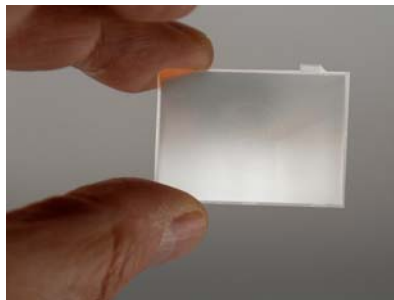
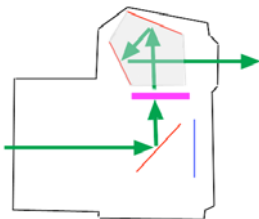
- The mirror and prism make it so that virtually all of the light collected by the lens makes it to your eye.⁶

⁶ Film SLR users may sense slightly less light in some Nikon DSLR viewfinders than they’re used to. The primary culprit is that the actual frame area of the DX-based DSLRs is smaller than film. A smaller frame area means less total light gets through (though the same amount gets through for any given spot; it’s a bit of an optical illusion that it seems dimmer). Think of the lens as part of a water pipe and light as water moving at a constant speed. If you make the pipe smaller, you’ll get less overall water. That’s what’s happening with the light you see in the viewfinder (which, is, after all, moving at a constant speed).

- The prism is necessary in order to flip the perceived image into the proper orientation (lenses reverse up for down and left for right, and we've got a mirror in the path which flips one axis but not the other). The prism has mirrored surfaces (red) to reflect light internally.



- Since the distance that the light travels via the mirror and prism to the eye is greater than the distance to the sensor (or film), we need an intermediary, called a focus screen (purple in illustration, below; shown removed from camera on the right, below). The mirror actually projects the image on the focus screen, which is the same distance from the mirror as the sensor, and the prism mechanism just acts as a viewing device so that you can see the focus screen.



- The focus screen shows the image as the sensor will capture it (well, close—many of the consumer Nikon DSLRs show 90% of the overall image area). You see basically the same thing the lens presents to the sensor when the shutter is open.

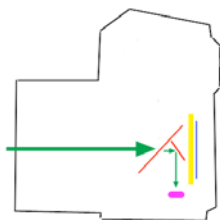
What you see through the viewfinder of your Nikon DSLR, therefore, is a bright, complete rendition of what your image will capture. Because you're looking through the lens, you're seeing a real time presentation—there's no delay due to

electronics, no degradation of the viewing quality due to electronics, and you're seeing the current state of the focus system (don't worry, we'll get to the details of focusing soon enough).

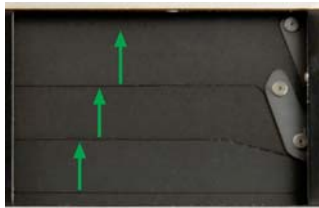
Here's a key difference between your Nikon DSLR and a point-and-shoot digital camera: the point-and-shoot uses the digital imaging sensor to do multiple things: the imaging sensor provides autofocus and metering information to the camera's electronics, collects white balance info, and often even measures flash output. One of the delays on these cameras is that they operate the digital sensor at a specific frame rate while previewing the image and must take some last minute updates after you press the shutter release. As in "the user has pressed the shutter release so I'd better take one last look at whether the focus should be moved, grab one last metering measurement, and then turn off video stream for a moment, let the sensor stabilize, then take a picture." Phew!

All Nikon DSLRs use dedicated autofocus and metering sensors; there's no delay because these dedicated parts work right up to the moment the camera flips the mirror out of the way. Amazingly, you can do a mechanical thing—flip the mirror out of the way and open a shutter—faster than you can do an electronic thing (at least for now with current technology).

We'll get to the autofocus and metering aspects of the SLR later in the book, but first we need to talk about what's behind the main mirror in your Nikon DSLR. It's not as simple as you might think. Behind the mirror you can see is a secondary mirror (small red line in illustration, below). We'll get to what it does in a moment. Behind the secondary mirror is a shutter (yellow bar in front of blue sensor).



The shutter isn't a single "door" that hides the digital sensor on your Nikon DSLR. Instead, it's like a closed window shade, with multiple slats. These slats move out of the way from one direction and close from the same direction. Think of a curtain in a theatre moving up from the floor and eventually closing by rising from the floor.



The secondary mirror probably surprised you. The primary mirror has several "partially silvered" areas. If you look at the main mirror with enough light (you'll need to take off the lens to do so), you may be able to see a rectangular area in the center of the mirror that's "discolored." That's the area that passes a tiny bit of light to the secondary mirror.

So why do we need some light going somewhere other than the viewfinder? As I mentioned earlier, SLR designs have dedicated sensors for many things. In the case of Nikon DSLRs, that light is bouncing off the secondary mirror down into an open area at the bottom of the camera that houses the autofocus sensors. At the bottom of the mirror box looking up is a set of autofocus sensors. If you could squeeze your head into the mirror box chamber and look down from the secondary mirror you'd see them. I'm not (yet) willing to take apart all my Nikon DSLRs to photograph this part, but here's

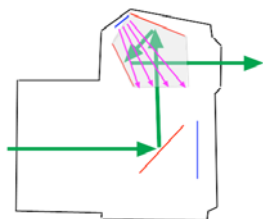
what the part looks like on the D50 and D70s (looking down from the secondary mirror):



Parts on other Nikon bodies are more sophisticated. The D90's part is slightly more complex than this, for example.

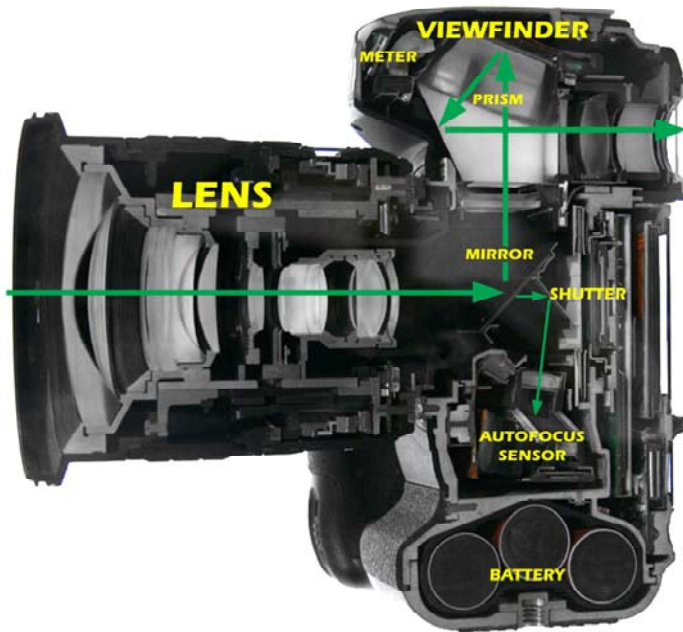
In other words, a small amount of light is split off from the viewfinder so that autofocus sensing areas in the bottom of the mirror box get some light. You may have noticed that Nikon specifies that a lens has to be f/5.6 or faster (larger physical aperture opening) for the autofocus system to work. That's partly because the autofocus system doesn't get all the light coming into the camera, just a small slice of it that manages to get through the partially silvered area of the main mirror.

All Nikon DSLRS have another dedicated sensor besides the autofocus sensor array. In the prism area of the camera resides a 420- or 1005-pixel sensor. This sensor (blue line in prism area in illustration, below) is dedicated to measuring exposure (both normal and flash exposure). It actually looks at the focusing screen at the bottom of the prism to get its slice of light (the purple lines indicate where it is looking).



In case you wonder what that really looks like on your Nikon DSLR, Nikon conveniently has cut one of their more

sophisticated DSLRs in half so that you can see all of these parts in action:

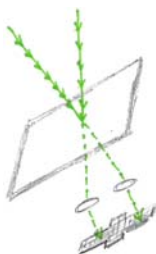


The green path in this case is still the path that light takes. The primary portion goes through the lens to the mirror, bounces up through the focus screen into the prism, where it is redirected to your eye at the back of the viewfinder. The metering sensor looks at the focus screen in this case (on some Nikon DSLRs the metering sensor is in another position in the viewfinder and gets light via yet another split mirror). A small amount of light gets through the partially silvered portion of the main mirror, hits a secondary mirror just in front of the shutter, and is redirected down into the autofocus sensor.

Let's talk for a moment about the "order" in which things are done in an SLR. Remember, with compact digital cameras, they execute a sequence of things using a *single* sensor, which

slows them down. In a DSLR, many things happen simultaneously once you press the shutter release partway down:

- *You observe what the lens sees via the main mirror and prism.* This allows you to compose your picture or follow action.
- *The autofocus sensors get light through the partially silvered portion of the mirror and look for phase detection that indicates that the subject is in focus.* This is even more complex than it sounds, as there are lots of focus options on a Nikon DSLR, but in essence, all autofocus sensors get information that has been split by separator lenses just on top of them (see illustration, below). The sensors provide a stream of information about the separated data (distance between them) to the camera's main computer. The computer calculates whether the optimal "split" has been achieved; if it hasn't, it tells the lens to move its focus point, as necessary (if the lines are too widely spaced, the focus is in back of the best point; too narrow indicates focus in front of the best point; thus the camera knows which way to turn the lens).



Light (green lines) coming down from the secondary mirror reaches a plane that's the same distance from the lens as the sensor (large rectangle in above illustration) but the separator lenses are placed just below this, meaning that the focused light beam is already broadened a bit before it hits the separator lenses (two small ovals in the illustration). These lenses refocus the light to the AF sensor below. The light reaching should be a known distance apart when it reaches the AF sensor. If the distance is shorter than expected, focus is in front of the desired position. If the distance is greater than expected, focus in back of the desired position. In practice, the focus plane, separator lenses, and AF sensing unit are all part of

the same seven sensor AF part I mentioned earlier (in other words, we're looking at what happens in a cross section of the actual AF sensor here).

- *The metering sensor in the prism is capturing exposure info.* The dedicated metering sensor (either 420- or 1005-pixel) is concurrently providing a stream of exposure information to the camera's main computer. In the latest Nikon bodies (D90, D3, D300, and D700), the color information is integrated with the autofocus information from the autofocus sensor, as well. Based upon your camera settings, the exposure information is updated in both the viewfinder and the top LCD of the camera.

At this point the camera's computer is looking at all your camera settings plus the information streams coming to it from the various sensors and is making decisions about how to expose and focus the camera. So far, almost everything is electronic (the lens movement for focusing is mechanical). But the moment you press the shutter release all the way down, a series of additional actions occur, some of which are mechanical:

- *The flash may fire a preflash.* If the flash is active (up and ready for use) and set for automatic (TTL⁷) use, a very brief series of preflash pulses are fired from it and reflections off the subject from those flashes are measured with the CCD in the viewfinder. When I say brief, I mean brief. The preflash comes so close to the actual flash during the main image exposure that you can't usually see it. The preflash has to occur before the mirror moves because the preflash is measured by the sensor in the viewfinder.
- *The mirror flips out of the way.* This is the big physical action the camera makes and accounts for much of the sound you hear from a DSLR. When the mirror is out of the light path, you no longer see what the lens sees (the

⁷ *Through The Lens.* This indicates that flash output is measured through the lens instead of by a dedicated flash sensor on the outside of the camera or flash.

viewfinder “blacks out” momentarily) and the autofocus sensors no longer get light. No need to worry though, the camera’s computer had a stream of data from the autofocus sensors and can “guess” what the next data point might be—called predictive autofocus—so even if your subject is moving, the camera usually still focuses correctly on it⁸.

- *The aperture is set.* Inside the camera there’s an arm that physically moves to set the lens aperture (the opening in the lens that the light goes through) to the proper value (as set by you and/or the exposure system).
- *The shutter opens.* The curtain that sits in front of the main imaging sensor opens. The main imaging sensor itself is turned on and begins collecting light.
- *The flash fires.* If flash is active, it fires once the shutter curtain is completely open. The camera detects the point where the curtain is open and sends an electronic signal to the flash to start, and later, to stop (assumes TTL BL or Standard TTL flash, the usual methods we use with flash; Manual and Automatic flash modes only send a start signal to the flash as the flash itself figures out when to stop, and TTL FP fires the flash continuously in a low pulsing action from start of shutter opening to the end).
- *The shutter closes.* The curtain that sits in front of the main imaging sensor closes. The main imaging sensor itself is turned off and the data it collected is moved to the other electronics within the camera, where it is measured, manipulated, and saved.
- *The aperture is reset.* The activation arm returns to its resting position and the physical aperture in the lens is

⁸ A number of the footnotes in this first part of the eBook, such as this one, are really just reminders that things aren’t always as simple as they first seem. Yes, there’s a caveat to what was written above: it is possible to set your camera so that it focuses once on a target and doesn’t refocus if the subject moves. We’ll get to the nuances of autofocus settings in the section on that later in the eBook, but for now just believe what I wrote.

reset to the largest opening (so that the most light gets through to the viewfinder and sensing systems).

- *The mirror returns to its normal viewing position.* The mirror returns to its main viewing position (and the secondary mirror unfolds behind it so that the AF sensors can again get information).

Here's the amazing thing: all that mechanical movement (mirror, shutter, and aperture arm) happens so fast that it can be done several times a second. And even when a DSLR is operating at full speed (which can be anywhere from 3 to 11 frames per second on current models), the mirror is down in its viewing position more than half the time (it has to be for the metering and AF systems to work between shots).

I'll have much more to say about each and every one of the subsystems within your DSLR in the main eBook, but suffice it to say that the engineering that goes into designing cameras like the Nikon DSLRs is pretty sophisticated.

Photographic Terms That Are Important to Know

I've already introduced some terminology that's specific to photography, and in some cases specific to SLR cameras. This isn't a book called *Introduction to Photography*, so I don't want to get bogged down in basic photographic concepts. On the other hand, some of you are coming from cameras that automatically controlled some of these things and thus you may not have encountered the terminology. So before we go on, let's get some basic definitions out of the way for those of you new to all these terms.

The recording of image data—whether it be on film or on a digital sensor—is dependent upon a few key variables:

- How sensitive the recording media is to light. This is known as the *ISO sensitivity* of the digital sensor for your Nikon DSLR.
- How big the the opening in the lens is. This is the *aperture*.

- How long the digital sensor is left exposed to the light. This is the *shutter speed*.

Lets look at each a bit more carefully.

ISO. Sometimes referred to as the “sensitivity rating.” Higher ISO numbers mean less light is needed to record an image. If we only get a little bit of light data into our digital collection buckets (see the description of *Exposure*, below), we may need to amplify that data so that it looks more like the image we want, so we set a higher ISO value. ISO values in film refer to more sensitive light receptors, but ISO values in digital always refer to a process of amplifying the data we record.

Aperture. The physical opening in the lens that light goes through. This opening can be changed in size from very small in physical size to the full size of the glass used in the lens. Aperture blades (usually between five and nine blades that form a near circle) are used to make this adjustment. We refer to the aperture opening as an *f/stop*, as in *f/2.8*. Lower *numbers* make for *larger* openings. Thus, *f/2.8* is a large physical opening letting in a lot of light, *f/22* is a small physical opening letting in a little light. Apertures are one of the ways we use to control the amount of light that gets to the sensor, and thus the “*exposure*” (see below). Common apertures you’ll encounter go in the following sequence (all one stop apart): *f/2.8*, *f/4*, *f/5.6*, *f/8*, *f/11*, *f/16*, *f/22*. Most Nikon DSLRs allow you to set these values, plus values that are 1/3 or 1/2 stop increments between them. The observant amongst you will notice those full-stop values I just listed are all 1.4x apart; if you memorize any photographically-related number, that’s the one you want to remember, as it can be

used for a lot of things⁹.



Same lens, two different aperture settings (f/5.6 on left, f/16 on right; aperture opening shown here highlighted in red). This particular lens (a Tamron 90mm Macro) uses an opening defined by nine “blades” to approximate a circle. Note that you can see a bit of lopsidedness in the opening (especially true of the smaller aperture, at right). Badly mishapen openings or ones made with fewer blades can produce objectionable artifacts in the out-of-focus areas of your image. The Japanese refer to this as the “bokeh” of the lens.

Shutter Speed. This term refers to the amount of time the shutter is open and letting light hit the sensor. Shutter speeds go in increments a little more predictable than apertures, as each doubling of the time is another stop (doubling) of exposure. The commonly used shutter speeds go: 1 second, 1/2, 1/4, 1/8, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000, 1/2000, 1/4000, 1/8000. Most Nikon DSLRs allow you to set these values, plus values that are either 1/3 or 1/2 stop in between.

We need to put these three things together to get the proper recording of information, and we call that the *exposure*.

⁹ E.g., if you know the Guide Number of your flash for one ISO value, 1.4x gets you the Guide Number at double the ISO value; or: the light from your flash falls off one full stop for each 1.4x the distance it has to travel.

Exposure. Think of the digital sensor as a series of buckets. Into each bucket (technically a photosite—we'll talk about those in the main PDF file) light photons fall. But buckets have a fixed capacity and so too does our digital sensor. If we were to let too many light photons into the bucket, the bucket would overflow and we wouldn't be able to count the results accurately. Likewise, if few light photons got into a bucket because we restrict their flow too much (too small an aperture or too short a shutter speed), we might not be able to count that level accurately, either, as we couldn't differentiate the number of light photons getting in and being converted to electrons with the stray electrons already there. Thus, we need a way to control how much light gets to the bucket. We mainly do that by changing the aperture (size of the opening letting light through) and the amount of time we let light in (shutter speed). When I talk about setting exposure, I refer mainly to setting camera controls for aperture and shutter speed to control how much light gets to our digital buckets. We're going to try to optimize that amount. Too much light and we have spillage we can't count. Too little and our counting mechanism can't distinguish light data from the residual in the bucket.

Of course, we need something to measure whether we're letting in enough light or not, and that is a process we call *metering*.

Meter. The mechanism that measures the amount of light in a scene. We also talk about "metering" the scene, which means we're using the facilities of the camera to measure the amount of light hitting the scene. The process of metering establishes an exposure, and that exposure is a specific combination of aperture, shutter speed, and ISO sensitivity. (Are you starting to see that many of these terms are closely related?) Nikon DSLRs have very sophisticated meters with quite a few options. I deal with all those options in the main PDF file.

Finally, you'll probably hear a term used in exposure called *stops*.

Stops. When photographers talk about “stops of light” (as in “I needed another stop to get the exposure right”), they’re referring to a doubling or halving of light. Each additional stop of light—usually referred to with plus signs, as in +1 stop—means that they doubled the amount of light. Each removal of a stop of light—usually referred to with minus signs, as in -1 stop—means that they halved the amount of light. Stops and the term *EV*¹⁰ are used interchangeably by most SLR users; “increase the exposure by 1 stop” and “use +1EV exposure compensation” mean the same thing.

Wrapping Up

See, that wasn’t so bad, was it?

The primary thing you needed to know is that you’ve got a sophisticated product in your hands that’s different and more complex than the simple compact cameras you may be used to. Instead of a single monolithic part doing all the work, your DSLR has many parts doing individual tasks, which speeds up the camera and makes it more accurate.

The other aspect that should be getting clear is that *you* now have control of this sophisticated camera. While you can turn on all the automated features and shoot like you did with a compact camera, one of the benefits of moving to a DSLR is that you get to decide how the camera treats various different aspects (exposure, white balance, focus, and so on). Because all these parts are independent on a DSLR, they have precise control ability and operate faster than they do on a compact camera. But that also means there will be a lot of subsystems you’ll need to master to get full control over your DSLR. That’s what the main PDF file will help you with.

The D90’s History

My most accounts, the D90 was late. Nikon’s usual consumer DSLR iteration time is 18 months, but the D90 didn’t appear

¹⁰ Exposure Value.

for two years after the D80 it replaces. I suspect that most of this delay was due to the addition of video, as the other changes from the D80 are modest and incremental.

The Nikon D90 was introduced on August 27th, 2008 and shipped to customers in most parts of the world in mid-September.

Overall, the D90 derives very closely from the D80. Indeed, from the outside the only truly obvious difference is the larger 3" LCD on the back (the D80 had a 2.5" one). A closer look reveals a few minor differences: different Scene Exposure mode choices on the Mode dial, rounder buttons a slightly different switch designs, a different Autofocus Direction pad, the **OK** button has moved to the middle of the Direction pad and two new buttons appear above and below the pad, the rubber flaps on the left side of the camera (from the rear) have new markings and under the top one a new connector (HDMI). That's pretty much it.

From the outside, then, this is one of Nikon's least changed designs. If you've used a D80 the D90 will almost certainly feel the same to you, and, other than the moving of the **OK** button, everything is where you expect it to be.

That should tell you something about the D90. Nikon has spent most of its time fiddling with what's inside, not on making cosmetic changes to the exterior. That's exactly the way we want an update to a standard model to be handled, I think.

So what's different on the inside? First, there's a new 12mp imaging sensor (see "The D90 Sensor" on page <66>). But a lot of other things have been tweaked, as well. Nikon has changed the menu system a fair amount (Custom Settings are grouped, RECENT SETTINGS and MYMENU have been added, **Optimize image** is now replaced by the Picture Control system, plus we have new menu items for all the new features). The metering system now is patterned after the

Scene Recognition System Nikon first introduced with the D3 and D300 (the D90 and D700 now share the same basic technology). But the big new goodies Nikon packed into the D90 are Live View and video capability. I'll have a lot more to say about them when we get to discussing their features later in the eBook, but these two items alone extend the capabilities of the D90 significantly beyond that of the D80.

Along with the D90, a new lens was announced, the 18-105mm f/3.5-5.6G ED AF-S VR DX. This new lens is intended as an all-around travel lens. Nikon has packaged the D90 as either a body only or as a body with this new lens (thus, we call this the "kit lens" as it comes in a basic kit Nikon makes available). The lens is targeted more towards a true amateur user: simple, light, and good quality at a modest price.



The D90 with the 18-105mm lens mounted.

Virtually every autofocus lens Nikon has made will work on the D90, as will most manual focus lenses (though metering will be disabled). No doubt Nikon will announce additional lenses that would be of interest to D90 users in the coming years. That's one of the joys of using an SLR-type of camera: different lenses give your camera different imaging capabilities. Nikon has made everything from fisheye (takes in

180 degrees) to exotic telephoto, from macro (close up) to tilt and shift lenses (to control perspective). No compact point-and-shoot camera has the lens versatility that SLR cameras do.

An Aside about Lenses

You're probably wondering about all those cryptic initials in Nikon's lens designations (e.g. "ED AF-S VR DX"). Nikon is pretty good at coming up with acronyms for just about everything associated with a lens design. You'll find a full description of the entire range of Nikon abbreviations on my Web site at <http://www.bythom.com/lensacronyms.htm>. But let's get rid of the primary lens designations in the lenses I just mentioned in the previous section, as they are ones you'll encounter often.

First up, we have the focal length designation (e.g. 18-105mm). This tells us a bit about how wide an area the camera can frame (see "Lens Angle of View" on page <363>). Roughly speaking, anything less than 24mm is considered a wide angle lens on the D90, anything over 55mm would be considered telephoto. Wide angle lenses are used to frame a large area all at once, telephoto lenses are used to isolate a single item and bring it closer.



On the left, a wide angle view of a Patagonian glacier (24mm lens used); on the right, a telephoto view of one small section of the scene near the lower right corner of the wide view (120mm lens)

used). Both photos taken from the same position; only the focal length used was changed.

Second we have a statement of maximum aperture (f/3.5-5.6). A lens stated this way has a *variable* maximum aperture, meaning that it has one aperture at one focal length (e.g. f/3.5 at 18mm) and a different one at another focal length (e.g. f/5.6 at 135mm). Good lenses for low light have maximum apertures of f/2.8 or lower (e.g. f/2 or f/1.4)¹¹. The camera starts focusing more slowly when the maximum aperture of a lens gets near f/5.6¹² (and stops completely if you use a lens with a maximum aperture of f/8 because not enough light is getting through the main mirror to let the AF sensors do their job).

The view through the camera (remember we're looking through the lens) also darkens as maximum apertures get higher in number. The new lens with the D90 (the 18-105mm) ranges from the middle to the low end of brightness transfer. An f/2.8 lens would provide a brighter image in the viewfinder, as all autofocus lenses are always viewed at their maximum aperture, and f/2.8 would also allow more light to get to the autofocus sensors than f/3.5 or f/5.6 (the range of the maximum aperture of the 18-105mm).

Which brings us to those abbreviations:

- **G**—The letter following the maximum aperture value tells us that this is a lens that provides distance information to the camera, but has no aperture ring (a lens with an aperture ring would have a **D** in this location). **D** and **G**

¹¹A lot of confusing things come up in photography. One of them is that lens apertures get physically bigger (larger in diameter) as the numbers get smaller. Thus, a 50mm f/1.8 lens would have a larger maximum diameter lens opening than a 50mm f/2.8 lens. Almost all lenses allow us to choose smaller-than-maximum aperture openings, so that f/1.8 lens would allow f/1.8, f/2, f/2.8, f/4, f/5.6, f/8, f/11, and so on, while the f/2.8 lens would allow f/2.8, f/4, f/5.6, f/8, f/11, and so on.

¹²Thus my comment about the lens being “more amateur” in orientation than the camera. The D90 has a sophisticated, fast, and accurate autofocus system, but with the 18-105mm lens mounted on it and set to 105mm, the camera's autofocus system isn't nearly as responsive.

type lenses are the ones that enable the most features on the D90¹³.

- *ED*—Refers to a type of low dispersion glass Nikon uses in many lenses. This special lens material has the primary property of focusing different colors at the same exact spot (regular glass tends to make different colors focus at slightly different spots, which can create a slight prismatic effect at hard edges in subjects). All other things being equal, an ED lens produces better quality images than a non-ED lens.
- *AF-S*—Lenses marked as AF-S have a focusing motor built into them instead of having to have their lens elements moved by a driveshaft via a motor in the camera. Such lenses focus faster and more quietly than lenses that don't have a focus motor built in.
- *DX*—Any lens marked DX is intended only for Nikon digital cameras. It has an imaging circle that's only big enough for the smaller digital sensors (35mm film cameras require lenses with larger imaging circles, see "Lens Differences When Used for 35mm/FX versus DX" on page <362> for more).
- *VR*—This type of lens compensates for vibration and motion, allowing you to handhold the camera and get good images at slower shutter speeds than you otherwise would. A 105mm lens handheld on a D90 should normally be used at a shutter speed of 1/150 or faster, but since the lens has VR, you may get acceptable images as slow as 1/30 second *as long as there is no subject motion*.

The new lenses that appeared with the D90 are rather well specified compared to the low-cost lenses that used to appear with film cameras. The new lenses have ED glass in them and an AF-S focus motor. More important, the telephoto zoom has VR. As you've just learned, these are all good things.

¹³ Further compounding the confusion: third-party makers, such as Sigma and Tamron don't use D and G specifications in their lens naming. The lens databases on my site try to point out which third-party lenses are D-compatible. In general, all recent lenses are.

Back to the D90 Body

The D90 steals the best features from previous Nikon digital bodies, builds on the basic components of the D80:

- From the D3, D300, and D700, the D90 gets similar scene-aware matrix metering capabilities, the new white balance capabilities, the Picture Control settings system, **Active D-Lighting**, Live View, the 3" color LCD, plus the RECENT SETTINGS and MYMENU menus. The Custom Settings menu is also now "grouped" as it is on the more expensive Nikon DSLRs.
- From the D300 the D90 gets the same basic imaging sensor (but without 14-bit capabilities), plus the dust shake cleaning mechanism.
- From the D700 the D90 gets the new **INFO** button shortcuts and Shooting Information Display.
- From the D80 the D90 gets the body, controls, and the D200-style viewfinder, though a few things have been improved (such as shutter lag and frame rate).

There isn't much unique to the D90, as it cleverly combines things that were already in production with from the D80 through the D700.

However, there are a couple of subtle, but important differences that take the D90 beyond the realm of still photos into the world of multimedia productions:

- The D90 can record video. Specifically, it records several motion JPEG formats, ranging from 216x320 to 720P HD video (1280x720). Besides the video component, the D90 has a microphone on its front that records audio along with that motion.
- Slide shows done from the camera now include an automatic **Pictmotion** choice that's a little more sophisticated and subtle than the D80's version.

If this all sounds like it might be a technological powerhouse in a small package, you're right, it is. And you'll note that

Nikon is pretty good about standardizing on technology across their lineup. While the D90 isn't as capable as a D3, it's a lot closer in ability and function than most people at first guess.

The initial US\$999 street price (body only) will surely attract a new generation of photographers shifting from 35mm film to digital as well as existing DSLR owners wishing to upgrade from 6mp cameras (e.g. D40, D50, D70 series, and D100 users). While I saw a large influx of 35mm SLR users arrive when the D100 first shipped, the D70 turned that initial rush into a stampede, and the D90 is probably going to catch the remaining holdouts.

But What about Film?

Some of you reading this may still be pondering whether or not to make the big switch from 35mm to digital. The thing that usually holds serious users back is their fear that there isn't enough resolution in digital cameras. The argument that 35mm film provides more resolution than the D90 series, while potentially true, is a bit misleading.

Technically, there are still plenty of reasons to use film. The largest file a D90 generates contains about 12 megapixels. While digital scans from 35mm film can produce far larger files, they don't necessarily resolve more detail. For example, Nikon's own midrange desktop scanner, the Coolscan 5000, generates files from 35mm film slides with a far higher pixel count and color depth than a D90 shot, but if you were to look at the finest detail rendered by each, you might be surprised to find that the D90 resolves most of that detail slightly better, and without revealing grain patterns.

In practice, I don't see major differences of resolution between film and the D90 showing up in prints, especially at the sizes most people print at. Most of the amateur world wouldn't be able to tell the difference between well produced prints from film or a D90. Even pros might have difficulty at that.

Still, almost everyone who ponders purchasing a D90 asks the same question: “is the resolution as good as 35mm film?” Some ask this question in a slightly different way (e.g., “can I get professional results with a D90?”), but the issue is essentially the same: just how good are pictures you take with a D90 compared to those with a 35mm film camera?

As I previously noted, on a pure pixel level 35mm film can still win. Let’s look at the numbers more closely. The D90 generates a maximum of 4288 x 2848 pixel images with 12 bits of data per color channel. The Nikon Coolscan 5000, generates 5782 x 3762 pixel images with 16 bits of color data per channel from a full 35mm film frame (expensive drum scanners generate even larger files). Thus, one would be tempted to say that the D90 is, at best, about *one-half* as good as 35mm film on a middle-of-the-line desktop scanner (12 megapixels versus 21 megapixels, with only three-quarters the color information at any point). But that wouldn’t be completely accurate¹⁴.

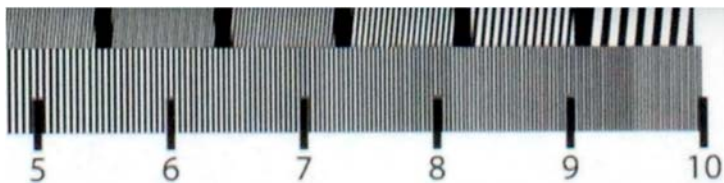
Let’s try another way of looking at the issue. Most pros tend to believe that the very best film can be scanned at up to about 4000 dpi. Anything less than that (say 3000 dpi) leaves a small bit of detail behind; anything above that (e.g. 5000 dpi) doesn’t resolve any additional detail. The long axis of the D90’s sensing area is just a tad shy of an inch and it resolves 4288 points in that distance. In other words, the D90 is working at somewhere around 4000 dpi at the sensor, or about the same value you could get from film in that same area scanned on the very best equipment available.

True, the 35mm frame has another half inch of width over the digital sensor, but the cleanliness of the digital detail versus the grain in the film detail makes things about a draw, as far

¹⁴ There’s also a school of thought—which I subscribe to—that believes that lack of “noise” in an image is more important than additional resolution. Our eyes and brains are very sensitive to “detail,” but false detail (noise) can be very distracting. To demonstrate this in action, one only has to compare an enlargement from a scan of a grainy film to one from a low-noise digital camera.

as I'm concerned. I've heard people describe the D90's useful resolution as anywhere from about 100% to 125% of film, perceptually, and I'd tend to agree it's in that range.

Unfortunately, it's not quite so simple to just state a resolution "number" like I just did in the last paragraph. Digital cameras do well up to a point, and then they "break down" in terms of resolving objects. If you photograph a black and white test chart (see example, below), you'll find that the digital camera simply does far better than the film camera up to the point where digital sampling artifacts get in the way. In other words, there's a difference between what happens when detail goes beyond the resolving power of an analog device (film) and a digital one (a DSLR such as the D90).



On such test charts, the digital camera generally has higher contrast and clarity up to the point where the pattern becomes close to or slightly less than the sampling frequency. Note how the big, diagonal lines above the "10" in the above example are resolved well but as we get to smaller and smaller versions (to the left) the lines start getting "beat frequencies," or false line reflections (very obvious in the diagonals above the "5" and "6"). (See also the example shown in "Sharpening," on page <396>).

The anti-aliasing and Bayer filters digital cameras need (see "The D90 Sensor" on page <66>), unfortunately, complicate calculating exactly where the real resolution versus false resolution changeover occurs. As you can see, once the samples are too small, it might look like detail is being

recorded, but this is false detail—mostly artifacts¹⁵ that mimic detail. Film, being purely analog in nature, has no such problems. At some point grain effects become visible and compete with detail, but essentially film doesn't have the same kind of "break point" as does digital. Of course, if you scan the film digitally, all bets are off!

At the other end, we have print technology to contend with. Most digital color print technologies max out at slightly more than 300 dpi (dots per inch). Inkjet printers often only need about 240 dpi; even the top print technologies generally don't go beyond 360 dpi). At 300 dpi, a D90 file generates a print size approximately 9.5 x 14.3" (>ISO A4). The re-sampling techniques used in Photoshop (or used with a program such as Genuine Fractals) can easily generate images twice the original dimensions with invisible artifacts (essentially unnoticeable at viewing distances), so 17 x 28" prints are easily obtainable using D90. That, by the way, is larger than the consumer Epson printers (1800, 2200, 2400, 2880) can produce (they max out at 13 x 19").

Note: Those of you who own an Epson or other inkjet printer probably read that last paragraph and said, "but wait, my inkjet says it prints at 1440 (or 2880) dpi." A close reading of the Epson literature, however, shows that their printers don't necessarily place that many dots every inch, but instead use a spray adjustment technique to simulate that resolution (the size of the dot is varied). When moving the paper the Epson technologies max out at increments of 1/720 of an inch. The practical physical resolution you need to give the Epson inkjets is about 288 dpi; beyond that and the actual gains are subtle and often not at all visible (the most you could give the printer and see any difference at all under magnification would be 360 dpi). Other maker's

¹⁵ *Artifact*, used in this context, means an unwanted visual side effect. Digital imaging is full of artifact-producing technologies—the analog-to-digital conversion, sharpening, noise, and JPEG compression, for example—but for the most part these artifacts are extremely small and subtle and don't impact image quality in ways that most people can see. Certainly you can't see these artifacts by casual, arm's length observation.

printers are similar. While it's a bit out of the scope of this book, there is a reason why printers use higher dpi settings during printing. Note that you can present the printer with 288 dpi and still have it print at 1440 dpi—the printer driver does a very good job of creating the additional information, and with high quality papers you can usually see a small difference if you look closely. We'll talk more about printing in the last section of this book.

So, the question really should be addressed in a different way: how do you intend to use your images? If the answer is that you're going to print them on an inkjet printer, virtually any difference you see between a D90-generated image and a scanned 35mm film image is going to be subjective, not objective. Most photographers I know say the D90 image is actually better, as the sampling artifacts of the scanner's CCD are less objectionable than those from desktop scanners. The D90 image also tends to have less noise¹⁶ in the Red and Blue channels than most low-cost desktop scanners and no grain, especially if you're comparing ISO 800 from a D90 with ISO 800 film from a film camera.

Nikon's DSLR models have changed the minds of quite a few Nikon mount professionals. Wedding photographers have been especially drawn to digital cameras because of the quick turnaround and ease of touchup they allow. Photojournalists have virtually all switched to digital, again because of the fast turnaround for images (and the ability to send them in by modem from the field) coupled with no incremental film expense. Many wildlife photographers have switched to digital because it makes their big lenses work as if they were even bigger (the 10-pound 400mm f/2.8 functions more like a 600mm f/2.8; where else can you find such glass?).

In short, if you want the very best available resolution, consider going to a medium format camera (and paying the price of doing so). As far as 35mm film versus digital goes, the

¹⁶ I'll detail what noise is and how it gets generated in the section entitled "Noise" on page <88>. Until then, think of noise as inaccurate detail.

race favors digital for moderate print sizes, due to the lack of film processing and scanning costs. And yes, I've put my pocket book where my mouth is: with the introduction of the Nikon D1x in mid-2001 I stopped using most of my film-based cameras and now shoot nearly all digital. I normally use a D3 or D700 in my shooting, but when I need to go light I use a D60 or D90.

And What about Video?

If the D90 holds up well against film, the next question probably is "how does it hold up against video cameras?" In a word: well.

The D90 actually has a much bigger sensor than virtually all affordable (read: non-pro) video cameras. This has implications for the "look" you can get in videos. The D90, for example, produces a much more Hollywood-like look in its videos because the depth of field is not overemphasized as it is in most consumer camcorders. Curiously, the low light abilities of the D90 just about match that of consumer camcorders that shoot 720p.

The 720p size is decidedly in the HD (high definition) realm. Normal television (NTSC video) runs at about 480 useful lines of resolution, but because it only shows half those in any given "frame" (a technique called "interlaced"), the temporal resolution is more like 240 lines. Compare that against the D90's 720: three times the vertical resolution. Many people feel temporal resolution is more important than spatial resolution.

True, the D90 doesn't support 1080i or 1080p, the other common HD formats. But 720p is generally preferred over 1080i by most people (720 lines of constant resolution versus 540 lines that interlace to form 1080). But the D90 has another trick up its sleeve: it's not using the more onerous forms of MPEG compression that most video formats (and distribution systems) use. Each frame in a D90 video is a full frame (in JPEG format). Frames in more compressed video

streams are usually what is called “delta” information—information that changed from the root frame at the start of the scene. Thus, the D90 has far fewer visible compression artifacts.

The downside is that JPEG frames strung together in an **.AVI** file the way Nikon has done it mean that video files are extremely large. By extremely large I mean that each minute of 720p video will consume about 100MB of storage. Put another way, a 2GB card will hold about 20 minutes of video.

Another downside is that autofocus isn’t supported by the video capabilities of the camera. I’ll have more to say about this in the section on video (see “Shooting Video on Your D90” on page <669>).

Overall, the video side is a good news, bad news situation. The D90 performs like a decent HD camcorder, with the benefit of being to produce better subject isolation than consumer camcorders. It’s not the be-all, end-all video camera that some first made it out to be, but considering that the still camera portion is better than the D80 at the same price point *and* you now get a competent video camera, as well, there’s little to complain about.

Debunking Some Myths

If you haven’t already purchased and started using a D90, you’ve probably been perplexed over some of the contentious and sharply worded posts on some Internet forums concerning several D90 traits, or the rumors that seem to float through some photo shops. Indeed, you may have purchased this book in an attempt to determine which claims are true and which aren’t. Here’s my quick take (some of these things are revisited in detail later in the book):

- *The autofocus sensor wasn’t changed.* True. The D90 uses the same CAM1000 focus sensor that the D80 did. This is an 11-sensor system that is mostly concentrated in the center of the frame. The good news is that the D90 has

moved to a use of the autofocus sensor that is patterned after what Nikon used with the D3 and D300: we've now got a better Auto Area AF than we had in the D80.

What hasn't changed is the focus speed or the breadth of the focus sensors. For off center subjects the D90 is not optimal in either respect. However, its focusing capabilities fall exactly between that of the more inexpensive and expensive cameras in Nikon's line. I'd judge that they picked the focusing capabilities correctly for the target audience: good, not great.

Bottom line: the D90 has consumer-level autofocus, just as you'd expect.

- *The video has problems.* This is usually a reference to something called a "rolling shutter." All consumer camcorders have one, as does the D90. I'll deal with it more in the video section, but the short answer is "yes, video can have artifacts just like stills can." In particular, a rolling shutter tends to cause jello-like effects or erratic motion.

Bottom line: As with all consumer video equipment, you have to avoid certain camera and subject motions to avoid the video artifacts.

- *Video isn't fully fleshed out.* The five minute recording limit and lack of autofocus is usually referenced in this argument. The time limit appears to be Nikon's way around certain tariffs in Europe, but frankly, unrelentingly long shots don't make for compelling video, so I don't see this as an issue. The lack of autofocus during video will force you back to the old days of manual focus, though.

Bottom line: the five-minute limit really shouldn't limit you, though the lack of autofocus will impact your shooting methods.

- *It's not full frame.* The argument that a sensor has to be 24mm x 36mm (the same size as film) just doesn't play for me. Ostensibly, there are two reasons that proponents

give: (1) bigger sensors mean bigger photosites which means less noise; and (2) full frame means that focal lengths work like you expect them to. I suppose you could add “more resolution” to the reasons, but I’ve already noted that the D90 easily holds up against the resolution of film. Meanwhile, the D90’s noise is well controlled, so the notion that the photosites have to be larger also doesn’t seem to have much traction.

As for focal lengths working one way, yes, if you’re moving back and forth between a 35mm body and a D90, that could be problematic. But who does that? Nikon’s provided us with plenty of wide angle options (with more coming), so it’s not as if there’s much we’d want to do focal-length wise that we can’t. Any format/focal length relationship has been arbitrary. The D90 is no different. Better still: the D90 is using only a portion of the imaging circle of most Nikkor lenses, so the edge problems—softness, vignetting, chromatic aberration—that some have seen with the Nikon D700 simply aren’t there on a D90.

Bottom line: get used to the change and re-align your lens arsenal with a few DX lenses.

- *The D90 only has a flash sync speed of 1/200.* This is, of course, true. The protests come because the D50 and D70 series had flash sync speeds of 1/500, so many think this is a major step backwards. In reality, the exposure at which you can no longer fully sync the flash is only a third of a stop less on a D90 than the D50 (1/200 at ISO 100 is the same as 1/400 at ISO 200). Moreover, the D90 supports FP flash with the SB-600, SB-800, and SB-900 (FP is a lower power TTL ability available at any shutter speed).

Bottom line: Yes, there are some situations where you’d still like the 1/500 limit, but overall I don’t find the lower sync speed to be nearly as limiting as some suggest.

- *The D90 uses Secure Digital cards.* This too, is true. The rationale behind complaining about this feature is that the

D90 uses a different kind of card than the D300, which means that it's a less-than-perfect backup camera for D300 users. Those choosing to upgrade their D70 series body to a D90 also complain, as the cards they were using won't work in the D90.

Bottom line: Given the ever dropping price of storage cards—I was able to find a 4GB card for US\$14.50 on the day the D90 was announced—I just don't see this being an economic issue of any note.

If you were to believe the posts in some Internet forums, the D90 is a terrible camera with a defective design and not worth the money. I completely disagree. If I were told I could only use a D90 for the next two years, it wouldn't upset me greatly. Sure I'd miss some of the speed of my D3, but handled properly, the D90 can produce quite stunning images. Moreover, the D90 comes mighty close to what the D3 can do for well under one-third the price.

Funny thing is, every DSLR camera that gets introduced these days seems to get its share of criticism on the Internet. Indeed, a word has popped up to describe some of these hyper-critical folk: *measurebators*¹⁷.

That's why an eBook like this one is so important: I'll deal with the abilities of a D90 in a practical and no nonsense manner, hopefully explaining along the way why "digital" does not equate to "perfect" and how you can use the D90 to consistently produce high quality images regardless of any of its minor imperfections. No such thing as a perfect DSLR exists—but you can perfect the way you use your DSLR.

The bottom line is that the D90 is a very capable camera at a modest price that, with the right settings, produces state-of-

¹⁷Definition: folk who get intense self-pleasure from repeatedly measuring camera abilities in minute detail rather than from the pictures they take.

the-art digital images. My goal in this eBook is to help you do just that.

D90 Basics

In this section we'll look at the controls of the camera, how it is powered, how images are stored, and the important things you'll need to set up before you first use it.

D90 Design

The D90 is a variant on an existing Nikon body design. Nikon has mostly taken parts from the D80 bin, added a new sensor, then tweaked a lot of the camera's internals to give it new capabilities.

The basic D90 body design is directly taken from the D80. The size and control placements are almost exactly the same, though there are added controls (Live View and **INFO** buttons) and the **OK** button moved. The use of Secure Digital cards, the IR receiver, and the access doors and flaps are taken straight from the D90. The 420-pixel sensor for metering is also a part that was used in the D80, though it has been updated. The larger, better, color LCD is borrowed from D3, D300, and D700.

Internally, the D80's old electronics are replaced by electronics that mostly come from the D300 design. The imaging sensor is a twin of the D300's, and the D90 gets a version of the D300's sensor cleaning system as well. The use of the EXPEED imaging processor provides the same Picture Control capabilities and excellent JPEG capabilities of the higher end cameras. Live View is also part of this package, allowing you to frame shots using the imaging sensor and color LCD instead of the optical viewfinder. The menu system has a more D300-like look to it, and includes capabilities that weren't on the D80 (**GPS** and **Active D-Lighting** are the two primary additions).



The D80 (left) and D90 (right) are essentially twins from the front.

The D90 uses the same mount for interchangeable lenses that Nikon has used since the first F-series camera, introduced back in 1959. While Nikon has made subtle improvements to the mount to support electronic exposure calculations, autofocus, and vibration reduction, the physical attributes have remained virtually unchanged. This allows D90 owners to use virtually any manual focus or autofocus lens Nikon has made (for a list of the very few that can't be used, see "Lens Compatibility" on page <365>).

One significant drawback to lens usage exists: the D90 body cannot meter with older, non-CPU manual focus Nikkor lenses (see "Lenses and Focusing," on page <357>). The D300 *can* meter with these older lenses, so if you have a lot of manual focus Nikkors, you might want to consider the D300 instead of the D90.

The D90 retains the "button and command dial" interface for most major controls that was first seen on the N8008 and F-801 in 1988. The D90 also uses a derivative of the exposure system first found on the F5 and D1 series and which received a substantive update with the D3 and D300. Finally, it includes most of the autofocus capabilities of the D200, with some new wrinkles there, too.

As I noted, the D90 shares the D80 and D200 viewfinder design. This design is not quite as friendly to eyeglass wearers,

but shows a bigger and brighter image than the D50 and D70 series cameras.



The backs of the cameras are more fraternal rather than twins. The D80 (left) has much of its controls pushed towards the left, while the D90 (right) has a more centered, refined layout.

In short, the D90 will be remarkably familiar to anyone who's used a recent high-end Nikon 35mm film or digital SLR. If you're used to an F5, F6, D1 or D2, you'll even find most of the major shooting controls are in the same place on the D90, and offer much the same set of options. If you've used almost any recent Nikon DSLR, the similarities are even more apparent, as the D90 controls are essentially the same as the D80's, and very similar to those of everything from the D70 to the D3.

So, what's different about a D90? Let's take this in steps. If you're coming from a film camera such as the N80 or F100 the primary visible differences are found in three areas:

- On the back of the camera you'll note a large color LCD and additional buttons for the digital functions, while some of the shooting controls you're used to have been moved to slightly different positions.
- The camera back no longer opens as it does on 35mm film models, but several new "doors" and connections are present. The door on the right side of the camera houses Secure Digital storage media (see "Image Storage" on page <121>), while the small rubber "doors" on the left reveal new connectors that allow the D90 to be hooked

up to a TV, computer, USB device, or controlled with a wired remote.

- The battery compartment no longer accepts AA batteries. You must use an EN-EL3e Lithium-Ion rechargeable battery. (In the US, D90 models are only sold with an EN-EL3e and charger.)

The D90 also sports many internal changes from the film cameras:

- In the mirror box inside the camera, the shutter mechanism has been altered slightly. While the mirror, autofocus system, metering system, and shutter curtain remain, many of these have been modified significantly for improved performance. The D2 series mirror system has the shortest viewfinder blackout time of any Nikon SLR made to date (a trait shared by the F6), but the D90 is no slouch, with a faster blackout than the consumer film SLR bodies Nikon has made. The shutter itself has seen some modifications: no second physical shutter mechanism exists behind the primary curtain; when the curtain is open, a small digital sensor is revealed instead of film. And the shutter lag, at 65ms, is much better than the consumer film cameras. One thing that isn't visually apparent is that the D90 uses a 420-pixel sensor in the viewfinder as the main means to measure flash. Unlike film bodies (and the D2 series), the D90 does not have a set of flash sensors in the mirror box to support the old Nikon TTL system. This means that *i-TTL* capable flash units (e.g. SB-400, SB-600, SB-800, SB-900, or SB-R200) are required with the D90.
- All mechanisms associated with film transport have been removed. Mechanically, a D90 is even more reliable than the rugged F100.
- While the CPU and software that run the film SLR's controls remain (albeit substantially updated), they've been modified to deal with the all-electronic nature of the D90, plus additional electronics have been added. In particular, the D90 models have added internal memory

buffers, a multi-channel analog-to-digital converter (ADC), a dedicated digital processor with software to analyze and interpolate pixel data, plus additional I/O support. Top that off with new control software that uses the Direction pad, new buttons, and the color LCD to provide additional camera options and image review.

Thus, one should conclude that Nikon has done a considerable amount of camera engineering since the F5. Whereas the F5 was a modest step above the F4 that preceded it, the D1, the D2, and now the D90 represent larger steps beyond their predecessors. Indeed, even F5 users would covet virtually every non-digital aspect of the D90: faster autofocus, better flash metering, more power options, and even better body ergonomics.

If you're coming from a previous Nikon digital SLR (DSLR), the D90 still represents plenty of change, especially if you're coming from one of the previous generations of consumer DSLRs (D40, D40x, D50, D70 series, D80, or D100).

Here are the primary differences between the D90 and the camera it was mostly based on, the D80:

- *New Sensor.* Both the D80 and D90 use a sensor technology made by Sony; but the D90's sensor is now a 12mp CMOS versus the 10mp CCD of the older camera. It also features a built-in-sensor ADC to move data off the sensor faster than before with less read noise. In addition, a sensor cleaning function has been added. *The benefits:* increased resolution, faster shooting speeds, and better image quality.
- *Bigger Screen.* The 2.5" 230k dot LCD on the back of the D80 has been replaced with a larger and better 3" 920k dot one. *The benefits:* menu fonts are easier to read, image quality is easier to assess.
- *Improved Autofocus and Exposure.* While the same CAM1000 autofocus sensor from the D80 is used, the 420-pixel sensor in the viewfinder is improved and now

the two have been integrated to work better together, a technology that Nikon calls Scene Recognition System. While not quite the fully integrated system of the D3, the D90 does use many of the same techniques. *The benefits:* improved focus accuracy, improved exposure accuracy.

- *New Features.* The big additions are Live View and video, but hidden beyond the obvious additions are lots of more subtle additions and changes: ISO 6400 support, 4.5 fps instead of 3 fps, Picture Controls replace the old Image Optimization system, the viewfinder has a bit more coverage, **Active D-Lighting** has been added, the RETOUCH menu has NEF processing, straighten, and distortion capabilities the D80 doesn't. *The benefits:* a more capable camera that does things its predecessor doesn't.

A better approach might be to ask what *didn't* change from the D80 to the D90:

- *Focus Sensor.* The same 11-area CAM1000 part is used, with mostly the same focusing options.
- *Built-in Flash.* The same flash is used, and it has the same capabilities.
- *Buffer.* The same buffer size is present: 23 JPEG, 6 NEF.
- *Body.* The body is identical in size (and in most details), though it weight 35g (.1 pound) more.

Up through the F5, Nikon's major product cycle generally took about eight years between substantive engineering changes. With the D2 series, this cycle dropped to three years, yet many of the changes are more dramatic than ever before. In the consumer DSLR bodies, Nikon is generally iterating on an 18-month timeline (the D90 was slightly over this being 24 months after the D80, which was probably because due to the addition of video). On the Internet you see plenty of criticism about how slowly Nikon is moving, or how Nikon is falling behind (usually in relationship to Canon or Sony), or how Nikon isn't innovating. My analysis shows the opposite: Nikon is moving as fast as ever and leaving no stone

unturned, and they continue to pioneer new technologies (video in a DSLR being the D90's contribution).

In short, while much of the visible D90 resembles earlier Nikon bodies and it's nearly identical to the D80 on the outside, there's a lot more going on inside the camera than any previous Nikon consumer camera body. Moreover, the D90 is a lot closer to the D300 and D3 in capability than many people think.

The D90 Sensor

The key element of any digital camera is the image collection device, called a sensor. In the case of the D90, that is a CMOS (*Complementary Metal-Oxide Semiconductor*) sensor made by Sony (derived from the IMX021).

Sensors all work in basically the same way: they have light collection areas, called photosites, which are sensitive to light photons. CMOS, CCD, and LBCAST¹⁸ refer primarily to the transistor type and underlying electronics methodology used to do the collection and transfer of light data.

CMOS is likely the long-term winner in the sensor wars. While it is more difficult to design, the manufacturing costs usually are much lower. You can also design more electronics into the sensor itself (the D90 has built-in analog-to-digital converters that connect to a 12-channel parallel output). But CMOS has the problem of being inherently noisier than CCD technology, all else being equal (see "Noise," on page <88>).

The CMOS sensor used in the D90 appears to be a close relative of the Sony IMX021 sensor used in the D300. The

¹⁸The Nikon-designed sensor used in the D2h and D2hs. LBCAST stands for *Lateral Buried Charge Accumulator and Sensing Transistor*, a technology unique to Nikon sensors. LBCAST is a relative of CMOS—the primary difference is that LBCAST uses a JFET type of transistor instead of MOSFET.

primary differences are that the D90 has a video function implemented and does not support 14-bit output¹⁹.

Since the D1 sensor first was produced, Sony and Nikon have both gotten a great deal of experience with improving the basic technology and dealing with potential sensor issues at the ADC and in post processing. One primary change in the D90 and D300 is the use of built in ADC and a twelve-channel transfer mechanism, which reduces read noise.



*The D90's sensor. The top shot was taken with **Mirror lockup** so that the mirror mechanism flipped out of the way to reveal the sensor as it appears during the taking of a picture. The blue/green area is the actual image sensing area; the narrow green band around that isn't involved in creating the image. The bottom shot shows the sensor itself with the self-cleaning mechanism and filter array removed.*



Any dust or dirt that gets into the mirror box (behind the lens) seems to ultimately work its way and attach itself to the sensor. Unlike some of the earlier Nikon bodies where the frame holding the sensor came right up to the imaging area, there's enough room in the D90 to get a Sensor Swab or SensorBrush off the imaging area when cleaning. See "Keeping the Sensor Clean" on page <654>.

Many newcomers to digital photography are confused by the published information about imaging sensors. Here are the key specifications for the D90 and other Nikon DSLR models:

¹⁹ It's possible that the sensor could do 14-bit output at a reduced rate like the D300, but if so, Nikon hasn't chosen to implement it.

Sensor Specifications (Size)

<u>Camera</u>	<u>Size " (mm)</u>	<u>Pixel Size</u>
D70/D70S	.93 x .61" (23.7 x 15.6mm)	7.8 microns
D100	.93 x .61" (23.7 x 15.6mm)	7.8 microns
D80/D200	.93 x .62" (23.6 x 15.8mm)	6.05 microns
D90/D300	.93 x .61" (23.7 x 15.6mm)	5.49 microns
D2h/D2hs	.93 x .61" (23.7 x 15.6mm)	9.4 microns
D2x/D2xs	.93 x .62" (23.7 x 15.7mm)	5.49 microns
D3	1.42 x .94" (36 x 23.9mm)	8.46 microns

Sensor Specifications (Pixels)

<u>Camera</u>	<u>Active Pixels</u>	<u>Bit Depth</u>
D70/D70S	3008 x 2000	12 bits (but compressed)
D100	3008 x 2000	12 bits
D80/D200	3872 x 2592	12 bits
D90/D300	4288 x 2848	12 bits (D90), 14 bits (D300) ²⁰
D2h/D2hs	2464 x 1632	12 bits
D2x/D2xs	4228 x 2848	12 bits
D3	4256 x 2832	14 bits

Note: Nikon's pixel dimensions are always for the active imaging area of the chip. Moreover, Nikon has sometimes chosen a slightly different active area than the chip manufacturer suggests (3008 x 2000 instead of 3000 x 2000 for the D100, for example). But the active imaging area may be slightly less than the number of "effective pixels." You'll note, for example, that Nikon claims the D90 has 12.8 million effective pixels, but the image only ends up with about 12.3. That's because some of those extra pixels at the edges are masked off and used for noise management and other purposes. Curiously, Sony claims the same sensor is 13.05mp total, 12.41mp active, which shows how Nikon is once again using a different than suggested masking.

Obviously, not all sensors are built the same, so what are the key differences, and what do they mean?

²⁰ Nikon uses 16-bit processing for the full 14-bit image data for JPEG and TIFF processing on the D3 and D300.

First, note that the physical size of the D90's sensor is larger than that of the all-in-one consumer digital cameras, such as the Coolpix models, which use sensors much smaller (typically 4 x 5.4mm or 5.4 x 7.2mm, which is about one-ninth the area of a DSLR sensor in the best case). Likewise, the individual areas used to capture light and generate pixels—called *photosites* by engineers—are much, much larger than the Coolpix models (~30 square microns on the D90 compared to the best case Coolpix, the 5000, at 11.56 square microns). Note, however, that the D90's photosites are significantly smaller in area than those in the D40, D50, D70/D70s, D100, and D1 series²¹.

Size of the photosite is directly related to the ability to record a wide and accurate tonal range and inversely related to the amount of noise in the image data. That makes the D90's performance with its modest-sized photosites remarkable, as the light capture area is significantly smaller than that of many previous Nikon DSLRs. Yet the D90's sensor manages to eke out better performance in almost every area that can be measured. That just goes to show how fast technology has changed since the original D1 sensor design was completed in the late 1990's²².

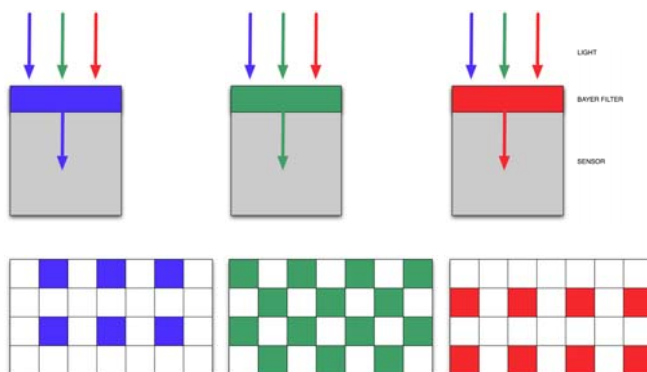
Sensor Filtration

The D90 uses a Bayer-pattern filter over the photosites, named for the Kodak engineer who originated the method. Each individual photosite has a colored filter over it so that

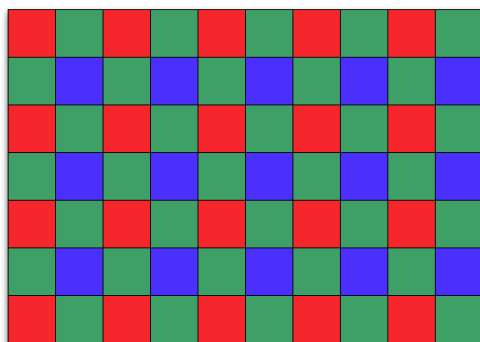
²¹ The critical measurement is *area*. The best case in a Nikon DSLR, the D2hs, has a bit over 88 square microns of area in a photosite, while the worst case, which includes the D90, has only about 30 square microns. Other aspects do come into play: somewhat less of the area of a CMOS sensor is devoted to light collection than on a CCD sensor, but overall, the area measurement gives you a ballpark way of comparing light collection ability.

²² You might wonder if the pace will continue as quickly in the future. Perhaps, but other issues will start to make such advances less important. For example, the D90's sensor is good enough to clearly show the differences between poor and good lenses, and some designers think that the D90 and D300 are nearing the resolution limits current lens designs can manage, especially in the corners of DX lenses. More likely, we'll continue to get software that addresses physical lens defects if sensors continue to downsize (increasing the photosite per millimeter ratio).

the underlying photosite is responsive to a particular range of color:



Adjacent sites have different colored filters over them, which produces an alternating array of colored filters. Here's a close view of a small portion:



Basically, odd-numbered pixel rows alternate filters to produce red and green values, while even-numbered pixel rows alternate filters to produce green and blue. It's very important for D90 users to understand what this pattern does, and the consequences it produces in images.

Many first-time digital users wonder why the green filter is used for twice as many photosites as the blue and red filters. One reason is that photosites, like our eyes, are most receptive to light wavelengths in the 500 to 600 nanometer

range (i.e. green). Likewise, green light waves are in between the red and blue positions in the spectrum, and are found to some degree in most colors. Duplicating the green value gives the camera a better chance at discriminating between small differences in color and the amount of light (luminance) in a scene. (Photosites are least responsive to blue wavelengths [~400-500 nm], which produces other problems we'll discuss later.)

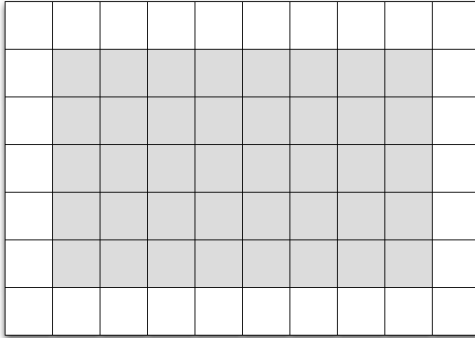
If you're saving images in NEF format (see "NEF format" on page <158>), the camera simply saves the values it recorded at each photosite into a file (along with some additional camera data). Software on your computer (Nikon Capture NX or one of the many third-party RAW file converters that are available) is then used to interpret the photosite information to produce RGB values and a visible image.

If you're saving images in JPEG format (see "JPEG" on page <144>), the camera must first process the photosite data into image data. It does this by a process called *interpolation*²³. Interpolation looks at a block of photosite data and "guesses" the actual RGB values for any given photosite location (remember, at any given photosite, the camera only produces Red, Green, or Blue data, not all three; interpolation produces the missing two data elements).

Most interpolation routines examine a 5x5 or larger block of adjacent data to determine the actual RGB pixel value for any given location. This is one reason for the difference in number between the "effective megapixels" and actual megapixel count in an image that is produced: extra photosites along the edges of the sensor array (white in the following illustration) are there solely to provide data for the interpolation routine to

²³ Technically, the actual name given to routines that convert Bayer pattern data into RGB pixel data is *demosaicing*. (The data is a *mosaic* of color information, and that mosaic must be reinterpreted into image data, thus the routine is called de-mosaic-ing.) *Interpolation* is a more general name given to any conversion that involves creating new data from partial or smaller datasets.

look at in order to calculate the pixels that end up at the edge of your image (gray in following illustration):

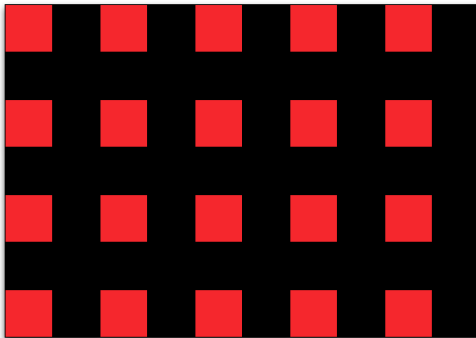


Interpolation has several serious consequences:

- *Green data are the most accurate.* Because the Bayer pattern repeats green, the camera has more data from which to make its guess. It also helps that the sensor is most sensitive to the green bandwidth. Moreover, subtle differences in green values actually make for larger perceived differences in colors, especially skin tones (yes, there's some green value in skin colors).
- *Red and Blue data generate the most "noise."* Since both the red and blue photosites aren't repeated in the Bayer pattern, there are fewer of those color data points from which to predict each pixel's value. Worse still, when the light hitting a red or blue photosite is low, noise becomes a significant possibility in the photosite's value (see "Noise," below). For example, you'll sometimes see noise in the red channel of a blue sky, or noise in the blue channel for a skin tone. Since the blue photosites are the least sensitive to light, indoor lighting can be a real problem for the sensor, as very little blue wavelength light is generally produced by incandescent lighting, and the lighting indoors tends to be dim to start with. Indeed, overall, the blue channel on the D90 tends to be the noisiest (at least until the camera's noise reduction circuitry comes into play), and this problem is

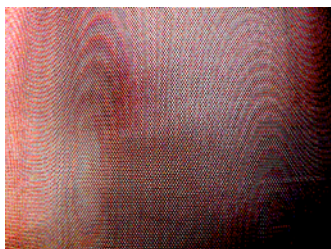
compounded in incandescent light because there is so little energy in the blue wavelengths available to be captured by the sensor.

- *Red to Black and Blue to Black transitions compromise detail.* Black is defined as the absence of light in all three channels (R, G, and B). Thus, when you have a pure red area adjacent to a pure black area, the Bayer pattern gets in the way (no value is being reported by the G and B photosites, thus only one in four photosites is providing useful information that can be translated into image detail). Red to Blue transitions can also exhibit a similar problem, though usually not as visually intrusive as the Red to Black or Blue to Black ones.



Shooting a scene with only red and black renders three quarters of the photosites inactive, as only the red photosites are providing measurable light values. Compare this matrix to the previous one and you'll see that the effective resolution has decreased (I've made the patterns the same size).

- *Moiré patterns may appear.* When the frequency of image detail changes at or near the pitch of the photosites (imagine a photo of the screen on a door where the line intersections of the screen hit almost, but not exactly on the photosites), an artifact of interpolation is often a colored pattern called moiré.

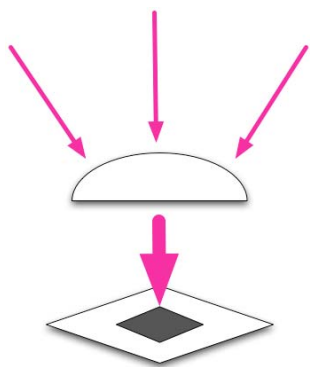


Moiré shows up as added “detail” not in the original, usually with a color pattern to it. In this example I’ve exaggerated the contrast and color so that you can see wavy patterns that weren’t in the screen being photographed (the original screen is silver with a tight diagonal weave in a regular pattern—those curvy lines and color changes don’t appear in the screen’s pattern). You get moiré most often from things like screen doors, tightly woven fabrics, and any other object that has a small, repeating, regular pattern of detail.

Before we leave the sensor filtration topic, we need to discuss how information gets off the sensor, since it is color specific.

The part of the photosite that is exposed to light is called the photodiode, and it makes the conversion of light photons to electrons. Photodiodes are sensitive to the angle at which light hits them. The general rule of thumb has been that light must hit within 15° of perpendicular for it to be accurately captured by the photodiode. Light hitting at more oblique angles produces less photon-to-electron conversion, which falls into a general category of sensor design issues called “shading.” We photographers see a similar effect as vignetting in the corners of our images.

In order to “align” the light more properly with the sensor, a microlens is placed over each photosite. The microlens has the task of trying to make the light hit the photodiode at a more perpendicular angle, thus reducing shading effects.



Like the Bayer filtration, the microlenses are part of the sensor itself and manufactured at the same time as the sensor.

We don't want light hitting the photosite from oblique angles, because it might not get into the photosite's photodiode (the gray section in the above illustration). So the microlens is designed to take light hitting at all angles and redirect it straight down into the photosite well.

The smaller sensor size also comes into play here. Getting light from the rear element of a wide angle lens to the far corners of the full 35mm frame means that light can hit the extreme corners of the frame at a very oblique angle with older lens designs. Nikon has done three things to make light hit more perpendicular to the sensor's photodiodes for the D90:

- *DX frame size*—The smaller frame size of the Nikon DX DSLRs mean light doesn't have to get "bent" as much to reach the far edges of the capture area.
- *Microlenses*—As already described, these small lens-like additions to the sensor capture light hitting the sensor from angles and reorient it more towards perpendicular.
- *New lens designs*—Starting as far back as the 17-35mm f/2.8D Nikkor, Nikon appears to have begun designing wide angle lenses with a modified rear element design. Essentially, all Nikkor wide angle lenses are now designed

with rear elements that don't try to make a final dramatic "bend" in the optical path.

On top of the D90's sensor sits a separate "low-pass" filter, sometimes called an anti-aliasing (or AA) filter²⁴. The low-pass portion of the filter is used to prevent (as much as is possible²⁵) color aliasing artifacts (like moiré). However, the low pass filter used on the D90 is a somewhat aggressive one—D90 images show modest anti-aliasing. The D1 series, D100, D80, D200 and have relatively high anti-aliasing applied compared to the D70 and D2h. The D90, D300 and D2x are somewhere in between.

The actual material used in most anti-aliasing filters uses a crystalline structure. That material is not quite as hard as the best glasses, but definitely harder than most optical plastics. You'll appreciate that when it comes time to physically clean the sensor, because you're not actually cleaning the sensor itself, but the anti-aliasing filter that sits just above it.

Embedded in the anti-aliasing filter is another component: UV and IR light blocking. Photodiodes have sensitivity to light outside the human visual range. This is particularly an issue in what is known as the near-IR spectrum. We can't see that light with our eyes, but if it is allowed to be added to the red component of a pixel, the resulting pixel colors will be incorrect.

Many dark fabrics—such as police uniforms—reflect a fair amount of near-IR. Thus, if near-IR wasn't filtered out before it hit the sensor, all the red photosites in the camera would get

²⁴ Nikon's penchant for jargoning-up the terminology and then abbreviating it leads them to call it an OLPF (optical low pass filter) in some of their literature.

²⁵ From a designer's viewpoint, the engineers must balance the intensity of the anti-aliasing filter with the destruction of resolution. The stronger the anti-aliasing effect, the more the acuity of small detail suffers. Likewise, the less strong the anti-aliasing effect, the easier it is to trigger unwanted moiré. Personally, I'd rather have the additional detail and deal with the moiré than vice versa, but some users hate moiré because it requires strong post-processing skills to remove.

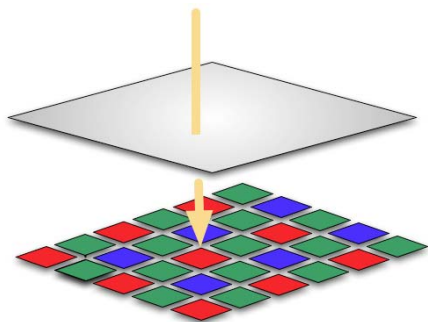
“extra” photons outside the visual range we see. Once that extra data got into the RGB pixel data, colors will drift. It wasn’t unusual, for example, in early DSLR cameras to see black fabrics go magenta (the Kodak DCS2000 was notorious for this, for example).

Yet another component of the anti-aliasing filter on a D90 is a static avoidance coating. This costly and optically transparent coating is applied to the front of the anti-aliasing filter in order to reduce the small static charge that builds at the front of the sensor and which can attract dust. The key word in that previous sentence is “reduce.” Coupled with the shake-it-off sensor cleaning mechanism in the D90, casual dust isn’t problematic.

The downside to the anti-static coating is that this very thin layer is somewhat more fragile than the underlying filter it sits on, and using the improper chemicals or techniques in cleaning can easily and permanently damage it.

If you’re getting the idea that the D90 sensor is a “sandwich” of things, you’re correct. Here’s a run-down of the things light has to go through to get to the actual “light-sensing” area on the sensor:

- Dust resistant coating – in the filter
- Low-pass filter (anti-aliasing) – in the filter
- Infrared removal filter (“IR cut”) – in the filter
- Microlenses – built into the sensor
- Bayer-pattern filter –built into the sensor



The antialiasing filter (top plane) filters out high frequency detail and near infrared energy in the light (green arrows) before it gets to the microlenses that sit over the photosites (below). The antialiasing filter also incorporates IR filtering.

Note: Why is the filter called a “low-pass” filter? Artifacts—unwanted data—are produced by any analog-to-digital conversion. There’s a basic rule of conversion that all input frequencies below something called the Nyquist frequency will be correctly produced, while those above the frequency tend to more easily generate aliasing artifacts (often visible as moiré or color fringing in digital cameras). The filter on the D90’s sensor attempts to pass the data below the Nyquist frequency for the sensor pitch, and reject data above that frequency, thus the name “low-pass.”

Note: The IR-cut and anti-aliasing filter can be removed from the D90 (with a great deal of fussy disassembly that will void your camera’s warranty). Why would you want to do that? Two reasons: (1) By removing this filter you remove all the anti-aliasing. This can produce higher acuity, but at the potential expense of more incidence of moire and aliasing of diagonal edges. (2) By removing the IR-cut filtration and substituting a visible light-cut filter you can convert a camera into a dedicated infrared camera (see “Infrared” on page <649>). However, removing the factory filter and replacing it with plain glass or IR filtration renders the shake-it-off sensor cleaning mechanism.

Tonal Range

12 bits-per-pixel tonal range may not seem like much, but it translates into the ability to render 4096 shades (using 12 bits) of an individual color versus 256 (using 8 bits)²⁶. While the capability of most human eyes is close to what an 8-bit capture contains (our eyes are usually said to distinguish about 16 million colors, which is approximately what 8-bit RGB produces; $256 \times 256 \times 256 = 16,777,216$), the extra tonality of 12 bit captures is still useful. When we “sharpen” and apply other corrections to an image in post-processing, it is usually easier to keep such manipulations from becoming visible with the extra bits (i.e. we can “hide” some of our manipulation in the extra tonality, and rounding errors have less visible consequences).



Here's a tonal ramp rendered two ways. On the top, it's rendered as a continuous spectrum from black to white. On the bottom, I've arbitrarily separated it into 19 different tones (slightly better than a 4-bit value can contain). The more tones we use to go from black to white, the more subtle transitions like this look. This is one reason why pros prefer to use raw files, which have 12-bit values, instead of JPEG, which have compressed 8-bit values.

But there's more to bits than just the subtlety of the tonal ramp. Once we reduce our data into 8-bits for a JPEG image, we're stuffing some of the stops of exposure data into a very small space.

Programmers might already know where I'm headed: the number of bits available for recording low values is more limited than the number of bits available for recording high values:

²⁶ n bits can enumerate 2^n values.

---X XXXX used for lowest stop
 XXXX XXXX used for highest stop

Put another way: there are 32 possible values possible in that bottom stop of exposure, but 256 possible values possible in the top stop of exposure²⁷. Therefore the accuracy of the highest stop of data (highlights) is going to be greater than the accuracy of the lowest stop of data (shadows), especially if we start using curves and other manipulations to move the data within the limited available space. That's the reason why I strongly suggest shooting raw files on DSLRs instead of JPEGs: by keeping the data in 12-bit space you have more data accuracy when you make changes, and fewer rounding problems and errors.

Just for the heck of it, let's assume that the D90 can capture exactly seven stops of dynamic range and we spread that evenly across the bits (we'll get to the reality in a bit). Put in a table this 8-bit versus 12-bit difference looks like this:

	<i>8 Bits</i>	<i>12 Bits</i>
First Stop	Values of 0 to 36	Values of 0 to 584
Second Stop	37 to 73	585 to 1170
Third Stop	74 to 110	1171 to 1756
Fourth Stop	111 to 146	1757 to 2342
Fifth Stop	147 to 183	2343 to 2927
Sixth Stop	184 to 219	2928 to 3513
Seventh Stop	220 to 255	3514 to 4095
<i>The critical element to note is the number of different values that can be recorded in each "stop" of exposure. There's a big difference between 36 and 585. The higher that number, the less likely that you'll see steps or roughness in the tonal ramps of your image.</i>		

²⁷ It's even worse than that. The linear nature of sensors means that we get a great deal of highlight differentiation but little shadow differentiation. But that's getting a bit ahead of our discussion.

It should be obvious that the data in each stop of exposure has more potential subtlety in 12-bit data than in 8-bit data. Thus, you'll want to keep your data in the higher bit realm as long as possible.

Fortunately, the D90 does just that. The EXPEED image processing system does the image demosaic and applies camera settings on 12-bits of data²⁸. Only at the final stage of creating the JPEG does the D90 reduce data to 8 bits.

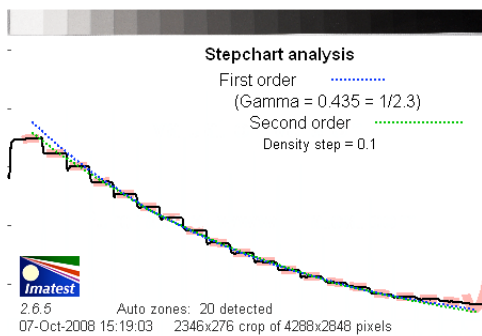
Better still, the D90 captures dark to bright in a somewhat more predictable fashion²⁹; 35mm film tends to have a widely varying response (density of image) to exposure, producing a distinct S-curve when you plot exposure against density. Worse still, most film has a property called reciprocity failure—the tendency to require a different exposure at extremely short or extremely long shutter speeds. The bottom line on digital tonality is that the shadow areas are less likely to “block up”³⁰ in underexposure, as does most slide film, for example.

One thing that is a bit unexpected about the D90's tonal range is that it isn't perfectly flat, as it has been on most previous Nikon DSLRs. By “flat” I mean that the rendering of the white-to-black patches on a Kodak stepped grayscale chart don't result in the expected flat line (see chart, below).

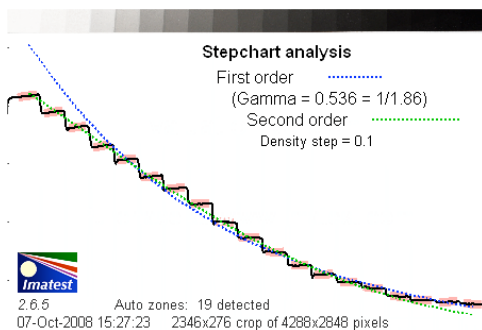
²⁸ Actually, the internal processing is done using 16 bits (the 12-bit value is pushed into the top of those 16-bits).

²⁹ “Predictable” isn't quite the right word to use, as no imaging device I know of has a perfectly predictable response to light. My point is that a D90's tonality curve is more regular than film's, which tends to vary more with brightness and exposure length.

³⁰ Imagine a chart with 64 increasingly brighter shades of gray from black to white. If you were to photograph that chart, a “blocked up” shadow area would be one that did not reproduce differences between adjacent dark grays, essentially rendering many of them black (or near-black). Because film has a non-linear response to light, many different light values are sometimes produced as black. Fuji Velvia, a slide film favored by many professionals, has a pronounced tendency to render *any* object underexposed by more than three stops as a rich, velvety black. The same problem can occur at the bright extreme, as well. Blocked up highlights would be all bright objects rendered as the same white (or near-white) color.



There's a slight but significant "dip" across the range of the tonal curve (at least at the camera's default exposure and settings), with rises in slope at both the deep shadow (right) and bright highlight (left) ends. The overall impact of this is a bit more mid-range contrast than previous Nikon bodies, and a little less of the "Nikon drab" look some have complained about in out-of-camera JPEG images. Note, however, that your exposure and camera settings can change this curve very substantially. Here's the same thing with **Active D-Lighting** active and using a Vivid Picture Control:



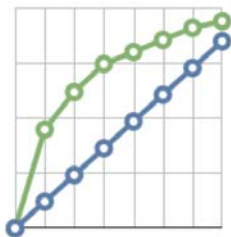
The curve has exposed larger steps in the bright regions while, surprisingly, revealing one fewer dark steps. You need to study the camera settings Nikon provides very carefully and match them against the scene you're shooting if you're a JPEG shooter.

Note: Some of the test charts presented in this eBook and on my Web site are pieces of the elaborate testing results that the

Imatest testing software produces. Imatest is also the software I use to verify the things I see in D90 images. While I don't always present the test results in this eBook (you've got enough pages and examples to wade through as it is), almost all of my statements about image quality properties have been empirically tested by both careful image shooting and running standard test charts through Imatest.

Imatest is probably the most precise testing facility easily available to the average user. I highly recommend it as a way to get to know the nuances of your camera's response. One small thing, though: you'll need a number of test charts to take full advantage of the program, and some of these charts are expensive because they're produced to exacting standards. See <http://www.imatest.com> for more details. And don't forget to tell Norman that I sent you.

We also have to talk about the “linear” nature of sensors. Simply put, twice as much light means twice as many electrons get collected and counted. Unfortunately, the human eye isn't linear. Here's what the difference looks like:



Green is our eye's non-linear response, blue is the sensor's linear response to adding light

To make these two response systems “line up” a digital sensor's data is adjusted with a “gamma curve” (you may have noticed a reference to this in the Imatest charts, above). This introduces additional issues with the way bits end up in the final pixel values. If you start with too few bits and start applying complex tonality curves to the underlying data, you end up with rounding and other issues in the final data.

Dynamic Range – Dark v. Bright

For any photographic situation we find ourselves in, there is always a range of brightness, from dark to light. In our offices we try to keep the range minimized—in other words, there’s usually not a big difference between the darkest areas and the brightest. But in the real, uncontrolled world, the range from dark (densely shaded area) to bright (sun bouncing off a metallic object) can be considerable. We call the brightness differences we encounter the *exposure range*. We refer to the ability of our film or digital camera to capture a range of brightness the *dynamic range*³¹.

We measure both ranges in terms of *stops*; each stop represents a doubling of light. So if I were to say that a scene I wanted to photograph had four stops of exposure range in it that would indicate that the brightest areas are 16 times lighter than the darkest. Unfortunately, many outdoor scenes can have 10 or more stops of exposure range in them. That’s a huge range of light.

Overall, the D90 has slightly less dynamic range than is captured by most print films, but slightly more dynamic range than most slide films can handle. What’s that mean in numbers? My measurement system says the D90 maxes out somewhere between seven and eight stops of dynamic range (some others measure a bit differently and come up with a slightly different number). Using the same system for the slide film I use (Provia F), I get about six stops of dynamic range. With the negative film I use (Portia) I usually measure eight or nine stops (processing and printing can have an impact).

Note: You’ll see camera dynamic range figures posted in various reviews that disagree with each other. Some of these numbers aren’t actually measuring scene dynamic range

³¹ Dynamic range is commonly used as the term for both things. You’ll often hear someone say “the dynamic range of the scene is eight stops and our camera can only capture six stops of dynamic range.” I’ve elected to keep the two terms separate here so that you’ll know if I’m talking about the scene (exposure range) or the device (dynamic range).

that can be captured and reproduced, but instead measure stepped reflective targets that range from black to white and measure the maximum signal to no signal values. The reflectivity and efficiency of the target comes into play, as do other factors, such as the camera settings when shot in JPEG. Other tests take a single target and vary either the amount of light hitting it in a series of tests with the camera's settings constant, or keep the light constant and vary the camera's settings from underexposure to overexposure. Unfortunately, you can only compare numbers from a single testing method, and then only if the test is done with rigid controls. You'll note that I don't quote a specific number in the paragraph above, but say "between 7 and 8 stops." This pronouncement comes from measuring many scenes with incident and reflective light meters to determine the scene dynamic range that was being shot, then observing where the cutoff of "useful" information is. This is then checked against using a single target with varying camera settings in a constant light. Since some camera settings impact the actual value that can be obtained, I prefer to report a number that can be clearly achieved with absolute consistency, regardless of how your camera is set (e.g. between 7 and 8 stops). But keep reading, I'll try to elaborate...

The dynamic range of the D90 is fixed, but the scenes you'll encounter and wish to photograph aren't fixed in their exposure range. Sometimes you'll find scenes that have very little exposure range (said to be low in contrast), sometimes you'll encounter situations that have extreme variations in exposure range (said to be high contrast).

In terms of our sensor and the buckets it collects light in (photosites), dynamic range is restricted at both ends by different things. At the bright end, as I've alluded to before, the bucket has a limit to what it can hold. Once the bucket is full, it doesn't matter how many more light photons strike it, they won't be collected, and thus not measured.

At the other extreme, we have the inability to measure small amounts of light. Imagine it this way: let's say you just washed

your bucket and gave it a quick wipe to dry it. Now one drop of rain hits the bottom of the bucket. Can you measure how much rain has fallen? Well, no. There's residual moisture in the bucket from the cleaning, and we haven't collected enough new water to distinguish that from the residual moisture. Likewise, with sensors: there are residual electrons in the photosite and we need to convert enough light photons into electrons so that we can differentiate the two.

Technically, engineers measure camera dynamic range as the difference between the full bucket (electron well capacity of the photosite) and the measurable empty bucket (the minimum data that can be read, which equates to the baseline of underlying noise). On a D90, this results in a high value of nearly 11 stops at the base ISO.

Photographers measure dynamic range a bit differently, usually defined as being between the lowest point at which usable shadow detail occurs up to the point where highlight clipping occurs. On my D90 I measure that to be a maximum of (rounded to the nearest half stop):

<i>ISO</i>	<i>Dynamic Range</i>
LO1	8.5 stops (but watch for clipped highlights)
200	8.5 stops
400	7.5 stops
800	7 stops
1600	6 stops
<i>Due to the amplification involved, dynamic range continues to drop as you increase ISO.</i>	

I want you to notice one thing about the numbers I just reported: *Higher ISO values mean less dynamic range captured.* Noise increases with ISO, thus the possible capture range gets smaller. As you can see, this can be trivial (just about a stop, and still higher than some previous Nikon DSLRs at their base ISO) at up to as high as ISO 800, but each ISO boost does rob you of more and more capture capability.

With a DSLR, *you* are in charge of getting the exposure “right.” That means that you have to consider what the D90 can capture (dynamic range) versus what you’re trying to photograph (exposure range). I’ll have much more to say about exposure as we proceed to learn about the camera (see “Metering and Exposure” on page <232>, for example). But suffice it to say that the sensor in the D90 has a fixed dynamic range it can capture while the situations you want to photograph will present quite a variety of exposure ranges you’ll need to deal with. Don’t fret—the D90 has a plethora of automated features to help you. But you’ll want to pay close attention to exposure, and knowing what the sensor can capture is part of getting exposure “right.”

Fortunately, your D90 doesn’t have one exposure problem that plagues film: reciprocity failure, or the tendency to require a different-than-expected exposure at extremely short or extremely long shutter speeds. If you can measure the light in a scene, the D90 can be set for that directly, with no compensations for short or long shutter speeds.

Spectral Characteristics

The spectral characteristics of the D90 sensor are currently unavailable. Unlike the D2hs, the D90 does not seem to have a near-infrared pollution problem, which required using a hot mirror filter on the D2hs to correct.

Indeed, the D90 seems to have reduced reactions to *all* light outside the visible spectrum. Both UV and near-infrared response is considerably lower on the D90 than any previous Nikon DSLR I’ve tested other than the D300, D3, and D700 (see “Infrared” on page <649>). This will have an impact on some purple values, which live down in the high UV spectrum. Finally, like many digital cameras, the blue spectrum seems to be the D90’s weakest; the green and red responses seem to be stronger and less prone to error.

Noise

Noise refers to pixel data values in your image that are different from what a “perfect sensor” would produce.

For example, in a “perfect sensor” three adjacent pixels from an evenly exposed gray card might be rendered with RGB values of 110,110,110. Most digital sensors aren’t that perfect (and there’s rounding going on somewhere to get to an 8-bit value for JPEG images, which slightly exaggerates noise), so you might have one pixel that’s 110,109,110, another that’s 110,110,111, and a third that’s 110,110,110. As noise increases, the divergence of those values would increase. For example, if the proper value is 110,110,110, then a value of 102,114,107 is clearly “noisier” (and less accurate) than one of 108,112,108.



Here’s a 100% view of a section of a D90 image taken at ISO 3200 and intentionally underexposed to present a worst case situation. Note the rough, grainy texture throughout, the dull look, and the appearance of other colors in the yellow of Harry (the duck). Plenty of false values are showing up here. The overall impact is more like that of a rough film grain printed badly.



Immediately below the original is a sample on which I’ve performed noise reduction using Neat Image and then fixed the exposure for. Note how the rough texture has now mostly disappeared (at the expense of very fine detail). Harry now looks yellow, though there is still a fair amount of false color in the image.

Sensors produce noise in two primary ways:

- *Shot noise.* Photons, like almost everything in life, have a randomness to them. In absolutely even light, there still is a statistical chance that any given photodiode does or doesn't see a photon at any particular moment. This statistical photon noise, called shot noise, is equal to the square root of the number of signal photons collected, and this relationship does not vary from sensor to sensor. What does vary from sensor to sensor is the number of photons collected. Remember that the D90's collection area is smaller than that of the D3, but substantially bigger than that of the Coolpix cameras. Thus, it should be obvious that the visibility of a D90's shot noise is lower than the Coolpix models but higher than the D3's. The generally accepted value is that it takes a signal-to-noise ratio of 2.7 before you can get meaningful data beyond the shot noise. Put another way, the minimally theoretical light fluctuation that can be accurately discriminated by a sensor is 8 photons. That's usually okay for us, as our brightest values in our shots are usually collecting tens of thousands of photons, but do watch out for underexposure of your shadow areas—there might not be a lot of photons represented there, and shot noise will rear its head when there aren't.
- *Read noise.* Likewise, we have to store the photons, which is done by triggering the creation and storage of electrons, then we move the electrons from the photosite through its ADC and count correctly. That can be less than perfectly accurate, too. We might lose or gain a few electrons in the process, and our Analog-to-Digital converter might not count accurately.

Sensors tend to produce more noise when:

- *left exposed to light for long periods of time.* Electrons get more chance to migrate from where they should be to places they shouldn't.

- *exposed to low levels of red or blue wavelengths of light.* The demosaic routine uses all adjacent photosites in calculating pixel values, so when one channel (color of photosite) is very low in value and thus has a low signal-to-noise ratio, it can contribute that noise to all the channels in the final adjacent pixel values.
- *used in very warm environments.* Those pesky electrons follow the laws of thermodynamics: they get more willing to move about as they are exposed to more energy (heat). The rule of thumb is that every 20°C temperature decrease results in an order of magnitude decrease in unwanted thermal electron accumulation³².
- *you set higher ISO values.* Higher ISO values generate more noise because they're obtained by essentially amplifying the underlying data values, so small disparities become more visible as you increase the amplification. Moreover, most Nikon DSLRs adjust the ADC circuitry at higher ISO levels to better match the available bits against the actual number of photons converted to electrons, and this has an influence on how noise looks in high ISO shots.

Noise shows up in photos as incorrect pixel values, and is easiest to see in large areas of a single color (like the sky, or the background in the above image) or in deep shadow areas (where noise shows up as false detail).

As I noted earlier, the larger the photosite, the less that noise is a factor. Thus, Coolpix users have discovered that pictures they've taken on very warm nights (>86°F [30°C]) often exhibit large amounts of incorrect or random pixel information, while D90 users don't typically see this problem until the temperatures get extreme (if you're uncomfortable, the D90 will likely be producing more noise than normal).

³² Thermal electron = internally generated. Photo electron = generated by external light trigger. We don't want the former and do want the latter.

Different types of noise exist, and the D90's ability to deal with each of the various types ranges from decent to excellent.

"Dark current" is the name for a form of thermally-induced current that the photosites produce even when they aren't struck by light³³ (thus the "dark" in the name). Each individual sensor tends to have a different dark current noise pattern, much like humans have unique fingerprints. That pattern will change a bit over time, and with temperature. Nikon, like all digital camera makers, masks off from light some photosites at the edges of the sensor so they can determine what the sensor thinks is absolute black (read: the average dark current), but this system isn't foolproof³⁴.

With **Long exp. NR** turned **On**, the D90 creates an exact "map" of the dark current in the sensor by taking a second "blank" exposure at slow shutter speeds (longer than 8 seconds), allowing the camera to further reduce noise by subtracting the exact dark current map from the image data. Dark current noise handling on a D90 is actually decent but not great without this function being turned on (for reasons we'll get to in a moment; but first we need to deal with one other type of noise).

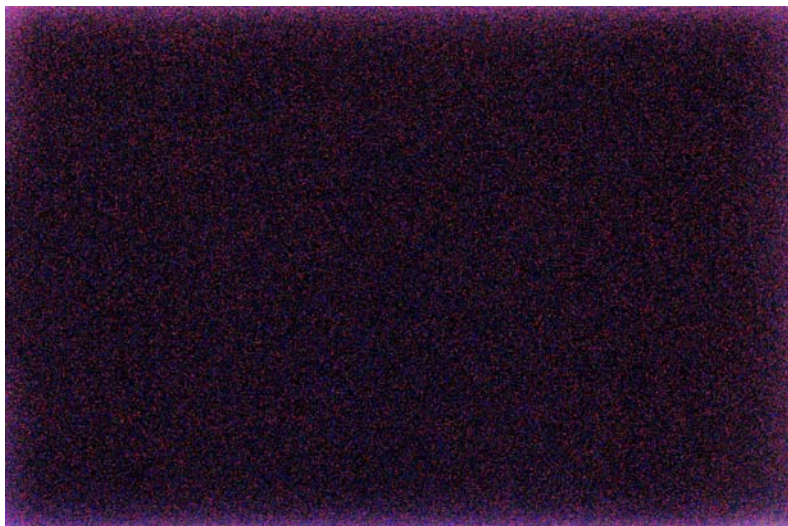
Another type of noise we generally deal with, and which the D90 has in moderate quantity, is noise visibility due to signal amplification. Noise caused by small variances in values get distorted as we use multiplication of signal values to get higher ISO values. The D90 is decent at handling this type of noise, as we'll see in the section on ISO sensitivity later in this eBook, though I get better results from using post processing

³³ Actually, struck by photons.

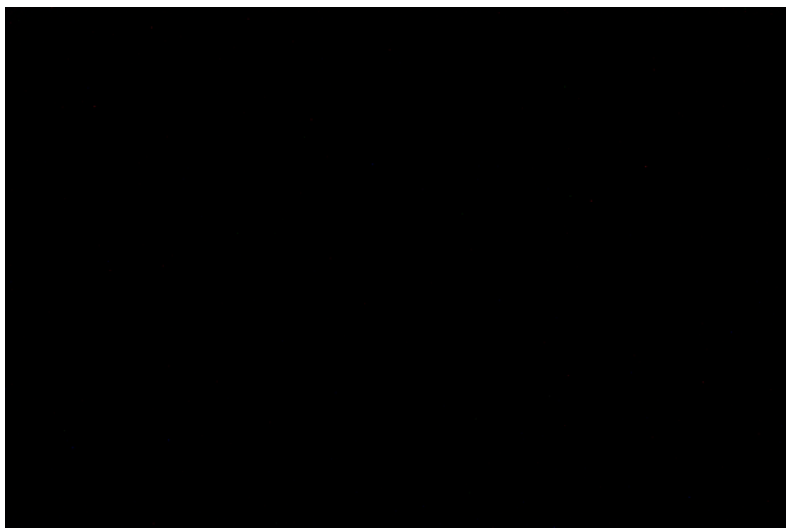
³⁴ You may have noted that Nikon claims the sensor is 12.3 effective megapixels, but the actual recorded image only has 12.2mp. Masking is part of the answer. The actual number of photosites on the sensor is 4428x2948 (compared to the final photo size of 4288x2848), but some of those extra photosites are used for the dark current mask and black level detection, as well as providing extra edge pixels for the Bayer demosaic.

noise reduction programs. The example image shown a couple of pages back is relatively high in amplification noise, though this noise is distributed relatively randomly and doesn't have the usual "digital look" due to color (chroma) variations.

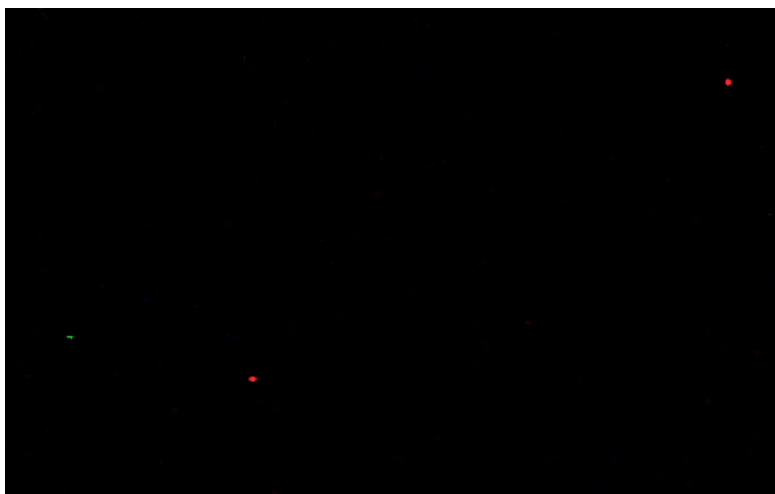
A third type of noise is called "amp noise" (not to be confused with noise *due* to amplification). This refers to thermally-induced noise generated by other electronics or heat sources near or adjacent to the sensor. Such noise is so low in value that you won't see it unless you shoot extremely long exposures. For example, here's a 15-minute exposure taken with my initial D90 at ISO 3200 and the lens cap on (the entire image should therefore be black):



You'll note that there are purple tendencies at the edges, and that's due to amp noise. Turning the **Long Exp. NR** to **On** or using a low ISO hides this noise (here's ISO 200):



However, while there is no amp noise in this image (which would show up as purplish blotches), all is not good news. The image has substantive hot pixels in it (the ambient temperature was approximately 64°F). Here's a close view at 250%:



That's not good, obviously. In general, **Long exp. NR** does a perfectly fine job of getting rid of these hot pixels, at the

expense of doubling the time between shots. I'll have more to say about hot pixels in the next section.

Before I wrap up this section on noise, I need to differentiate between sensor noise and image noise. So far in this section I've talked about noise that is generated by the sensor and the accompanying signal capture electronics. Once a final image is produced by the imaging ASIC³⁵ in the camera and we have RGB pixels to look at, we talk about noise differently.

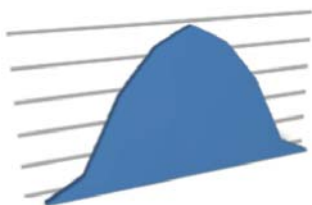
Specifically, we refer to two types of noise we can see in the final image data: luminance noise and chroma noise.

Luminance noise is essentially *brightness* changes from pixel to pixel that are incorrect. If you see a pebbled texture of same colored pixels in a broad single tonal area, such as sky, you're seeing luminance noise. This often looks similar to film grain. If you see pixels of color (typically red, blue, or green) where they aren't supposed to be, you're seeing chroma noise. This type of noise is decidedly un-film like.

Luminance and chroma noise are how the noise from the underlying sensor and supporting electronics end up appearing in the final image. The D90 is aggressive at trying to control chroma noise, but less so at controlling luminance noise. You have some ability to control this aggression by using the **High ISO NR** settings in the SHOOTING menu.

One last thing about noise: Nikon truncates it in raw files. What do I mean by that? Normally noise has a bell-like distribution around the actual value:

³⁵ *Application-Specific Integrated Circuit*



But what happens when a data point has a value of zero? Noise should distribute equally to either side of zero. Indeed, Canon raises the “zero” value high enough in the bit storage so that the distribution shown above is true for all data values in Canon raw files. But Nikon places zero at zero, which gives us a noise distribution that looks more like this:



I mention this because it has impacts on some types of photography, most notably astrophotography. Having noise evenly distributed across all values makes it easier to stack multiple images and extract the real data. With the Nikon bodies, the zero and near zero values have a slightly different noise distribution, which impacts the stacking results.

Hot and Dead Pixels

One potentially annoying visual variant of sensor noise is something known as “hot pixels.” Relatives of hot pixels are stuck pixels and dead pixels:

- *Dead pixel*—a dead pixel is one that is non-responsive to light and/or produces no electrons for the ADC to count. Dead pixels always appear as a *single* black data point (in a raw file) that is always at the same location. In the process of manufacturing a camera, Nikon detects and maps out dead pixels via software in the camera. Virtually

all sensors have a dead pixel or two, so this is a normal process. On occasion, a sensor will develop a dead pixel after leaving the factory, in which case you'll need to have it mapped out.

- *Hot pixels*—a hot pixel appears as a brightly colored pixel in your image, usually blue, red, or green, but sometimes white or another color. Again, these pixels appear in the same place from image to image. Hot pixels are caused because a photosite has a charge leakage or retention unlike that of neighboring photosites. Since we're talking about electrons, thermal properties and time are the two largest contributors. In other words, you're more likely to see them if the camera is warm or if you're using a long exposure. Hot pixels tend to come and go, though a photosite that has the tendency to produce one tends to retain that tendency. You can use **Long exp. NR** to remove them if you shoot exposures longer than 8 seconds on your D90. Otherwise, you need to either cool your camera, use a shorter exposure, or use a lower ISO value (amplification tends to make minor hot pixels into major, visible ones). I say don't panic about hot pixels. I've seen many sensors where some hot pixels simply go away with use. If one persists, you can map it out later. But my first approach to hot pixels is to cool the sensor (e.g. get the camera out of the sun).
- *Stuck pixels*—some people have started to refer to permanent hot pixels as stuck pixels. If you have a bright pixel that never goes away, no matter what the temperature of the camera or what the shutter speed, you've got a stuck pixel. These generally need to be mapped out.

I've mentioned "mapping out" pixels several times now. Nikon does this at the factory, and can do it at any of their authorized service centers. If you're in the "don't fix it if it isn't really broke" category, you can also use software to analyze and correct your images after you take them. The most commonly mentioned product in this category is the

donation-ware Pixel Fixer, unfortunately only available for Windows: <http://www.pixelfixer.org>.

Sensor Longevity

Another question about sensors that gets asked a lot is “how long will this sensor (and thus digital camera) last?” From the reliability and mechanical standpoint, the answer is as long as a film camera. But the Bayer and IR filtration does come into play here. Since the filtration itself is usually created using dyes, and dyes tend to fade with long-term exposure to light, I suspect that this is going to be the weak link in sensor longevity.

The good news is that, even if you take tens of thousands of shots, the sensor is being subjected to light for only fractions of a second at a time. In short, the overall light accumulation for even a heavily used D90 is going to be minimal, and your shutter is likely to give up the ghost long before you’ve let in enough light to start impacting the dyes in the Bayer filtration.

Consumer cameras such as the Coolpix expose their sensors (and thus filters) to light almost constantly, and we’ve yet to see any significant fading problems with units that are as much as a decade old. Thus, I don’t expect filter fading to be an issue at all with a D90, even after years of use. Still, I’ve added a new caveat to my cleaning instructions later in this book and on my Web site: clean quickly and not in the presence of high-powered light sources (e.g., the sun).

Another concern that comes up on Internet forums from time to time is cosmic rays. A direct hit by a cosmic ray on the right portion of a photosite could definitely damage it. But cosmic rays are relatively rare here under the earth’s atmosphere. Even up in space we have a number of digital cameras (NASA uses Nikon D2x bodies on the space shuttle), and they don’t seem to be worse for the wear due to cosmic ray penetration. As they say, “take a chill pill” if things like

this worry you. You're far more likely³⁶ to drop your camera than have it compromised in any way by excessive light exposure or cosmic ray penetration.

Sensor Wrap-up

One final reminder about photosites: their light-catching regions don't fill the entire area the sensor array occupies. This catches some digital newcomers by surprise, as they imagine that the photosites are all jammed up against one another and the entire sensor captures light. The photosites are jammed together, but the light-sensing portions of most sensors, including those in the D90, are smaller than the overall photosite size, partly in order to keep light photons from migrating too easily to adjacent photosites, partly to allow room for other signals on the chip (power and data transfer, primarily).

I've also sidestepped one issue in this discussion of how a sensor works: how the amount of light (an analog value) becomes digital data. To make a very complicated story short, the light photons captured by the individual photosites are converted into electrons at each photosite. These electrons are moved at the end of the exposure to the on-board Analog-to-Digital converters (ADC). These converters have a relatively simple job, which is to evaluate the number of electrons they see at each photosite and convert that into 12-bit digital values that are then passed on to the rest of the camera's EXPEED circuitry.

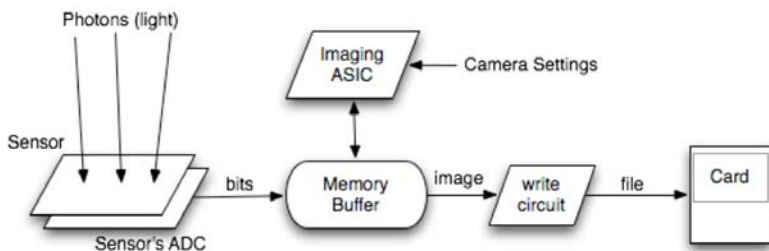
Tip: For a fuller discussion of how sensors work, see <http://www.bythom.com/ccds.htm>.

³⁶ By "far more likely" I'm not talking about an order of magnitude or two. More like orders of orders of magnitude. Computer memory is also subject to change by cosmic ray. What most university computer science programs teach is that sometime in the next century, one computer bit will be flipped randomly by a cosmic ray in a running program and cause a problem. So I repeat: don't worry about these things.

EXPEED

As part of the D3 (and D300) introduction, Nikon finally got around to giving a name to the digital imaging system internal to their cameras. The D90 gets that same system.

On a digital camera, there are a handful of parts that are involved in the imaging. First, we have the imaging sensor (see “The D90 Sensor” on page <66>). Either the sensor has on-board ADC (analog-to-digital converter) or an external ADC is used. (The D90 has on-sensor ADC, the D3 uses external ADCs, for example.) From there the image data is placed in a memory buffer where it is looked at by a custom ASIC that handles interpreting the data. After processing, the data is placed back in the memory buffer (where the imaging ASIC may continue to work with it). Finally, when the memory buffer contains a finished image file, that file is moved to the camera’s storage card.



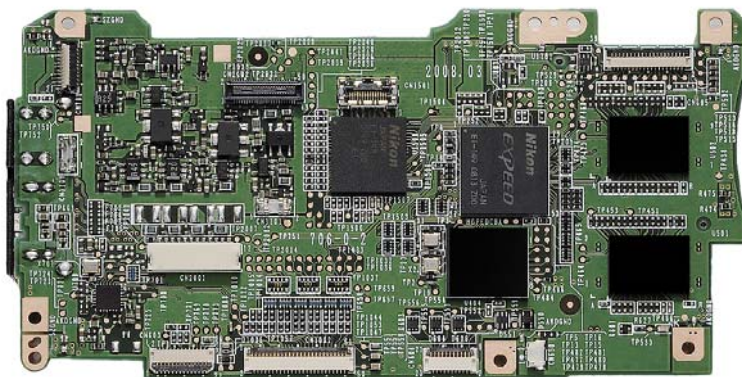
Canon was first to name their imaging system. They use the DIGIC name specifically for the imaging ASIC that does most of the heavy data lifting (demosaicing, applying camera settings, figuring out white balance, etc.). Sony named their imaging ASIC Bionz.

While Nikon has always had an imaging ASIC in their DSLRs, the marketing department didn't get around to naming it until the D3 and D300. And instead of naming just the imaging ASIC, they decided to give the whole system a name instead. The name Nikon chose was EXPEED. It even has a fancy logo:



Unfortunately, Nikon hasn't done much more than throw out some vague press releases on what EXPEED is or what it does. Essentially, EXPEED is just the name given to represent essentially all of Nikon's digital knowledge and algorithms that are applied in the camera's electronics. You'll note that Nikon has already applied the EXPEED nomenclature to Coolpix models as well as DSLRs such as the D90.

Inside the D90, sitting just behind the sensor and just in front of the color LCD, there's a PC board dedicated to the digital process. Curiously, somewhat contrary to Nikon's marketing, there's only one chip on that board labeled EXPEED (the largest chip in the photo below, just to the right of center), and that's the imaging ASIC.



Power

The D90 uses two batteries, only one of which is user-accessible. The main battery is a 7.4V, 1500mAh³⁷ Lithium-

³⁷ What's mAh mean? That stands for milliamp hour. In other words, the battery could provide a constant 1500 milliamps of current for an hour. Since the camera at idle draws less than 3mA, which would mean that the camera could be left on for over 20 days before the battery would go dead. Of course, once you start taking

Ion EN-EL3e pack, same as the one used in the D80, D200, D300, and D700. This battery is similar to but *not* the same as the EN-EL3 or EN-EL3a used in the D40, D50, D70, D70s, and D100. Each EN-EL3e battery weighs about 2.6 ounces (75g), which makes carrying multiple batteries painless.

The differences between the EN-EL3e and the previous EN-EL3 and EN-EL3a are:

1. The EN-EL3e stores more mAh than the original EN-EL3 (1500mAh versus 1400mAh; the EN-EL3a was also 1500mAh).
2. The EN-EL3e has a third connection terminal that the camera uses to monitor the battery condition.

It's this third connection that makes it impossible to use older EN-EL3 and EN-EL3a batteries in the D90: the camera will not operate at all if it can't get information about the status of the battery, which comes via that third terminal. However, note that the D90's EN-EL3e battery works just fine in a D40, D50, D70, D70s, D80, D100, D200, D300, or D700. In other words, if you have any of those other cameras, you can simply standardize on the battery that came with the D90.

To keep the confusion to a minimum, EN-EL3e batteries—the ones that work in a D90—are gray instead of the black color of the earlier, incompatible batteries. Bottom line: gray Nikon batteries work only in the D80, D90, D200, D300, and D700; while gray *or* black Nikon batteries work in the D40, D50, D70, D70s, and D100.

Note: Like all EN-EL3 type batteries, the terminals are exposed, so the risk of shorts that can cause battery damage, explosion, or generate heat that could start a fire are a small issue while carrying batteries without the protective cover. Keep

pictures and using the many powered features of the camera, that number drops considerably.

the protective cover on the battery when it is outside the camera or charger, if possible.

In the United States, the battery and MH-18a Quick Charger are supplied with the camera; in other parts of the world, the battery and charger may need to be purchased separately. In any case, you're most likely going to want a spare EN-EL3e.



The charger is light (3.6 ounces, or 100g) and modestly sized. The battery “docks” in the charger by sliding it into the charging position (don’t worry, you can’t do it wrong). The AC power cable is removable.

The design of the EN-EL3e battery makes it impossible to insert it incorrectly into the D90's battery compartment, so never force it. The same is true of putting the EN-EL3e into the charger. The MH-18a Quick Charger can fully charge a *fully depleted* EN-EL3e battery in a little over two hours. The MH-18a is fully compatible with 120 or 240 volt, and 50 or 60Hz outlets.

Another point of confusion for D90 purchasers coming from older consumer Nikon DSLRs will be the MH-18 versus MH-18a charger. It shouldn't be. Technically, the MH-18a is the charger designed to work with the 1500mAh batteries (EN-EL3a and EN-EL3e) while the MH-18 is designed to work with the older 1400mAh batteries (EN-EL3). But either will charge a D90 battery. The only real difference between them is that the older MH-18 is a little bit bigger than the MH-18a

supplied with the D90. For those of us who travel a lot, that was a welcome change.

The fact that the charger only has two connection terminals while the battery has three also confuses some users. The charger just charges the battery—more sophisticated battery systems sometimes use extra connections to tune or balance cells within the battery, which the MH-18a doesn't do—so the MH-18a only needs the two power connections. That third connection on the battery is *only* used by the camera, and it specifically is used to report the status of the internal power cells in the battery.

Note: Unlike the NiMH batteries used for the D1 series, the Lithium-Ion EN-EL3e used with the D90 shouldn't have to be "conditioned" prior to use.

Still, it has been observed by many that new EN-EL3e's seem to improve slightly with use, which means that they may have some storage effects that need to be rectified.

I would suggest, therefore, that you fully exhaust the battery (<10% charge remaining) the first two or three times you use it and make those first charges thorough ones, waiting until the battery cools before removing it from the charger (i.e. don't pop it off the minute the light stops blinking; let it continue to trickle charge for another hour or so). This should be enough to offset any storage effects and put the battery in full operating condition.

Changing Batteries

📷 The EN-EL3e battery is inserted into the camera as follows:

1. On the bottom of the camera, push the small indented button on the Battery Compartment door towards the center of the camera (towards the PacMan-like symbol; green arrow in photo). The door should pop

open.



2. Slide the EN-EL3e into the camera.



3. Once the battery is fully inserted, push the door closed. You should hear the door retainer click into place.

 To remove the battery:

1. On the bottom of the camera, push the small indented button on the Battery Compartment door towards the center of the camera (towards the PacMan-like symbol). The door should pop open.
2. Hold the camera so that the battery slides out of the camera. Don't worry, it won't fall to the floor; there's a retainer on the side of the battery compartment that

only allows the battery to stick 3/8" (1cm) out of the camera.

3. Firmly grasp the edges of the battery and pull it from the camera. You'll feel a bit of resistance at first, but the retainer should let go of the battery if you tug firmly.

*Note: The camera power switch should be in the **OFF** position before removing (or inserting) an EN-EL3e battery pack.*

Charging Batteries

 To charge the EN-EL3e:

1. Remove the battery from the camera.
2. Plug the MH-18a charger into a wall socket.
3. Slide the EN-EL3e battery into the cut-out on the top of the MH-18a. The status lamp on the MH-18a should begin blinking, indicating that the battery is charging.

Note: The legend next to the light on the charger confuses some people. If the charge light is blinking (), the battery is charging. If the charge light is in a steady on state (•), the battery is fully charged.*

Note: You do not have to completely discharge the EN-EL3e before charging it. Lithium-Ion batteries do not exhibit the “memory” effects that NiCad batteries did, and thus can be “topped off” at almost any time without consequences. That said, generally you’re better off not charging the battery if the level is at 90% or higher, as doing so repeatedly can reduce the overall capacity slightly. Likewise, you’re best off if you don’t run the battery down to <5% all the time, as repeated deep charges tend to reduce the life expectancy of the battery slightly. Neither is of enough concern to worry about, but if you’re trying to fully optimize your battery life, only charge it when it’s between 20 and 80 percent capacity if you can.

The battery charger can’t be used to power the camera, as is the case with some other cameras. This is a serious design flaw, in my estimation, adding extra cords and gadgets a D90 photographer shouldn’t need to deal with. (It doesn’t help matters that Nikon has had four different AC adapters and as many different chargers already in the short history of DSLRs). This proliferation of battery/charger/AC adapters is a very frustrating aspect of using Nikon DSLRs while traveling.

Battery Storage

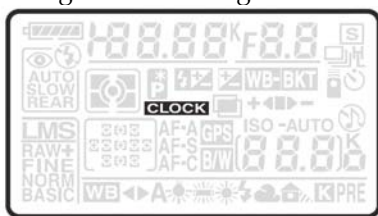
If you're not going to use an EN-EL3e for a long period of time (several weeks or more), you should make sure that the battery is neither fully charged nor almost empty. In the case of the former (fully charged), storing it for a long period may cause it to lose some of its capacity (a couple of deep charges—from <5% capacity to full—on the charger might restore that, but not always). In the case of the latter (empty), the battery could discharge too deeply and be damaged by that.

Thus, always store the EN-EL3e battery with a mid-range amount of charge left in it (optimally, it should be at 50% charge).

Clock Battery

The D90 also has a small, *internal* battery for keeping the date and time. This battery has an expected charge life of about three months. Keeping the camera powered for two days (either with an EN-EL3e battery in it or by connecting the camera to the AC Adapter) should fully recharge the internal clock battery.

When this battery depletes, a **clock** symbol appears on the top LCD and image files no longer have a date and time stamp:



Top LCD:

To recharge the clock battery, simply make sure that the camera has a fully charged EN-EL3e in it for two days.

Note that charging the clock battery is probably one of the reasons why some D90 users report that their battery life improved after the first uses of the camera. Once the clock

battery is fully charged, it needs only trickle charge energy from the EN-EL3e to keep it healthy.

Alternate Power Sources

As an alternative source of main camera power, you can use the EH-5a AC Adapter, which plugs directly into the **DC In** socket on the left side of the camera. The AC Adapter provides the camera with 9 volts at 5400mA (i.e. any third party battery or adapter that would connect to the **DC In** socket would have to supply the same voltage³⁸).

If you have an older EH-5 AC Adapter, you can also use that with your D90.

Here's the weird thing: the D90 uses the same battery technology (EN-EL3e series) as the D200, but uses a different AC adapter. It's an important detail for those of us who travel with and own multiple Nikon cameras. Personally, this was bad news for me, as at the moment I shoot with a D3 (uses an EH-6), a D90 or D300, and D700 (use an EH-5a), and an IR-converted D200 (uses an EH-6). This means that to have all the power capabilities I might need I end up having to travel with two sets of batteries, two battery chargers, and two AC adapters.

Note: Note that when running the D90 from the EH-5a without a charged battery in the camera, if you accidentally "pull the plug" during shooting, any images in the internal buffer are lost, and the Secure Digital card may be corrupted due to an incomplete write cycle. I generally recommend that you always have a battery in the camera when using the AC adapter.

³⁸ You'd also need to find the right connector which, unfortunately, is yet another Nikon-proprietary one. Here's the trick to get around that: buy the EH-5a. Cut the cable from the EH-5a to the camera in half. Wire the cut cable ends with a standard male/female connector set of your choice, and then use the same set on your external battery supply. You must be *very careful* to keep the voltages and polarities on pins correct. Failure to get these correct could fry the electronics of your camera, making it inoperable. Please read the legal disclaimer on the Copyright page before attempting to make your own external power supply.

*Note: The camera power switch should be in the **Off** position before removing or inserting **any** connection to the **DC In** slot.*

The D90 can also be powered by a variety of batteries in the optional MB-D80.



The optional MB-D80 comes with a tray (lower right) that allows you to use six AA batteries to power the camera. Alternatively, you can use one or two EN-EL3e batteries (lower left).

The MB-D80 can hold two EN-EL3e batteries or six AA batteries (which can be alkaline, NiMH, or lithium).

📷 To use the MB-D90:

1. Mount the MB-D80 to the D90 body.
 - a. Remove the Battery Compartment door on the D90. Open the door to about a 60 degree position from the body and pull on it with a steady force (green arrow). It should easily

snap out of its restraints. Do not force!



- b. Remove the cap covering the contacts on the MB-D80 and place the Battery Compartment door in the slot on the part of the MB-D80 that sticks into the battery chamber (green arrow in photo). This ensures you don't misplace the door while the MB-D80 is on the camera.



- c. Remove the EN-EL3e battery.
- d. Slide the contact end of the MB-D80 into the D90 battery compartment. As you do this, make sure that the tripod socket and outer

alignment tab on the MB-D80 are going into the D90 correctly. Do not *twist* the MB-D80 in relation to the camera.



- e. Use the large, knurled knob on the MB-D80 to secure the MB-D80 onto the camera.
2. Open the MB-D80's battery compartment by lifting up the Battery Door Latch handle and then turning it counter clockwise.

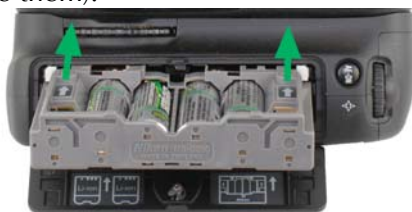


3. Remove the AA battery tray by pushing the two white plastic Battery Tray restrainers apart and pulling out

the tray.



4. If you wish to use AA batteries in the MB-D80:
 - a. Place six AA batteries into the tray in the orientation etched at each tray position (four batteries insert into on one side, two on the other side of the tray).
 - b. Push the battery tray back into the MB-D80. Note carefully the white orientation arrows on the top of the battery tray; these point to the side of the tray that goes into the MB-D80 first (and they should be facing up where you can see them).



- c. Set Custom Setting #D12 (see page <517> to the type of AA batteries you're using. (I recommend using NiMH rechargeable batteries of at least 2000mAh.)
5. If you wish to use one or two EN-EL3e batteries in the MB-D80.
 - a. With the AA battery tray removed, push a battery into either the left or right position in

the MB-D80. The proper battery orientation is the curved side down with the connectors up on the side that goes into the camera first.

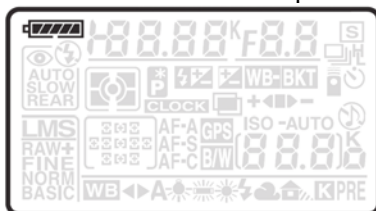


- b. If you wish to use two batteries (recommended if you have two), put the other into the second position, same orientation. You don't need to make any custom settings to tell the camera that you're using one or two EN-EL3e batteries.
6. Close the battery compartment door on the MB-D80, turn the Battery Door Latch handle clockwise, then fold the Battery Door Latch handle back against the MB-D80.

Note: If both batteries are fully charged, then the left-hand EN-EL3e battery (as you look at them with the door open from the back) is used by the camera first, and then the camera seamlessly switches to the right-hand battery. If one of the batteries you put in is only partially charged, then it will be used first regardless of which slot it is in.

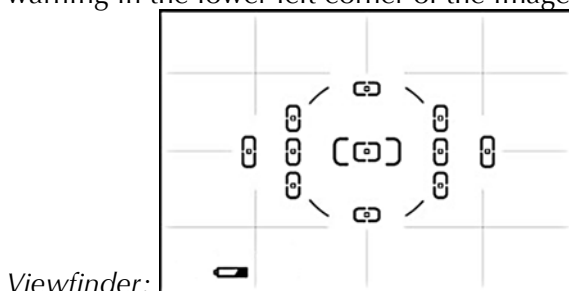
Battery Life

You'll probably be surprised to learn that the D90 uses very little energy when it sleeps between shots (<3mA). When turned OFF, it uses almost as much (typically <2mA). Thus, it makes little sense to turn the camera OFF between shots. The battery status is shown on the top LCD:



Top LCD:

When only one “bar” remains (i.e., the battery is low) and you have the Viewfinder Warnings option set (Custom Setting #D4, see page <509>), the viewfinder will show a low battery warning in the lower left corner of the image area:



Nikon’s manual gives two figures: 850 shots using flash every other picture and 4200 shots without it (there are some other small variables that change as well; I suspect Nikon was trying to suggest this as a likely range you might encounter).

Another way to think about battery life is by thinking about what batteries are actually installed:

<i>Internal Battery Compartment</i>	<i>MB-D80 Battery Compartment</i>	<i>Total Watt-Hours Available</i>
EN-EL3e		11.1
	One EN-EL3e	11.1
	Two EN-EL3e	22.2
	2500mAh AA	24.0

Put another way, if you get 1000 shots per battery just using the D90, adding an MB-D80 and using two EN-EL3e’s in it should double your life to 2000 shots. Ditto using high-capacity AA batteries in the MB-D80 instead of EN-EL3e.

More rigorous testing produces some more useful data:

- *Shooting any form of NEF reduces shots per charge slightly.* This is an unexpected result, but similar to the

D300. The only explanation I can think of is that something in the write-to-card mechanism is drawing enough power that the slightly longer write times impact the results. But it's clear and repeatable: the minute you begin to shoot NEF your shots per charge reduces. This is *not* a manageable parameter; if you shoot NEF, you get slightly reduced battery life, period.

- *A full image review on the color LCD reduces shots per charge by about half.* If you have **Image review** (PLAYBACK menu) set to **On** and the **Monitor off** time for image playback (Custom Setting #C4) set to **10s** and don't manually turn off the image on the color LCD after the shot, you'll reduce your shots per charge significantly. This, however, is a manageable parameter, and the curve is predictable. Cut your image review down from 10 seconds to 4 and you reduce the battery impact.

Note: Most D90 users use the color LCD to review the histogram, but there's still a trick you can use to preserve a bit of power. After you've reviewed the shot for exposure, press the shutter release partway to activate the metering and autofocus systems. The camera thinks you're getting ready to take another picture and turns the color LCD off (normally, the image would stay on the color LCD until the LCD time-out is reached or until you pressed the  button to turn it off).

No other factors are as critical to shots per charge performance as the two just mentioned. However, here are some additional tips on power consumption with the D90:

- *Use of autofocus lenses doesn't significantly contribute to power drain.* That's because it's a short draw of power. The peak may be over 500mA, but since it's normally such a short time during which this load occurs, it isn't a big deal (as long as you aren't repeatedly using autofocus between shots). The difference in power consumption using AF and AF-S lenses is negligible. But VR (vibration reduction) lenses reduce battery life by another 10% or more when the vibration reduction feature is used (the

vibration reduction in the lens is powered by the camera). Since many users tend to keep VR active by holding the shutter release partway, VR use can shorten battery life.

- *Power consumption is highest when the camera is “active”* (metering [200+mA], focusing [500+mA], taking a picture [1000+mA depending upon settings], transferring images to the Secure Digital card, etc.). Reducing the amount of time the camera is active (metering and focus active) is another key to reducing power consumption. Thus, you’ll get fewer pictures per charge if you leave the camera active for longer periods. You can cut the active timeout to 4 seconds via Custom Setting #C4 (see “Meter/Camera Active Time” on page <504>).
- *Power consumption is also high when the camera is connected to a computer or to a PictBridge printer.* This is one of the reasons I recommend using an external card reader for transferring files. While the camera is connected to the computer via the USB cable and the camera is ON, the camera consumes significantly more power than normal. It’s not unusual to see the battery indicator go from full to half or half to empty when transferring from multiple, large cards or shooting tethered for a long period. The same is true for PictBridge sessions: the camera is drawing significant power the entire time it is connected to the printer, so remove the connection when you’re not using it. Printing just 40 images with a Sony PictureStation printer connected dropped my battery power by almost half, for example.
- *The Lithium-Ion batteries of the Nikon D90 do not lose capacity over short periods of non-use.* If you store the battery for a long period of time, it will probably lose some charge, though. It takes very long periods of time to see significant power reduction on a battery not being used (a month or more). See “Battery Storage” on page <107>.

On the other hand, the D90 isn’t completely quiescent

when the Power switch is in the **Off** position. In particular, the D90 uses an LCD overlay mechanism in the viewfinder, which requires a small, but constant power source. This overlay supplies the AF sensor markings, the grid lines and the iconic warnings (if enabled with Custom Setting #D2 and #D4). You can verify this by looking through the viewfinder while removing the battery: the display will get darker without the battery in the camera.

The consequence of the LCD overlay needing power is that if you store a D90 for a month, at the end of that month you'll have either a discharged or low battery. Moreover, you'll likely be running the battery fully down, which as I've already mentioned, is not the way to leave Lithium Ion batteries if they're not going to be used for a period of time. Remove the battery from the camera if you're not going to use it for long periods of time.

- *Cold can affect apparent battery life.* Lithium-Ion batteries have pretty good cold weather performance—I'd be surprised if you see any differences down to freezing temperatures—but they still will have a tendency to produce power for shorter periods in extremely cold conditions. If you must use the camera in sub-zero temperatures, carry a fully charged backup battery with you and keep that in a warm place (some outdoor apparel has inside pockets for just this purpose). As performance drops on the battery in use, swap it with the warm one.

Cold doesn't actually "drain" a battery; it's the change in internal resistance at low temperatures that causes reduced function. So, once the replaced battery is again warm, it functions normally. You can usually juggle two EN-EL3e batteries this way and get the full number of expected exposures from each.

- *Fully charge your batteries.* When the charger indicates the battery is fully charged, it may not be. I generally leave my battery in for a short time after the charger

indicates that the battery is charged. The test: if the battery is cool to the touch and the MH-18a light is in a steady on state, the battery is fully charged.

- *5% is about the point where you definitely want to change batteries.* It is okay to ignore the battery level right down to about the 5% mark without any risk of losing the next picture (this is for a single EN-EL3e battery; users of two EN-EL3e batteries in the MB-D80 can let the first battery run down completely but should follow this advice for the second battery). Below the 5% level you'll want to switch batteries if you can, as VR, autofocus, and other major power drains can catch you unawares and leave you without the picture you just shot. I'd double that cut-off value if I were tethered to a computer. That said, I've run batteries down to the 0% mark—the meter is that accurate.

What I'm trying to point out is that once you're below the 5% mark, heavy current loads can make the camera power down suddenly, so you usually want to replace batteries to avoid potentially missing a shot, especially if you're filling the buffer. In a pinch, though, you can take the battery right down to empty. If you do, I'd recommend you do it one shot at a time, though.

Overall, it's generally not a good idea to run your battery completely down (below 5%), as you risk a "deep discharge" cycle if you do and don't immediately get the battery onto the charger. You can take batteries down until exhaustion if you have to, but you shouldn't do this regularly, and you should immediately put a battery discharged this way on the charger, if possible.

Overall, the D90's battery performance is decent. By minimizing use of a few power-hungry features and shooting only JPEG, you can typically get by on one battery in a full day of shooting (and I mean *full*).

Two fully-charged batteries are all I've ever needed shooting NEF images on my D90 during even the most intense shooting day, and that seems to be true for others I've talked to, as well. (Again, this might not apply if you're shooting with the camera tethered to a computer or printing with PictBridge.) The problem for me comes with multi-day trips in the backcountry, where I used to be able to carry two EN-EL3 batteries with my D70 and come out the other end of the trail a week later still taking pictures. With the D90, that won't happen unless I shoot JPEG, so I have to carry five or six batteries and watch my power consumption more carefully.

The good news is that carrying extra EN-EL3e batteries isn't really a big burden. They're small and light. But if you find yourself going through multiple EN-EL3e batteries regularly on shoots, you might want to consider getting the optional MH-19 Multi Battery Charger, which can charge two EN-EL3e batteries (it does so sequentially, one at a time). It's pricey (more expensive than buying two MH-18a units, go figure), but if it lowers the number of gadgets you have to carry it might prove useful.

Battery Notes

The D90's battery charger can be used worldwide, at any voltage from 100 to 250 volts. You *do* need to obtain the correct cables and/or adapters for the power socket, however. Sets of socket adapters can be found at any Radio Shack and most travel stores.

Since the D90 uses an intelligent battery system, you'll want to pay more attention to the information the camera tells you about the battery. Besides the usual battery status icon (on the top LCD), the D90 has the ability to tell you much more about your battery:

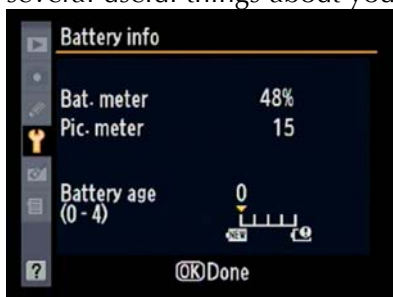
1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the SETUP menu (yellow wrench icon).

Note: Often this step requires you to first press the ◀ key on the Direction pad to get to the tabs, then use the ▲ and ▼ keys to get to the yellow wrench icon. Since I haven't yet fully described how the menu system works (see "How Menus Work" on page <192>) and this is the first point in this eBook with step-by-step instructions, I've added this note just in case you can't get to the right tab. All subsequent step-by-step instructions will assume you've read this note or the section on how menus work.

3. Use the Direction pad to navigate to the **Battery info** option and press the ▶ key or the **OK** button to select it.



4. The screen that is displayed next (below) tells you several useful things about your battery:



If you're using an MB-D80 with EN-EL3e batteries you'll see two numbers, one for the left slot on the MB-D80, one for the right slot.

- **Bat. meter** (battery meter) is a precise value for the amount of power left in the battery.
- **Pic. meter** (picture meter) tells you how many images you've taken so far using this battery charge. If you're trying to estimate how many batteries you need for an

event and you've been paying attention to this number (hint: look at it just before changing batteries) you'll have a very good idea. I routinely see values near or above 800 images when my battery is low when shooting NEF images³⁹.

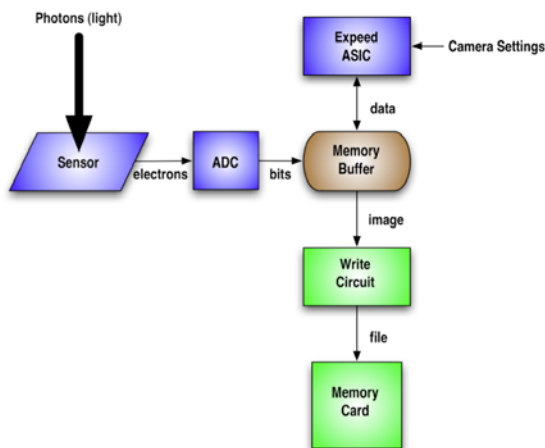
- **Battery age** (charging life) gives you an indication of how many more uses you can get out of this battery before you need to replace it. When the small yellow triangular indicator is above the right edge of the bar and reads **4**, you should consider retiring the battery and obtaining a new one, as it won't be able to hold charges well.

Image Storage

While the D90 has an internal memory buffer that *temporarily* stores data obtained from the sensor, it uses a Secure Digital memory card to permanently store digital images.

When you take a picture, the data is interpreted by the sensor-based ADC (Analog-to-Digital Converter) and image processor and then moved into an internal memory buffer. Images in the internal buffer are moved as soon as possible to the storage card. After an image is written to the storage card, the buffer space it used is freed up. Put another way: on the one side the D90's sensor and digital circuitry is filling up the buffer, while on the other side the storage circuitry is emptying it.

³⁹ The low value here is because I've had my D90 hooked up to the computer taking screen shots, not taking pictures.



Having a memory buffer is a very important concept to understand, as it has practical implications:

- Internal buffer memory space is limited.* The D90 can buffer up to 100 JPEG images in anything but the best quality, 25 JPEG Fine Large images (best quality), but a maximum of 9 NEF images or 7 NEF+JPEG images. The camera cannot take additional pictures when the buffer is full. As images are written to the Secure Digital card, buffer space is freed. Any time that there is enough space remaining in the buffer for an image, the camera can again take a picture. When using the D90 set to a Continuous shooting frame advance, once the buffer is full the camera slows, essentially to the speed at which it can write a single image to the card. Card speed determines the frame rate in that case (e.g. faster cards produce faster frame rates when the buffer is full).
- Internal buffer memory is temporary storage.* Images in the buffer are not accessible directly—only the camera’s electronics can touch the buffer memory—and until an image is written to the Secure Digital card, your photo has not been “saved.” If power is completely lost with images in the buffer, those images not yet moved to the storage card are also lost. When the camera is writing data from

the internal buffer to the card a small green LED light on the back of the camera is lit.

- *Some controls impact buffer size.* Specifically, **Long exp. NR** reduces buffer size, as do setting ISO **to 0.3** or higher, using **High ISO NR** at ISO 800 or higher, and using **Active D-Lighting**.

Why does the camera need an internal buffer? Well, the D90 has to deal with a large amount of raw data for each image (ranging from 10.8MB for NEF to just ~400KB for the smallest JPEG). Even at reasonably fast write speeds to the Secure Digital card (~9.5MB/second), it takes a measurable amount of time to write these from the camera to the storage card. While JPEG images are much smaller in size, the camera still has to create that image from the original data, which also takes a small amount of time. Without a buffer, the camera would force you to wait a large amount of time between taking pictures. The buffer allows the D90 to be doing two things at once (take another picture while handling the data for the previous one).

Note: The D90 can lose images. When you turn the camera off it may still be writing images from the buffer to the storage card. The green indicator light stays lit to indicate this—in other words, while you turned the camera off it is smart enough not to actually listen to you until the buffer is empty. But if you take the Secure Digital card out of the camera while that indicator light is lit, you'll not only lose some images, but you could corrupt the formatting of the card, potentially losing all the images on the card. So make sure the light is off before removing cards.

Tip: Here's one not many D90 shooters know about: you can clear the buffer! This is done by holding down the Delete button (the trashcan: ) while turning the camera off. The camera will finish writing the current image (so that it doesn't corrupt the card formatting) then purge the rest of the images in the buffer.

Buffer Sizes

The remaining buffer is always shown by the **r** indicator⁴⁰ while shooting, so it is always easy to see where you stand in terms of remaining memory. But a number of options impact buffer size. Here's what my D90 says is available at my usual camera settings:

	<i>Normal</i>	<i>High ISO NR</i>	<i>Long exp NR</i>
NEF+JPEG	7	5	2
NEF	9	5	6
JPEG Fine L	13	5	10
<i>These numbers show up in the viewfinder as r values where normally you see Frames Remaining. Example: r 13</i>			

Wait a second, what's with those numbers? After, Nikon says 25 for **JPEG fine Large** and 9 for **NEF** in their manual. The difference has to do with write efficiency. The figures the camera displays represent actual buffer size, but the camera is normally fast enough in writing that in Continuous frame advance you'll see the **r** indicator increment downwards more slowly than once per picture (with **JPEG fine Medium** and a fast card, it never gets below **r2** on my D90). Thus, the numbers in Nikon's manual are *effective* buffer sizes.

Unfortunately, Nikon doesn't give a full set of numbers in their manual (only the "Normal" *effective* buffer numbers appear, and then only in the Appendix). Just remember that setting the noise reduction capabilities will reduce the *effective* buffer size.

⁴⁰ Both the top LCD and the viewfinder Shots Remaining indicator switch to a Shots Remaining in Buffer indicator when the shutter release is pressed partway, and a small **r** is used in front of the number to indicate this. What you don't want to see is **r0**, which means that the buffer is full.

To repeat, the D90 never reports more than 99 images available in the buffer (and never more than 13 for the highest quality image settings), but if you set the camera up to shoot a series of images in Continuous frame advance, you'll note that, especially for most JPEG settings, the buffer remaining indicator doesn't seem to count down with each image you shoot.

The numbers I report in the table above are safe: they represent absolutely worst case scenarios, even with very slow cards.

*Note: If the number of images that can be stored on the card is less than the free buffer size would allow, the **r** Buffer Remaining indicator indicates how many images **are left on the card**. Thus, as you get close to filling a card with images, you'll start seeing the Buffer Remaining indicator mimic the Frames Remaining indicator. Put another way, you can't put images into the buffer that can't be saved onto the card.*

Note: 100 is the absolute limit for any single press of the shutter release. In other words, when the camera gets to 100 continuous frames, it will stop, even if the buffer is free. You have to take your finger off the shutter release and repress it to take more shots.

Secure Digital

In the United States, Nikon does not supply a Secure Digital card with the D90 (i.e., you usually must purchase one separately if your dealer didn't include one with the camera; though in a few cases I've noticed special deals where a card is bundled by the dealer with the camera).

Secure Digital is a very small card type that requires the camera to have all the necessary circuitry to communicate directly with the memory itself (CompactFlash cards have a more sophisticated intermediary "controller" in them that does some of the work).

As I write this, Secure Digital cards are available from a wide range of vendors in sizes ranging from 64MB to 32GB in size (the limit keeps getting pushed up; now that cameras like the D90 support FAT32, we're a long way from the theoretical limit).

*Note: A card labeled **SD** is probably 2GB or smaller in size and formatted as FAT16. A card labeled **SDHC** would be 2GB or larger and formatted as FAT32. If you format an SDHC card using FAT16 its usable capacity on the D90 is reduced to 2GB.*

The D90 can hold only one card at a time, which means that when the card in the camera fills up, you simply swap it with an empty card, just like you'd load in blank film after exposing a roll in a 35mm film camera (make sure you turn the Power switch on the camera to **Off** before swapping cards, and don't do that until the green LED Card Write indicator on the back of the camera is no longer lit).

Alternatively, you can transfer the images saved on the card to your computer, then reformat the card. But since that takes time and access to your computer, most D90 users carry a few Secure Digital cards with them so that they can quickly get back to shooting.

You may wonder where the "secure" in the name comes from. Secure Digital is really a derivative of an older format, called MMC (multimedia card) with the addition of a digital rights management system to protect Copyrights. Companies can therefore produce Secure Digital cards with protected content on them that can't be copied (as in pre-recorded cards for MP3 players). For camera use, however, this feature isn't used.

Secure Digital cards are often rated in three "classes" of performance:

- *Class 2:* minimum of 2MB/sec transfer speed
- *Class 4:* minimum of 4MB/sec transfer speed

- *Class 6*: minimum of 6MB/sec transfer speed

To get the full write performance the D90 is capable of, you need a Class 6 SDHC card. Unfortunately, not all cards are marked this way, and the classes only refer to minimum performance. Some cards are marked with specific MB/sec performance numbers, and I personally would stick to cards rated no lower than 10MB/sec with a D90 if I could.

Unfortunately, few mark their cards this way, and even the class indicators aren't 100% predictive of how fast a card will perform. I'll get to performance more in a bit, later in these sections on cards.

Solid State Memory

Secure Digital cards contain nonvolatile memory chips that retain information stored on them even when power is not present. The originating parties of the Secure Digital design are Matsushita (Panasonic brand in the US), SanDisk, and Toshiba; almost a thousand companies now make products that support the standard. One of those, of course, is Nikon.

While not indestructible, Secure Digital cards are designed to withstand a 10-foot drop without damage, and they're relatively impervious to the elements (they shouldn't be immersed in water, however). If you keep your Secure Digital cards in their small, plastic storage containers when not in the camera, they should last as long as the camera does.



Size of the card? About 1.25 x 15/16 x 1/16" (32 x 24 x 2.1mm).

The memory of a Secure Digital card is typically organized like a computer disk, complete with file directory, file allocation table (FAT), directories, and files (ironically, I find

⁴¹ There's also a "thin" version of SD that measures 1.4mm thick. This type of card can be used in a D90, as well.

that a book I wrote over two decades ago, *Programmer's PC Sourcebook*, has detailed information on the structure digital cameras use). Like a disk, a Secure Digital card can develop "bad sectors" over time and files can become "fragmented" if you delete individual files. Fortunately, the act of using the D90 controls to "format" a Secure Digital card generally removes file fragmentation (as well as the files!).

Formatting a card using a card reader attached to a Windows PC *also* isolates bad sectors, but only if you avoid using the Quick Format option⁴². In general, however, I recommend that you stick to formatting your Secure Digital card using the camera, not your computer.

If you use one of Microsoft's more recent versions of Windows to format a card, such as Windows XP, be sure to specify **FAT** for cards smaller than 2GB, not the **FAT32** format normally used by a PC⁴³.

Secure Digital cards that have solid-state memory do have a limit to the number of times that they can be written to. Fortunately, you're not likely to hit that limit (usually in the hundreds of thousands of times) in the lifetime of your camera. For example, if you had a 128MB card that had a

⁴² Virtually all disks and storage devices have a few "bad sectors" on them. That's normal, and all manufacturers "mark" these sectors with a flag in the tables at the start of the drive, so that the operating system doesn't use them. But if the flags get erased for some reason, they aren't restored with Quick Formats (which is what all digital cameras do, by the way). Likewise, if another sector eventually goes bad (which eventually happens on all drives), it isn't found and marked by Quick Formats. If all that isn't enough, there is a difference between a "low level" format and "high level," or "logical format." Bottom line: if you begin experiencing problems with a single storage card, try performing a *full* format of it on a PC. This may mark a sector that has gone bad and restore the usefulness of the card. If that still doesn't correct the problem, you'll probably have to return the card to the manufacturer for replacement.

⁴³ The D90 supports FAT32, but using FAT32 on cards that are 1GB or smaller is inefficient. Unless you have a card at least 1GB in size, use plain 'ole FAT. Moreover, Macintosh users don't have easy access to FAT32 facilities. If you know what you're doing, you can drop down into the command line interface and use something like `newfs_msdos -F 32 -b 32768 /dev/disk1` to format your card, but this is a utility for advanced users who know what they're doing.

stated life of 300,000 writes, and saved only in NEF format, you'd have to shoot somewhere north of 5 million pictures before you hit the card's write limit. You're more likely to encounter problems with the body's shutter mechanism (typically good for 50,000 cycles) before you will with your Secure Digital card.

Different card types work at different speeds. At the time of this writing, the Lexar Professional 133x (20MB/sec) and SanDisk Extreme III (30MB/sec) cards seem to be about the fastest in writing large files on the D90. Overall, the fastest I seem to be able to get a D90 to write to card is around 20MB/sec, and the SanDisk Extreme III (30MB/sec) is the only card on which I can achieve that.

Most cards marked in the 100x to 150x range seem to deliver between 10MB/sec and 15MB/sec performance (including the old SanDisk Extreme III not marked with a speed). Every Class 6 card I tried did achieve at least 6MB/sec, though I've heard reports from others that they've seen some that do worse than that.

Card performance is going to come up most when trying to empty the buffer of NEF files. The difference between 6MB/sec and 20MB/sec is enough to make between a three and twelve-second difference in *completely* emptying a buffer of raw files (depends upon your settings). But even freeing up the buffer to take another shot is different: at 20MB/sec the buffer gets a freed up image in about a half second, while at 6MB/sec it will take about a second and a half.

With JPEG shooting, the issue of card speed is slightly less important, both because the number of images that can be shot before the buffer is filled is lower, but also because the file size being written to the card is smaller. The difference between a quarter of a second and three quarters of a second is not quite as annoying should you fill the buffer and need to wait for it to clear. And if you shoot at any JPEG setting other

than the highest, the buffer size of 100 images is going likely mean you never encounter a buffer-clear wait.

Bottom line: NEF shooters should look for the fastest cards, particularly the SanDisk Extreme III (30MB/s). JPEG shooters probably will be fine with Class 6 or 133x and faster cards.



The card goes in connector-edge first (edge with notch), with the main label facing the outside of the camera (towards the back of the camera). You'll feel a bit of resistance when you've pushed the card most of the way in—you need to continue to push until the card is fully engaged with the connector inside the camera.

Using Secure Digital

📷 To insert a Secure Digital card in the D90:

1. Turn the Power switch to the **OFF** position.
2. Open the door covering the card slot. This is done by sliding the door towards the back of the camera, at which point it should spring open.
3. Examine the Secure Digital card and make sure that the switch on its side is *not* in the **Lock** position. Like floppy discs, Secure Digital cards have a Write Protect switch. In the **Lock** position, the camera cannot write to the card.
4. Insert the Secure Digital card (connector end first, label side *towards* the back of the camera facing you; the camera prevents you from inserting it incorrectly, so if seems like you need to use excessive force, you're probably inserting the card backwards). You have to push the card all the way in until it “clicks” into place.

5. Close the door that covers the Secure Digital card slot by folding it back from the sprung position and sliding it forward on the camera.
6. Turn the camera's Power switch to **ON**. If the camera blinks **CHA** and **0** on the Top LCD, the Write Protect switch on the card is probably set to **Lock**. The camera also displays the following if you try to take a picture:



Remove the card and try again, paying particular attention to Step 3.

*Tip: It is possible to “take” pictures without a card in the Secure Digital slot if Custom Setting #F6 has been set to **Enable release** (see “Lock Camera with No SD Card” on page <490>). With this setting, the camera acts like it takes pictures, but because there’s no card in the camera you’ll see a red **Demo** in the upper left corner of the frame on playback; nothing will be saved (unless you’re connected to a PC running Nikon Capture NX2) and the image eventually goes away (can’t be reviewed any more). If no card is present in the camera, you’ll see an **-E-** on the top LCD on the Frames Remaining indicator.*

📷 If you haven’t previously used the Secure Digital card before inserting it into a D90, or if the card contains images you no longer need, you should format it (see “Formatting Cards with the Camera” on page <134>).

Once the card is formatted, the Frames Remaining indicator resets and shows the number of images you can take at the current image quality setting (if that number is larger than

1000, then **K** is displayed just above the Frames Remaining indicator).

*Note: Formatting a Secure Digital card “removes” **all** information and images from the card. Always save your images to a computer before formatting a card! I use the quotes around “removes” because the image data isn’t actually erased; only the directory information that points to it is rewritten. While it is possible to recover images immediately after performing an in-camera format, it is a hassle to do, and won’t be fully successful if anything has been written to the card since the format.*

The D90 tells you when a Secure Digital card is full by blinking **FULL** and **0** in the Frames Remaining indicator (top LCD and viewfinder). The card isn’t necessarily full, however. It just doesn’t have enough room to store another picture at the current image quality setting.

*Tip: If you’ve been shooting using **NEF(RAW)** or the **NEF(RAW)+JPEG** qualities, both of which chew up considerable space per image, you can often squeeze a few more JPEG-only images onto the card because the JPEG compression makes the resulting image files much smaller.*

 To remove a Secure Digital card from the D90:

1. Turn the Power switch to the **OFF** position. *Important:* Before moving to Step 2, confirm that the green Write Access lamp is not lit (the camera does not completely shut down until buffer data is written to the card).
2. Open the door covering the card slot by sliding the cover towards the back of the camera.
3. Press in on the edge of the Secure Digital card. The card is spring loaded in the slot and should pop out slightly, allowing you to grab its edge.
4. Remove the card from the camera.
5. Insert another card into the slot, if desired.

6. Close the door that covers the Secure Digital slot.
7. Turn the camera **ON**. Check to make sure the Frames Remaining counter shows that you have frames available, and not **Err** or **0**. (If you see **Err**, try removing the card and flip the Write Protect switch from the **Lock** position; if you see **0**, try using the camera's **Format** command to erase the card.)

Nikon-Approved Secure Digital Cards

Nikon makes a big deal about “operation not guaranteed” unless the Secure Digital card has been tested and approved by Nikon. Unfortunately, their list of tested cards is short:

- SanDisk cards from 512MB to 8GB
- Toshiba cards from 512MB to 32GB
- Panasonic cards from 512MB to 32GB
- Lexar (including Platinum II and Professional) from 512MB to 4GB

I've used a range of other cards in the D90, including some generic ones, and have yet to find any that cause operational issues with the camera. Unfortunately, Nikon doesn't think that. I've received multiple reports from users who've contacted Nikon technical support about a digital camera problem and were dismissed out-of-hand for “not using an approved card.”⁴⁴ Don't let it be an issue: spend a couple of dollars to purchase one of the approved cards at a low capacity (e.g., 1GB SanDisk, which is commonly available) so that you can verify that anything you report isn't “card related.”

⁴⁴ Shortly after my D100 eBook stating the same thing first appeared, NikonUSA apparently changed their internal policy regarding non-tested cards. According to my talks with NikonUSA Technical Support, they are instructed to no longer refuse to troubleshoot problems for customers using non-supported cards. Still, I keep a supported card on hand—this way we can skip through the troubleshooting steps that try to isolate whether it has to do with the particular brand of card or not.

Personally, I've found the SanDisk Extreme III cards marked 30MB/sec (there are older ones that aren't marked that way) provide me the best performance on my D90.

Formatting Cards with the Camera

Like other Nikon DSLRs, the D90 supports a two-button format (two buttons marked with a red  are held down and used to initiate the formatting process); alternatively, you can use the menu system.

 If you haven't previously used the Secure Digital card before inserting it into a D90, or if the card contains images you no longer need, you should format it as follows:

1. Put the card into the D90 (with the camera's power off).
2. Turn the D90's power switch to the **ON** position.
3. Hold down the two buttons labeled  (in red) for two seconds. (One is on the back left of the camera [ button]; the other is just in front of the top LCD [ button].) When the top LCD begins blinking the label **For**, release the buttons.
4. Immediately press the two  buttons again. Formatting time varies with the size of the card; a fast 1GB card usually takes a few seconds. The top LCD shows **For** in the Frames Remaining indicator while the camera is formatting.

Note: Step #4 is a bit confusing to new D90 users. Apparently, Nikon didn't think that holding down two buttons once for two seconds was a unique enough combination to preclude accidental formatting. Since erasure is a permanent loss of data, I agree with Nikon's conservatism here.

Once the card is formatted, the Frames Remaining indicator resets and shows the number of images you can take at the current image quality setting (if that number is larger than 999, then **K** is displayed just above the Frames Remaining

indicator; 1.7 in the Frames Remaining indicator with the **K** also showing would mean 1700 frames can be taken).

Alternatively, to format a Secure Digital card in the camera using the menu system:

1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the **SETUP** menu (yellow wrench icon).
3. Use the Direction pad to navigate to the **Format memory card** option and press the **▶** key on the Direction pad or **OK** button to select it. (If the option is grayed out, make sure you have a card in the camera!)



4. Use the Direction pad to navigate to **Yes** and press the **OK** button to complete the action.



Secure Digital Troubleshooting

Problem: The capacity of your Secure Digital card seems to be a little less than the one stated on the label (e.g., you seem to only be able to store 114MBs of data on a 128MB card).

Solution: Actually, this is normal. Secure Digital works just like a disk drive on a computer, with an area set aside for a file allocation table and a file directory. In addition to the reserved space, storage manufacturers sometimes use 1K to mean 1000 instead of the more correct 1K=1024. Also, the number of folders created has a small impact on overall capacity. Like disk drives, sometimes areas of the card are marked as “bad,” and this, too, reduces capacity.

Problem: It seems to take longer to store information on a Secure Digital card than it did when you first obtained it.

Solution: If you erase individual files instead of reformatting the card, it's possible to get file fragmentation on the card. When this happens, data for any given file is non-adjacent, and the camera has to write extra information into the file directory. This, in turn, can cause slightly longer write times due to the extra information that must be written in the directory.

Likewise, it's possible for cards to get lost clusters⁴⁵ and files on a card. Use the camera's **Format** option to erase all information from a card instead of individually deleting files.

Alternatively, you can reformat cards on your computer if you have a card reader (it works just like formatting any disk drive—open a window for the drive in Explorer [Windows] or Finder [Macintosh] and use the normal formatting procedure

⁴⁵ Clusters are the basic unit in which information is stored on disk drives (and Secure Digital). A file is made up of many clusters, and the directory and other information stored at the beginning of the disk keeps track of which clusters belong to which files. When a cluster is “lost,” the information tracking it uses has been damaged or erased. This means that your data may still be intact, but that the structure of the disk is incorrect, hiding that data. As noted elsewhere, having a good disk recovery utility handy can sometimes help you retrieve precious photos you thought the camera had lost forever.

for drives; just make sure that you pick **FAT**, not **FAT32** if you're using a recent version of Windows, such as XP, and aren't using a 1GB or larger card). However, I generally don't recommend formatting cards on a computer unless the camera is specifically having an issue with the card that a full formatting might fix.

Problem: You get occasional "black" frames instead of images.

Solution: There's likely a bad sector on the card that isn't marked as such. Another symptom is sometimes excessively long writes to the card (or the green "writing to card" light stays ON), or you get large black areas through your images. You need to perform a *full* format⁴⁶ on the card using a card reader attached to a PC (which should detect and mark bad sectors). However, if black frames appear on more than one of your cards or on a regular basis, you should have your camera checked by Nikon. Black frames are also a possible indication of a shutter problem on D90 bodies.

Problem: You can't find images on the card or the computer complains about damaged files when you try to transfer images from camera to PC.

Solution: One of several problems is likely present on the card: (1) the FAT (File Allocation Table, which tracks clusters in use) is corrupt; (2) the directory has incorrect information about files, usually either cross links of data between two images or missing cluster information; or (3) something else is wrong with the data or structure on the card, such as a damaged sector, an incomplete file, an unexpected End-of-File marker, and so on. In every case, you must *immediately* fix the problem or risk the permanent loss of your image data. You may or may not be able to fix the problem, but if anything gets written to the card before you begin attempting a correction, your ability to recover data is compromised. Macintosh users should be extremely careful when mounting

⁴⁶ Note that the Windows default is to perform a *quick* format.

problematic cards on their computers, as several behind-the-scene tasks can write to the card without your knowledge.

So how do you fix the structure and data and recover your images? The best choice is to use a product such as Photo Rescue (<http://www.datarescue.com/photorescue>). This tool—versions are now available for both Macintosh and Windows—generally can find and recover images that are the result of most structure errors, though you may have to go into the advanced mode and play with some of the settings in order to do so. Current versions of Photo Rescue understand the NEF format, and can resurrect a raw data file, complete with the proper extension. If you haven't written anything to the card after the error occurred, you can often recover every image on the card. Note that to use Photo Rescue you need to connect the camera to the computer, or you need to put the card into a card reader attached to your computer.

Generalized disk tools (like Norton Systemworks or **SCANDISK**) know nothing about image file formats, so they usually can't scan data on the card and resurrect orphaned data or rebuild incomplete image files. Personally, I travel with Photo Rescue installed on my laptop and a card reader that can mount Secure Digital cards.

One other point: if you move cards between cameras, sometimes the reason why you can't find images is because they're stored in separate folders for each camera (see "Folders" on page <173>).

Still Image Formats

The D90 saves still images to the Secure Digital card in two image formats, JPEG and NEF:

- Saving an image in JPEG format performs the necessary steps to convert the sensor data into an image using the camera settings that are in effect, reduces the 12-bit capture data to 8 bits, copies the camera settings into the EXIF fields, and applies data compression that loses image

information. (Unlike many previous consumer Nikon DSLRs, all D90 manipulations of the image data are done in 12 bits prior to reducing to the final 8 bits required by the JPEG format.)

- The NEF format “preserves” the sensor data⁴⁷ along with copying the camera settings into the EXIF fields. In addition to the raw sensor data, NEF format also stores a **JPEG basic** image as a “thumbnail.”

If you want the highest quality image the D90 is capable of, use NEF (though note that the latter requires that you use appropriate software to decipher the data; see “NEF Format” on page <158>). If you know your way around digital image editing programs and immediately convert your JPEG files into a lossless format, such as Adobe’s PSD (Photoshop data) format, the actual loss of data using JPEG can be kept essentially invisible, at least at moderate viewing sizes.

I should probably take a moment here and elaborate on a sentence in the previous paragraph (the one that starts “If you want the highest quality...”). The primary difference between JPEG and NEF is that, for JPEG the camera’s electronics have to do all the work of assembling an image from the data and your settings, while with NEF that work is postponed until you get the image data to a computer. JPEG (potentially) suffers from four things that can “harm” image quality:

- *The camera’s electronics are static.* They’re only as good as the state-of-the-art in early 2008 when they were locked down in design. Those of us who’ve been using DSLRs for years know that image processing software is still getting better every year. By delaying the processing, you potentially can take advantage of image techniques that came to be after the camera was designed.

⁴⁷ Preserves is in quotes because the D90 doesn’t really preserve the actual 12-bit values when it stores in the compressed NEF format, instead using a “visually lossless” compression format.

- *The camera's electronics "reduce" the data set.* In particular, tonal data is reduced from 12-bits to 8-bits in the process of creating a JPEG image. That's not a big issue if you never post-process your images, but it can be if you make drastic changes in software post-processing of the image. Note that the D90 doesn't actually reduce the data set until it's done manipulating the image data and puts it into final JPEG format. All in-camera adjustments are made in 12-bit by the D90. Still, if you're going to make any changes after the fact to the image, the final 8-bit data storage size is a limiting factor.
- *The camera uses the settings you made.* Make a mistake on setting white balance, sharpening, or some other camera setting? Well, with JPEG that mistake is encoded into the image data, and it'll take careful post-processing to take it back out (if that can be done—not all such mistakes can be undone). NEF allows you to alter many of your camera settings after you've taken the picture.
- *JPEG involves compression.* The final step of taking the manipulated image data and putting it into a file format that can be understood by most software also involves a compression step that has the potential to "lose data." No, I don't mean that some pixels disappear, but rather that the original value of that pixel may be altered slightly and not recoverable. I'll have much more to say about that in the section on JPEG that comes in a few pages.

If you're getting the feeling that I'm strongly in favor of the NEF format, you're right. For serious photographers, shooting in NEF is like retaining and working with a negative while JPEG is like accepting the print that comes out of the lab. The reason most amateurs avoid NEF format is that they don't want to spend any time post-processing their images. Likewise, some event photographers shoot so many images that post processing all of them would take too much computing power and time.

Fair enough. Just realize that you're going to have to make some choices about how you shoot with your D90, and JPEG

versus NEF is one of the key ones. Make sure you're making the right decision for yourself⁴⁸.

Okay, let's delve into the details so you can better understand what you just read.

Video Image Format

The D90 has the ability to create and store video files, as well as still images. These files are 24 frame per second Motion JPEGs saved in the **.AVI** file format.

Motion JPEGs are not the same as MPEG (of which there are several subtypes), yet there are many similarities. In traditional MPEG files, the initial frame in a scene is encoded fully (called an I-frame) and subsequent frames are usually only defined by differences, called interframe prediction.

The problem with MPEG files is that they require sophisticated equipment (software and sometimes hardware) to edit, as the individual frames are not defined in an easily deciphered way. Motion JPEG, on the other hand, records each frame as an individual and complete JPEG, making display and editing much simpler. Think about it: to see the third frame of an MPEG you must first get the first frame, then apply the second frame differences, then apply the third frame differences. With a Motion JPEG, you just look at the third frame!

One thing that makes things confusing is that Motion JPEG is often abbreviated M-JPEG, which starts to look and sound a lot like MPEG. But be aware they are two distinctly different beasts, and Motion JPEG can be edited by just about anything

⁴⁸ JPEG shooters should note that the D90 does a pretty darned good job of rendering images in the camera. In particular, the noise reduction in-camera is quite good and difficult to equal or better in raw file conversions. It's not that JPEG quality is *bad*, it's that NEF quality *can be* better in the right hands. By these comments I don't mean to try to scare anyone off from shooting JPEG—I do it myself from time to time when the situation warrants it—but only to point out that you give something up by doing so.

that edits digital movies, while MPEG requires equipment and/or software that understands it.

Finally, we have the **.AVI** bit to deal with. **.AVI** and **.MOV** (Quicktime) are what are known as container files. Why do we need a container? Because we have other things that need to be stored with the video, most notably the sound! Container files can contain many other things, as well (codecs, for example), but for our purposes the main two things in the container are video (JPEG frames) and audio (8 kbps monaural ADPCM⁴⁹ sound).

The downside of Motion JPEG is that it creates very large files, because there is no interframe (time-based) compression. At full size (1280x720) the D90 generates a little over 100MB per minute. Put another way, you can fit only *two* five-minute video scenes on a 1GB card. If you're serious about using the D90 as a video camera, get lots of large capacity SDHC cards.

Another downside is that Motion JPEG—unlike most of the other related video formats—doesn't currently have a universally recognized standard definition. Fortunately, because it's part of that container, there's usually enough definition in the container itself that virtually everything that produces Motion JPEG is supported by virtually everything that reads and displays Motion JPEG. At least as I write this...

Pixels

Before we get to the individual data formats, let's make sure that we have some basic understanding of the underlying element used in them: pixels.

A pixel is the smallest element of a digital picture. You've probably seen camera resolution figures expressed in the form of two numbers, say 4288 x 2848. This means that the camera produces results that have 2848 rows containing 4288 columns of data. At each row/column intersection, there's a

⁴⁹ Oh no, another acronym! Means Adaptive Digital Pulse-Code Modulation.

pixel, which is used to describe the color that should be displayed there.

Pixels contain color information, usually expressed as individual values for red, green, and blue⁵⁰. Each color value is stored in a series of bits. Bits are the smallest data elements computers understand; a single bit has a value of either 1 or 0 (thus, an example 8-bit value is 0100 1101). While the D90 is capable of producing 12-bit values for each color (assuming you shoot NEF and use a converter that retains that data), most computer imaging programs, including Photoshop, normally use 8-bit values for most work⁵¹.

In computer jargon, eight bits are called a byte, and most disk and memory storage capacities are expressed in bytes. For example, the main memory of your computer might have 67,108,864 bytes (64MBs) of space. The non-round number is caused by the binary nature of computers, where everything is expressed as a power of 2. A thousand in computer counting turns out to actually be 1024; therefore most storage capacities are slightly understated. Secure Digital cards used by the D90 have storage capacities expressed in bytes, as well.

To form one complete digital image you must store 24-bit (for JPEG) or 12-bit (for NEF) values for each pixel. Why 24-bit for JPEG? Remember, we need 8 bits to store each of the three primary colors for JPEG files, while NEF files just contain a single 12-bit data point for each photosite (the color information is deciphered later). You do this in a compilation of bytes called a file. On a D90 at its highest in-camera resolution, that amounts to a minimum of 36,636,672 bytes of data (4288 x 2848 pixels at 24 bits each), which we'd

⁵⁰ When I write about the Red channel, Blue channel, and Green channel elsewhere in this eBook, I'm referring to these individual color data points.

⁵¹ Photoshop CS3 allows most of its image editing tools to function with 16-bit data, but since all consumer printers and almost all commercial printers only accept 8-bit data, most people still use Photoshop only with 8-bit data. Photoshop CS4 now supports 16-bit printing with Apple Macintosh OS-X, by the way.

normally just round off and call 37MB. That means that a file containing that image would contain a string of over 290 million 1's and 0's. Actually, slightly more than that, since most file formats require some additional information that describes the characteristics of the data in the file. (Puzzled by the 290 million number? Remember, there are 8 bits in a byte!)

To put that in perspective, this eBook only has close to a million characters in it, so if you took every letter in this eBook and made it into a 1 or a 0, you'd need almost 300 eBooks just to contain the data for one image.

Obviously, we're talking about a huge amount of data. To help deal with the storage issues all that data raises, Nikon *compresses* the image data (i.e. makes image files smaller). This is true for both JPEG and NEF files on a D90.

JPEG

The D90 normally stores images in JPEG format⁵² (in Windows, the three-letter file extension limit reduces this to **.JPG**, so you may also have seen this format referred to as JPG). JPEG (pronounced *JAY-peg*) stands for Joint Photographic Experts Group, which developed and ratified the original standard for this file format.

JPEG files can be read by a wide variety of programs, and is one of the file formats directly supported by HTML, the standard language from which Web pages are created.

The wide acceptance of the JPEG format means that you can share a JPEG-encoded file with others, regardless of what type of computer or software they have.

⁵² Technically, JPEG isn't a *file format*, but simply a data compression scheme. However, the fact that most computers use a file extension of **.JPG** or **.JPEG** for such files has caused users to call it a file format. I'll bow to this common practice in this eBook.

To produce a JPEG file from raw digital information, the following steps are performed (note that the words in parentheses are gross oversimplifications to help you understand the process):

1. The image is divided into 8 x 8 pixel blocks.
2. The information in each block is run through a series of “transforms” (calculations) to produce a set of 64 “coefficients” (results) that are then “quantized” (compressed)⁵³. Essentially, pixels are converted from numbers into equations (the calculation used is called a Discrete Cosine Transform). Blocks are operated on from top left to bottom right. Essentially, detail within each 8 x 8 pixel block is reduced, the amount of reduction determined by the amount of quantization (compression) applied.
3. The quantized (compressed) results are gathered into a single binary sequence, and this sequence is further encoded in a scheme called modified run-length algorithm, which generally produces further compression of the information (run-length encoding assigns the shortest bit sequence to the most-often-used pixel value, and the longest bit sequence to the least-used pixel value).

Note that compression happens twice when a JPEG file is created. The first compression is variable in level, but results in *permanent* loss of information. Generally, it takes a JPEG compression ratio of 10:1 or more to produce annoying artifacts (see “JPEG Artifacts” below). JPEG compression ratios of 4:1 or lower produce virtually imperceptible artifacts in most common photo scenes. The second compression step (run-length encoding) is lossless, meaning that the original information—in this case, the discrete cosine transform formula—can be fully retrieved.

⁵³ An aside: which set of words you use (transforms, coefficients, quantized or calculations, results, compressed) depends upon whether you’re a mathematician or a layperson. A nerdy party trick is to use the vocabulary of the one you aren’t.

The D90 can produce photos encoded in JPEG format. The D90 uses approximately 4:1 compression when set to **JPEG fine**, 8:1 compression when set to **JPEG normal**, and 16:1 compression when set to the **JPEG basic** option. (This is the “lossy” compression, so **JPEG fine** is visually “better” than **JPEG basic**.)

Note: There is wide variance in the way JPEG compression levels are presented in software user interfaces. Some programs show you the approximate compression amount as a ratio (e.g. 4:1), some use descriptions (e.g. “high,” “moderate,” and “low” or Nikon’s “fine,” “normal,” and “basic”), and still others use sliders and other controls to continuously vary the amount of compression. The best programs show you a preview of the resulting compression, letting you visually determine how much compression to use.

One interesting side note about JPEG: the process that converts the pixel values into equations ends up putting the “average” pixel of each 8x8 block in the upper left corner of that block prior to compression. Nikon doesn’t use this average pixel directly (the D90 generates the image’s thumbnail using other methods; some older Coolpix models used this pixel to generate the thumbnail).

Thus, if you want to create smaller images from the JPEGs that the D90 produces (say for Web use), the highest quality will be obtained if you reduce the size to 1/8 (e.g. 536 x 356 from the **Large** JPEG size created by a D90). That’s because you’ll force your image editing program to summarize the 8x8 blocks used in generating the JPEG, and minimize any artifacts that might be otherwise produced.

Setting JPEG

The D90 allows you to create three sizes of JPEG images:

<i>Image Size</i>	<i>Pixels</i>	<i>Megapixels</i>	<i>JPEG fine Size</i>
Large	4288 x 2848	12.2mp	6MB
Medium	3216 x 2136	6.9mp	3.4MB
Small	2144 x 1424	3.1mp	1.6MB

Note that the size in the last column is basically a maximum for a scene with average detail. You can create smaller file sizes by picking more aggressive JPEG compression settings. Some highly detailed scenes may produce slightly larger file sizes.

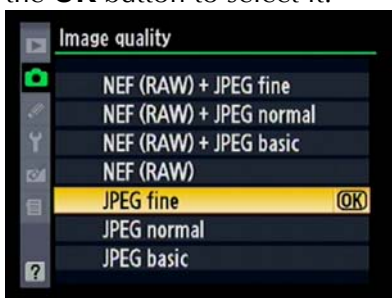
 To set the D90 to record JPEG images:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).
3. Use the Direction pad to navigate to the **Image quality** option and press the **►** key on the Direction pad or the **OK** button to select it.



4. Use the Direction pad to navigate to the JPEG quality you wish to use (**JPEG fine**, **JPEG normal**, or **JPEG basic**), and press the **►** key on the Direction pad or

the **OK** button to select it.



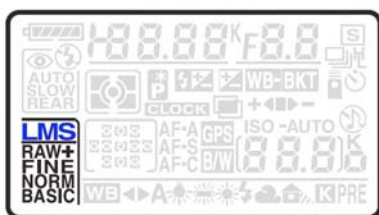
5. Use the Direction pad to navigate to the **Image size** option and press the **►** key on the Direction pad or the **OK** button to see the options.



6. Use the Direction pad to navigate to the JPEG size you wish to use (**Large (4288x2848; 12.2M)**, **Medium (3216x2136; 6.9M)**, or **Small (2144x1424; 3.1M)**), and press the **►** key on the Direction pad or the **OK** button to select it.



Alternatively, **Image quality** can be set by holding down the **QUAL** button on the back of the camera and rotating the Rear Command dial; **Image size** can be set by holding down the **QUAL** button and rotating the Front Command dial:



Top LCD

Front dial controls Size [blue], Rear dial controls Quality [black]

Let's examine how the three JPEG options impact the look of an image. Surprisingly, there's not a very big penalty for using the various JPEG settings. My overall test scene looks like this:



This is a tough, mixed lighting, high-contrast scene that attempts to provoke the D90 into worst-case images. Some of the colors will go out of gamut in some of my tests—this is intentional (like I said, a worst-case test). White Balance is set to **Auto**. ISO is 1600 here in order to try to provide visible differences.

Camera Shop



JPEG fine. At the camera defaults, this setting does a fine (pardon the pun) job of balancing detail rendering versus file size. No particular flaws are evident at normal size. At 400% view, bottom, you might see just a teeny bit of ghosting at the right edges of the numbers. Keep an eye on that as we move to the other settings.

Camera Shop



JPEG normal. Even at ISO 1600, the differences between **fine** and **normal** are almost non-existent when viewing at normal sizes, though the very observant amongst you might have picked up that there was a subtle pump in perceived contrast. What's happening in the compression scheme is subtle, but it's definitely there. In the 400% view look at the right edge of the "3"—you should clearly see a JPEG artifact that's cropped up there (two faint echos of the humps).

Camera Shop



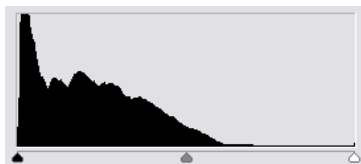
JPEG basic. Still a good performance at ISO 1600, but now we have some easily visible things to look at. You should have seen that the contrast has bumped up. Moreover, the white has gone a bit grayer. This is *not* an exposure difference. The only thing that changed between shots is the JPEG setting. In the 400% view you should start to see all kinds of mottled effects at the edges of numbers and bars. These are JPEG artifacts. Still very well handled, but nevertheless present and starting to distort fine detail.

JPEG Rendering

The D90 renders JPEG images a bit differently than the D40, D40x, D50, D70, and D70s DSLRs (but the same as the D80 and other later consumer DSLRs). While not publicly talked about, Nikon uses a NuCore JPEG engine to do the actual rendering. What is known is that all manipulation of the image is now done using 12-bit data. The translation to 8-bit JPEG is made only after all the demosaicing, color

manipulation, sharpening, and other effects are first handled. In other words, the D90 takes the 12-bit raw data, renders a 12-bit set of pixels from that data, and then reduces that to 8 bits only at the end of the process of creating an image occurs, where the JPEG encoding is performed.

While this doesn't sound earth shattering, it does have an impact on the images the D90 produces compared to early Nikon consumer DSLRs. When you apply sharpening, tone curves, or color manipulation on 8-bit data, you risk posterizing bits of the data. Posterization means that some bit values just don't exist. Too much posterization can result in visible artifacts, usually "bunched up" or unnatural tonal ramps. The problem is compounded if you take an 8-bit rendered image and do additional post processing on it.



A histogram from an image before manipulation.



The same image overly manipulated, which reveals big posterization (gaps) in the darker levels. Posterization of highlight detail makes for detailless highlights; posterization of shadow areas makes for blotchy looks in the shadows. Once image data has been posterized, each additional manipulation can compound the problem.

For example, one typical problem found by D1x users was that they'd underexpose slightly to make sure highlights were properly captured, and later use a Curve to reshape the tonal ramp (similar to what the example shows above, actually). Unfortunately, posterization in the shadow detail would often then become visible, resulting in a blotchy, muddy look in the

darker areas of the image. By keeping the in-camera manipulations in 12-bit data, the D90 avoids this problem when applying curves in the camera (different Picture Controls). Shadow detail in JPEGs made on a D90 is much better than most previous consumer Nikon DSLRs and even a few pro ones.

JPEG Artifacts

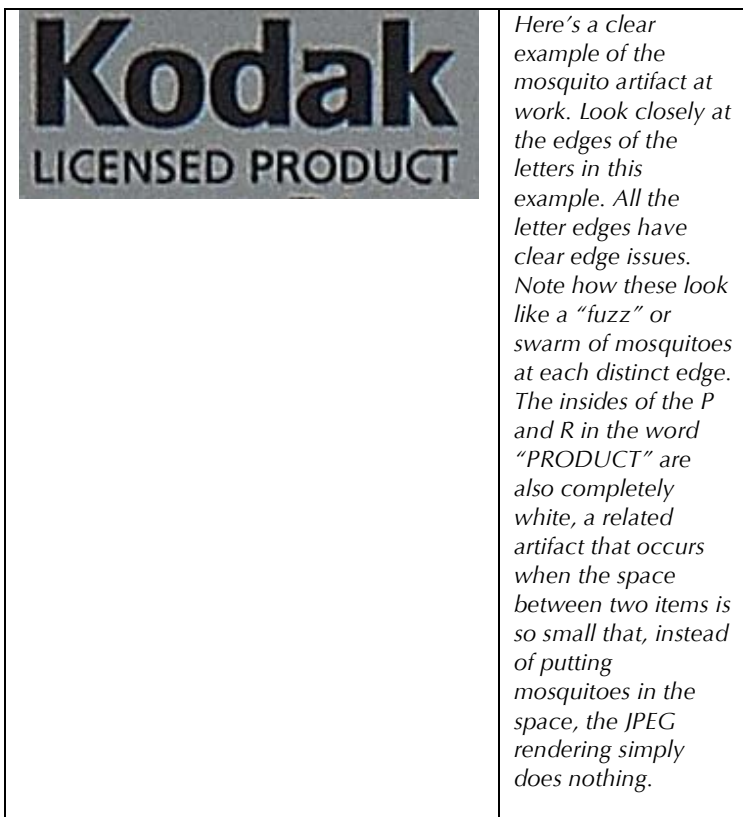
JPEG compression produces two primary types of visible artifacts. The higher the compression used, the more visible these artifacts tend to be. Also sharpening set to high levels tends to trigger these artifacts.

The first artifact is best described as “visible blocks” (see example, below). Visible blocks are created because JPEG operates on images in 8x8 pixel blocks.

Blocks are most often seen in areas where there is little detail but a continuously variable color (shading on an unevenly lit wall, for example). The quantization step attempts to throw away minor differences in colors or gradients, but when there is a gradual change of color that spans blocks, the block averages sometimes differ enough that you can see the block boundaries.



*JPEG “blocks” tend to appear in broad areas of gradually changing color, as in the highly magnified portion of sky, here. To the right of the arrow, you’ll see several left edges of blocks. The blocks don’t always appear in 8x8 pixel size. This sky, for example, varied gradually from top to bottom, but not left to right, resulting in bands of blockiness rather than distinct blocks. (I’ve exaggerated the contrast to make the blocking more visible.) I find it very difficult to get any block artifacts generated by the D90, even using **JPEG basic**.*



Curiously, applying a small amount of "blur" to the original data before applying JPEG compression reduces the visibility of artifacts and the size of the resulting file. That's because hard edges contain conflicting data the compression scheme needs to resolve, and more bits are needed to hold that information. Setting high levels of sharpening with JPEG files at high ISO values should be avoided, when possible, with the D90.

The D90 is a bit like the D200 and more recent high-level Nikon DSLRs, though: something in the JPEG rendering scheme used tends to make **JPEG fine** and **JPEG normal**

images relatively immune to over sharpening and edge artifact issues, at least at lower ISO values. Indeed, if you run a resolution test on both JPEG and NEF images from a D90, you'll find that the NEF image resolves slightly more detail, an indication that JPEG encoding is "smoothing" edges a bit.

(Just in case it's not clear from the preceding: it's okay to use higher levels of sharpening on D90 images at the lower ISO values and higher JPEG quality levels. It's not okay to use high levels of sharpening if you're using the highest ISO values and lowest JPEG quality level.)

Note: If you rotate a JPEG file and resave it, you may lose information! That's because each 8 x 8 block must be rotated in place to preserve its compression information. If an image editing program simply grabs rows of pixels and converts them to columns, when you resave the file, a JPEG recompression may again be applied to the entire file. If the 8x8 blocks are rotated in place and each block individually placed in the new orientation, JPEG compression is preserved and no new recompression takes place.

*ACDSee, IrfanView, Photoshop CS3 and a number of other programs can rotate JPEG files without recompressing. Nikon's supplied Nikon ViewNX also preserves data during rotation (and can do so automatically during downloads if you've set **Image rotation to On**). But make sure you know what the programs you use do! Older software programs (pre-2003) tend to recompress rather than rotate correctly.*

Note: There's a persistent myth circulating that any time you resave a JPEG file that you'll force a full recompression of the file, adding artifacts. Well written software doesn't do this. For example, beginning with version 6.0 of Photoshop, the only recompression that is done on JPEG images that are resaved is on portions of the image that were changed. In other words, if you bring a JPEG file into Photoshop 6 (or later version) and make no changes, resaving it results in no degradation of the image.

This is probably a good point to introduce the interaction effect of certain camera features, since I've already mentioned a few. The D90 does have a few image quality issues that you need to be aware of, and we've come to one of them.

- *JPEG compression has a tendency to increase the visibility of moiré.* For example, if you're shooting a tight fabric pattern—which might generate moiré—you probably should avoid high levels of JPEG compression and sharpening together. Put those three things together—moiré, JPEG compression artifacts, and sharpening artifacts—and you're asking for trouble. It'll be extremely difficult to remove the color fringing that'll occur.
- *Higher JPEG compression produces more artifacts at higher ISO levels.* The noise on the D90 tends to be very granular and visible only at high ISO levels, and this triggers the compression engine towards mosquito-type artifacts on hard edges. Avoid **JPEG basic** at ISO 1600 and above.
- *JPEG compression interacts with sharpening at high ISO levels.* Again, it's the noise that's the problem, but sharpening can further trigger excessive artifacts on edges. Avoid **JPEG basic** at ISO 1600 and above, and definitely consider lowering the sharpening level as you increase the ISO value.

In each of these cases you can create image defects that won't be easily removed after the fact. Moiré can sometimes be removed (or at least downplayed) by moiré removal tools (or a bit of well-applied Gaussian Blur), but if JPEG edge artifacts get melded into the image data along with moiré or sharpening, all bets are off.

I'll describe these interactions more when I get to the shooting suggestions later in this eBook.

Overall, however, the D90 exhibits very little tendency towards producing JPEG artifacts at the lower ISO values. Only at high ISO values do I see mosquito-type effects, and

some of this is actually noise destruction of edges that triggers JPEG rendering issues. JPEG blocks are almost non-existent on the D90, probably because the data is kept in the 12-bit realm while manipulating it.

NEF Format

NEF format often confuses D90 novices (Nikon and others sometimes also refer to this format as RAW). Nikon advertises it as the highest quality format, one that preserves the “raw” image photosite data. What Nikon doesn’t tell you is that you need to purchase an additional software product to really get the most from this format⁵⁴. Nikon Capture NX2 is what Nikon recommends, but other alternatives exist (see the *Introduction to Nikon Software* eBook on the CD you received with this eBook).

Note that the data saved in a D90 NEF file is pretty much what comes from the Bayer-pattern sensor in the camera. That “pretty much” qualification in the last sentence has partly to do with the way Nikon defines “black” in raw data, and partly to do with the compression used for raw data.

Nikon has long differed from Canon in how “black” is placed in the bit storage of raw files. This reason gets quite technical and is generally only of interest to those using their camera to shoot astrophotography (e.g. through a telescope). I’ve already covered it in the section on the Nikon sensor, so I’ll cut to the chase: essentially, Canon places the black value higher in the bit storage and allows the “noise” in the black signal to be fully recorded. Nikon places the center of the black signal at 0, essentially clipping some of the noise. This really doesn’t make any tangible difference unless you’re trying to resolve very low magnitude stars using image stacks.

⁵⁴ A fully functional 30-day trial version of Nikon Capture NX2 can be downloaded from Nikon’s Web sites by D90 owners (you may need to create a user account and supply your camera’s serial number).

There's long been debate about whether a raw file contains the exact values coming off the sensor's ADC. As the definition of black might indicate, the answer is no, raw is not exactly the count of electrons the sensor stored at each photosite during the shot. Normally, the camera circuitry applies a "gain" to the actual data, meaning that if the number of electrons stored at a photosite was 10,000, the value stored in raw file for that point might actually be 38,800. Gains can and do vary with bit recording level, ISO value, and other camera settings. Thus, there are sometimes small differences between raw files created from the same photosite data.

Raw file compression has an effect on the other end of the data (the highlights). The D90 uses only one type of NEF compression (the pro cameras support two). The D90's compression is what Nikon refers to as "visually lossless." It *does* lose and modify data (more on that in a bit in the section labeled "Compressed NEF").

But I'm getting ahead of the discussion here. Let's back up for a moment. Data coming off the ADC is a set of 12-bit raw information, essentially the photon count for each photosite multiplied by some gain factor. For raw files, this information simply needs to be saved into a file along with the camera setting information (EXIF data) and an image thumbnail. The image thumbnail is generated by the EXPEED imaging ASIC, which creates a JPEG thumbnail image while the raw data is in the memory buffer, then the file is written to the card. The format used is Nikon's derivative of the TIFF-EP standard. In other words, a Nikon NEF is a TIFF file with Nikon-defined tags pointing to various special information, including the raw data. Instead of .TIF as the extension, .NEF is used instead.

This special TIFF (NEF file) has three primary data repositories: the raw image data, the EXIF data for the camera settings, and a JPEG thumbnail created from the raw data by the imaging ASIC. Raw image data is packed as two 12-bit values in every three bytes (three bytes = 24 bits). We're mostly interested in this raw data section of the NEF at the moment.

When a NEF is unpacked, the first pixel in the top row of the raw image data is 12 bits of green data, the second is 12 bits of red data, and this pattern alternates throughout the first row. The second row starts with 12 bits of blue data, then 12 bits of green data, and then this pattern repeats.

No interpolation or major corrections are applied to this data—NEF files contain essentially what the Analog-to-Digital converter obtained from the photosites, multiplied by a gain factor, and potentially with that pesky visually lossless compression I'll eventually get around to talking about. Raw data is "linear," meaning that it is recorded exactly as the camera saw it (each doubling of light doubles the electron count). Our eyes will eventually require a non-linear (gamma corrected) version to interpret as a photo. This is one reason why NEF files require special software to decode; the sensor data must be converted (demosaiced) into RGB pixel data and color corrected.

Tip: If you're a programming wizard and want to know the exact format of the NEF files, here's a quick explanation: the file is built in standard TIFF format (technically TIFF-EP) but given a .NEF file extension, and starts with tags for EXIF header information and white balance tables, then a thumbnail image (in JPEG Basic format), and finally the raw pixel data stored in a simple left-to-right, top-to-bottom format.

If you're a programmer, you might want to examine the C code that can be found at:
<http://www.cybercom.net/~dcoffin/> --it's the same code that's formed the basis of Bibble, Photoshop, and other converters. While at first this looks like it only refers to Canon raw files, the code indeed has Nikon NEF support embedded in it, including compressed NEF files.
If you're just curious about how software converts the Bayer pattern data into RGB data, send your browser to
<http://www.liralab.it/teaching/SINA/papers/demosaiicking-IEI-02.pdf>, which contains a short discussion on common demosaicing methods.

Since I know you're curious, a simple demosaic routine for the D90 might work something like this (warning, geek speak ahead):

- Decompress and unpack the sensor data.
- Convert all data for the green positions into luminance values (Y).
- Obtain luminance values (Y) for red and blue positions by averaging/interpolating the data values for adjacent green positions.
- Calculate the color channels for the red and blue positions: $C_r = R - Y$ while $C_b = B - Y$.
- Obtain C_r and C_b values for the positions that don't yet have them by averaging/interpolating the adjacent values.
- Obtain RGB data from the $Y C_r C_b$ ⁵⁵ data: $R = Y + C_r$, $B = Y + C_b$, and $G = 0.2R + 0.7Y + 0.1B$.

Many other demosaic routines exist; the one just given is one of the simplest (especially if you use "averaging" instead of "interpolating" for the missing data⁵⁶). Thus, each software product that understands the NEF file format tends to perform the interpretation of the photosite data slightly differently (and at different speeds!).

If you open an NEF file with Bibble, Photoshop CS3, and Nikon Capture NX2 side by side, you will see subtle differences in rendering of color and detail. If you're getting the idea that it might be worthwhile to sample all the NEF converters, you're right. Fortunately, most have trial versions available. I deal with this in *Introduction to Nikon Software*.

⁵⁵ Geeks will have already guessed that this is essentially CIE Lab Color space, the grandfather of all color processing definitions. You can write demosaicing routines for just about any color space you'd care to define, but most that I know of stick to Lab Color, RGB, and CYM(k).

⁵⁶ Okay, we're in footnote hell. An *interpolation routine* generally tries to do more than just average two adjacent data points. Complex interpolations examine a matrix of adjacent cells, usually a minimum of a 3 x 3 grid, but sometimes as wide as a 16 x 16 grid. Obviously, the smaller the grid, the faster the results are generated. But also, the smaller the grid, the cruder the results will be.

Compressed NEFs

The D90 creates only compressed NEF files. This compression is said by Nikon to be either “virtually lossless” or “visually lossless,” meaning that results visually indistinguishable from the original data can be recovered. This isn’t quite the same thing as “lossless,” in which case the original data would be recovered exactly.

I’m not sure I’d term the methodology Nikon uses as “compression,” but here’s how it works: when photosite data comes off the ADC, it has 12 bits of value to it. A value of 0 would represent “no data” (black), a value of 4095 would represent “saturation” (white). If that was the way we stored the data, we’d need 12 bits to store each photosite’s data. In order to reduce storage size, the way the D90 (and other Nikon bodies) “compress” NEF data is as follows:

- Shadow and low mid-range values are passed on as is.
- High mid-range and highlights values are split into groups (essentially, nearby values are rounded to another value). The manner in which this is done isn’t linear. The last possible group value (almost white) has more adjacent values in it than the first (mid-range).

Thus, there are less than 4096 data values possible. These remaining values are now compressed using a somewhat traditional method that looks at adjacent differences and is truly lossless; the final data is packed across byte boundaries for space efficiency. The result is that the 12 bits of original data stores in about 9.5 bits⁵⁷.

To get back to 12 bits of data, a NEF converter such as Capture simply does the following: the adjacent differences are reversed (uncompressed) to get the data values back and

⁵⁷ It appears that the value splits used in the D90 are slightly different than the compressed NEF formula used in earlier Nikon bodies. Instead of the 40-50% reduction in size generated by earlier Nikon DSLRs, the D90 only produces about a 30-40% reduction from expected size.

the resulting 12-bit data is placed in 16-bit containers (computers like data with 8-bit boundaries).

The problem, of course, is that there will now be “data gaps” that get progressively larger as we go higher in value—many original 12-bit values in the highlight range are essentially rounded to a different value, with the rounding being more aggressive as we move to brighter and brighter objects.

With a single trip through compression/decompression, D90 compressed NEF images are usually indistinguishable from what you’d see with no compression. Our eyes don’t resolve the small differences that are made in the brightest areas of the photo. That’s partly because our eyes work in a non-linear fashion with brightness (sensors are linear—the NEF compression scheme mimics our eye’s non-linearity), but also because our eyes generally are thought to distinguish tonal changes only about equivalent to those produced by 8-bit RGB data. Even with the NEF compression scheme used in the D90, we still have the equivalent to more than 8-bits of original data. Since we almost always reduce 12-bit data down to 8-bits for printing, anyway, the minor tonal loss that compressed NEFs introduce into highlights isn’t usually a big deal.

There is a slight possibility that the data loss introduced by NEF compression will show up in some way, though. Such changes would appear mostly in the highlight detail, and only if you made very dramatic post-processing changes (abnormally high sharpening amounts, lots of color shift, etc.).

Why NEF?

Why would you want to use NEF files?

If you have software that can understand this format, you’ll get a more consistent tonal range in your images than with JPEG images and more subtle and accurate colors. Using 12 bits to record color data instead of 8 bits makes gradual (non-edge) transitions look smoother and subtler, even with the

data loss due to compression (the exception is in the top highlights, but we don't discern tonal values as well in highlights). You'll also get a slight bit more detail than with JPEG images (resolution chart numbers are about 4% higher on average in my testing).

Post-processing exposure changes are also more easily made with NEF files (these are not really exposure changes, but changing of the linearity⁵⁸ of the exposure, which is why it works better to correct underexposed images instead of overexposed ones, though note that underexposure definitely brings up more noise on a D90, so the amount of correction range you have will be dependent upon your tolerance for noise). You also gain full *post-shooting* control over color correction and white balance decisions (with JPEG those decisions are irrevocably recorded in the data when the picture is taken). And, as just noted, you can usually "correct" slightly incorrect exposures.

With JPEG images, you're working from the camera's interpolation of the color and white balance. While you can often rebalance images using a program like Photoshop, you're one step removed from the original information—in digital media, each interpolation of original data can result in lost data or changes to data. The more changes you make, the more likely that artifacts of those changes become visible.

*Tip: If storage space isn't a consideration, strongly consider shooting in the image quality that saves both **NEF(RAW) + JPEG fine** files for each image. This gives you the best of*

⁵⁸ You may wonder what "changing the linearity" means. Normally, each rise in bit value represents an equal corresponding rise in "brightness." As shot, images have input-to-output relationship that is almost a straight line from 0,0 on a graph to 255,255 (you may have seen such a line in Capture or Photoshop's Curves tool). An increase of 16 on the Y axis is equal to an increase of 16 on the X axis. We can actually change this straight line to a steeper or shallower straight line, a curved one, or an even more complex relationship. When we change the linearity, we change the relationship between the X and Y axis. Instead of a data increase on the Y axis of, say, 16 being output as a value 16 higher on the X axis, we might lower that number (e.g. an increase of 16 on Y is output as an increase of 8 on X) or raise it (e.g. an increase of 16 on Y is output as an increase of 32 on X).

*both worlds. If image space is a consideration, remember that every NEF file embeds a **JPEG Basic** image in it that can be extracted, if necessary.*

Setting NEF

NEF allows you to create only a single kind of file on the D90 (the D3 has a whopping 18 possibilities):

<i>Pixel Count</i>	<i>Typical Size</i>
4288 x 2848 12.2mp	10.8MB
<i>NEF file sizes vary in size with the amount of detail in a scene. The more detail in the scene, the larger the file will be, and vice versa.</i>	

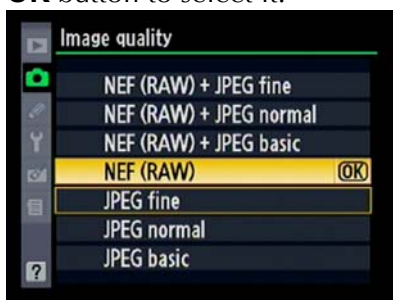
📷 To set the camera to record NEF images:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).
3. Use the Direction pad to navigate to the **Image quality** option and press **▶** key on the Direction pad or the **OK** button to select it.



4. Use the Direction pad to navigate to the **NEF (RAW)** option and press the **▶** key on the Direction pad or the

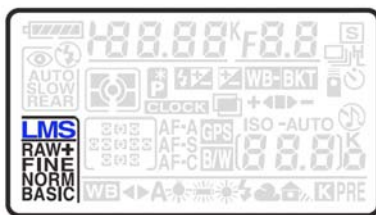
OK button to select it.



Note: You can also choose to save both NEF and JPEG images simultaneously on the D90, which gives you the best of both worlds: the “digital negative” of the NEF and an immediately usable JPEG for simplified workflow. The D90 allows you to choose the JPEG quality level that’s saved with the NEF, so you get choices of **NEF(RAW)+JPEG fine**, **NEF(RAW)+JPEG normal**, and **NEF(RAW)+JPEG basic**.

Tip: A JPEG image (in basic quality) is already stored along with the NEF image! It’s embedded as the preview image. Software exists that lets you extract this JPEG (see <http://drchung.new21.net/previewextractor/>) or Instant JPEG from Raw (<http://www.rawworkflow.com/downloads.html>), so the NEF+JPEG choices are a bit redundant. Too bad Nikon didn’t provide an option to extract the embedded JPEG from NEF files during downloading from camera to computer or to change the embedded JPEG type.

Alternatively, make sure no image is being previewed on the color LCD, hold down the **QUAL** button on the back of the camera and rotate the Rear Command dial to select **RAW** (or one of the **RAW+JPEG** options; the top LCD displays the Image Quality setting as you change it):



Top LCD:

Rear dial controls Quality (black), Front dial controls Size (blue) if you've selected a RAW+JPEG option.

Note that you don't normally set the **Image size** when you select **NEF (RAW)** format, as the D90 always records the full 4288 x 2848 image size for NEF files. However, if you elect to record a JPEG image along with your NEF, you *can* set the size of the JPEG image that's recorded using the **Image size** menu item (or the Front Command dial with the **QUAL** button).

EXIF

Even if you're a seasoned computer graphics pro, you may be surprised to find that JPEG and NEF files contain more than the image data. This extra information about the photo is sometimes referred to as *metadata*.

Nikon D90 cameras follow a standard developed by the JEIDA (a Japanese standards body), sometimes referred to as EXIF. The current standard version is EXIF 2.21, and is supported by the D90.

The additional data EXIF tags attach to an image includes:

- The name of the camera maker (Nikon).
- Camera model (D90).
- The camera's firmware version number.
- Information about the exposure itself: shutter speed, aperture, exposure mode, ISO value, date/time, overall brightness of scene (EV), exposure compensation, focus

distance, metering mode, flash mode, focal length, and even the average compression ratio.

- Thumbnail image.

If you're interested in the esoteric inner workings of your D90, a fuller description of the EXIF file format is available at <http://www.exif.org/Exif2-2.PDF>. Note that just understanding the EXIF tags isn't enough—programs must also know what each of the values each manufacturer assigns means.

Aperture, Lightroom, Photoshop CS3, Nikon ViewNX, and Nikon Capture NX2 all can display EXIF data and understand Nikon's values. Some programs may not fully display all the EXIF data values, though. And because codes are used instead of full text (to keep the data small), new lenses and features sometimes mean that a program can't display information about the latest things you use with the camera (at least until the software is updated).

Not only is looking at EXIF data fun for the merely curious, but if you study the information closely, you may even learn about the idiosyncrasies of your camera and your shooting practices.



Here's the EXIF (Metadata) window as shown in Nikon ViewNX. Note how all the most important exposure data is shown, as is information about a number of additional camera settings. Wait a second, you say, how did I get the D90 to record a TIFF file? I didn't. This is a file that I edited in Photoshop CS3, but Photoshop has noted the EXIF data and retained it.

EXIF is one of the reasons why you can't create or edit a JPEG file on your computer, save it back to the camera, and then see it on the camera's LCD, by the way. When you perform any **Save** or **Update** action on your computer, some of the EXIF tags in the file get modified (or removed) in ways that the D90 detects. This is too bad, as it prevents you from editing a series of JPEG files on your computer, then moving them to the camera for playback as a slide show. (In theory, if you replaced the EXIF tag with the correct, camera-consistent information, and didn't edit the thumbnail, you might be able to display edited pictures on the D90. In practice, I don't know of anyone who's successfully doing this.)

Note: For a program to display the correct EXIF information for an image, it has to know something about the camera and the codes that are stored in the EXIF tags (e.g. "18-70mm F/3.5-4.5" isn't stored in the lens field, but is instead stored as a short code that is unique to this lens). Now that the Nikon DSLRs have firmly established themselves (and because Nikon used consistent codes for many of the manufacturer

functions in the various digital SLR models), most software applications correctly identify most D90 EXIF data. However, if you find the program you're using doesn't, check to make sure that you're using the latest version. If you are, suggest to the developer that they contact Nikon for the EXIF codes for Nikon cameras. In theory, products that use Nikon's SDK should return correct EXIF data tags.

*Note: Older EXIF specifications define the color space of all digital images as being sRGB, and a number of digital editing programs, including very early versions of Photoshop (but not versions starting with CS), assume that sRGB is the color space of any JPEG file that is opened and has EXIF data. The current EXIF definition has a special way of dealing with color space: the file is named differently for AdobeRGB color space: instead of **DSC_####.JPG** the file would be named **_DSC####.JPG**. This is implemented in the D90 firmware. Some programs you use may not recognize the color space if they haven't been updated to support the new standard. See "Color Profiles and Color Spaces" on page <636> for more information on this subject.*

IPTC

Another type of metadata is sometimes incorrectly referred to as IPTC (International Press Telecommunications Council). IPTC is an organization, and the standard they've developed for common digital photo metadata is DNPR (Digital Newsphoto Parameter Record). For the purposes of this eBook, I'll refer to it as IPTC, as do almost all software programs.

Like EXIF data, the IPTC metadata is stored in the photo file, in this case using Adobe's XMP framework. An IPTC-aware program is required to show and edit the IPTC metadata. If you shoot photos for news organizations, you need to be aware of this data and have some way of entering it, as most publications require it to be in place with photo submissions—it's become the primary method by which news organizations track captions and photographer credits. IPTC has defined a common set of coding guidelines, but you

should also check with the publication you're working with, as they may have their own specific standards, as well.

Though the D90 doesn't create any IPTC metadata on its own, many software programs allow you to add it to your D90 files, including Nikon Transfer. Nikon Transfer's image transfer function also has a setting that allows you to copy some basic EXIF data into IPTC fields, which I recommend using. I'll deal with that in the section on the Nikon software in the companion *Introduction to Nikon Software* eBook you received with this Complete Guide.

Here's what the IPTC pane in Nikon Capture NX2 looks like:

The screenshot shows the Nikon Capture NX2 IPTC/EXIF Information window. It is organized into a sidebar with expandable sections and a main content area. The sections and their fields are as follows:

- Tags**: Expandable section.
- Description**:
 - Title: Basketball test shot
 - Copyright Notice: Copyright 2007 Thom Hogan -- all rights reserved
- Contact**: Expandable section.
- Content**:
 - Headline: [Empty field]
 - Subject Code: [Empty field]
 - Intellectual Genre: [Empty field]
 - Scene: [Empty field]
 - Location: [Empty field]
 - ISO Country Code: [Empty field]
 - Description Writer: [Empty field]
- Origin**:
 - Date Created: 12/12/2007
 - City: Macungie
 - State/Province: PA
 - Country: US
 - Job Identifier: [Empty field]
 - Instructions: [Empty field]
 - Provider: bythom.com
 - Source: [Empty field]
 - Rights Usage Terms: No use without prior written permission from Copyright ho
- Categories**: Expandable section.

Here's the IPTC/EXIF Information window for one of my images as shown in Nikon ViewNX. The amount of information that can be stored with the image is actually quite high, including ratings, keywords, categories, contact information, and much, much more.

To find out more about IPTC, go to the organization's Web site, <http://www.iptc.org>. Note that the list of software supporting the standard that's available on that site is incomplete.

DPOF and PictBridge

The D90 supports DPOF information in the image files. DPOF stands for Digital Print Order Format and was developed by Canon, Kodak, Fuji, and Matsushita to allow Secure Digital cards (or other storage cards) to contain information that automatically instructs a printer (or photo finishing machine). Amongst other capabilities, DPOF-capable cameras can specify:

- Which photos to print.
- How many copies of each photo to print.
- Whether or not to print a thumbnail index of all the images.
- Whether photos should be rotated.
- User information (name, address, etc.).
- Picture information (title, description, date, etc.).

A summary of the DPOF specification is available at: http://panasonic.jp/dc/dpof_110/white_e.htm.

You select the pictures to print on your D90 by adding them to a Print Set (see "Printing Your Images" on page <724>). When you remove the Secure Digital card from your D90 that has a defined Print Set and insert it into a DPOF-capable printer, such as the Epson Photo 875, the printer automatically prints out all the photos you've selected.

PictBridge is related to DPOF. Think of DPOF as the print data embedded in the image file and PictBridge as a communications protocol to transmit files from camera to printer. The D90 supports PictBridge, so you can connect a printer directly to the D90 and print from the storage card in the camera (see "PictBridge Printing" on page <729>).

If you're confused about why I just covered DPOF in the Image Formats section of the book, remember that DPOF is a set of standardized information that is stored *in* the image file.

File Names and Folders

The D90 follows an industry standard practice for putting images on portable storage media (Design Rule for Camera File Systems, sometimes referred to by the abbreviation DCF; the 1.0 standard is published at <http://www.exif.org/dcf.PDF>). Unfortunately, the designers of this format didn't make it particularly friendly. Likewise, many of the standards digital cameras follow are interwoven. DCF is related to the EXIF specification, for example.

Essentially, the standards committees put together by the early digital camera manufacturers were trying to establish a set of rules that made it easier to interchange data between connecting devices. So while the standards seem arcane and confusing, remember they're actually there to make the user experience simpler. Really.

One problem with DCF is that almost all of the firmware in cameras was being designed using a relative of DOS, and that operating system (and its ancestors) used a specification that produced short filenames (called "8 dot 3" by those of us who go back that far in high tech, because the name consists of eight characters, a period, and a three-letter file extension). This limited size for the name makes for some serious issues that we camera users now have to deal with.

As with current personal computers, files are organized in our cameras within a hierarchy of folders, so you need to understand both the folder structure and the file naming standards.

Folders

Images are stored in folders on your Secure Digital storage card. The top-level folder for a digital camera is *always* named **DCIM** (Digital Camera Images). Actual image storage

occurs in the structure underneath this folder. Within the **DCIM** folder, digital cameras place one or more additional folders. Each folder can have up to 999 images in it.

On the D90, Nikon names the first such folder **100NDC90**, the second **101ND700**, and so on.

DCIM

+----100NCD90

+----101NCD90

Like all previous professional Nikon DSLRs, we don't get to override the name (though we can change the three-digit number prefix). I'll get to how you make prefix changes in a moment. First, we need to deal with something else about the folders that live under the **DCIM** folder.

For example, if you use multiple cameras and move your card between them, you may find multiple folders under the **DCIM** folder, thus you need to know how your cameras name these:

For cameras that use Secure Digital cards:

<u>Camera</u>	<u>Folder Name</u>	<u>Example</u>
D40	###NCD40	100NCD40
D40x	###ND40X	100ND40X
D50	###NCD50	100NCD50
D60	###NCD60	100NCD50
D80	###NCD80	100NCD80
D90	###NCD90	100NCD90
Coolpix	###NIKON	100NIKON

For cameras that use CompactFlash cards⁵⁹:

D1h	###NCD1H	100NCD1H
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⁵⁹ I'm including CompactFlash cameras because some day you may transfer an entire **DCIM** folder over to your computer and then need to figure out what lives in it.

D1x	###NCD1X	100NCD1X
D2x	###NCD2X	100NCD2X
D2xs	###ND2XS	100ND2XS
D2h	###NCD2H	100NCD2H
D2hs	###ND2HS	100ND2HS
D3	###NC_D3	100NC_D3
D70	###NCD70	100NCD70
D70s	###ND70S	100ND70S
D100	###ND100	100ND100
D200	###ND200	100ND200
D300	###ND300	100ND300
D700	###ND700	100ND700
Coolpix	###NIKON	100NIKON

Note: Obviously, there's a pattern to the folder naming: the first three characters are a numeric value that starts at 100 and goes as high as 999; the next five characters indicate the camera maker and model. Usually Nikon uses the first two to indicate that this is a Nikon Camera (NC) and the final three characters indicate the type of camera that created the folder (D90). But not always. With cameras that have only one or that have three digits in their name you get a slightly different pattern.

Also note that Nikon allows you to rename the five-letter portion of the folder name on all the SecureDigital card cameras, but not on the CompactFlash cameras.

If you move a card between two different camera types, each will create an appropriate folder name under the **DCIM** folder! And each camera won't deal with the images already on the card from another camera. Short of doing a complete card format, you won't be able to remove a Coolpix folder that has images in it using a D90.

Other pitfalls occur with multiple cameras, too. Notice that three-digit number? If one of your D90's is set to use a folder named **145NCD90**, then if you take that card out of that camera and put it into your other D90 and do something that triggers creation of a new folder, the number for the folder on

the second D90 will be incremented to one higher than what the first D90 was using.

Another problem to watch for: if you have multiple folders on a card, the D90 will use the highest numbered one. Okay, it's a little subtler than that: images are saved into the currently selected folder *name* with the highest number.

On the D90, Nikon names the first folder the camera creates **100NCD90**, the second **101NCD90**, and so on. Unlike the CompactFlash-based Nikon bodies, on the D90 we have the ability to override those last five characters of the folder names (i.e., the three digit number is always assigned by the camera).

If you want, you can use the menu system to change your folder name from **100NCD90** to **100BYTHM**. (Note that the folder number stays the same; we change only the last five characters.) I'll get to how you make those changes in a moment.

First, I want to enumerate all the things you can do with folders. The D90 allows you to do four things with folders:

- Select from existing folders
- Create a new folder
- Rename an existing folder
- Delete *all empty* folders.

Before I tell you how to do those things, here's my recommendation: don't. Consider that recommendation

boldfaced and italicized if you use multiple digital cameras using the same set of Secure Digital cards⁶⁰. **Don't.**

Astute readers have noticed my use of the words “pitfall” and “problem” in relation to folders. The classic worst case scenario is this: you use multiple folders to capture images, download the images from only one folder (perhaps because you used a drag and drop method from card to computer instead of using Nikon Transfer), then reformat the card. Goodbye images. I've learned the hard way not to get too creative with folders—indeed, if I were to rename them from the base names, I wouldn't know which folder was created by which camera unless I was paying careful attention in my naming practices.

Okay, you've been warned. Should you choose to play with fire, uh, I mean folders, keep reading.

 To create a new folder:

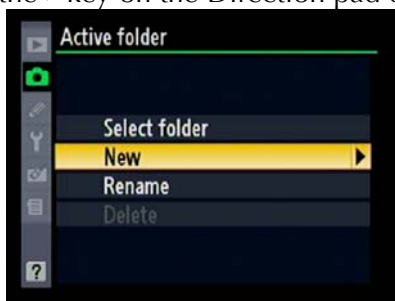
1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (yellow wrench icon).
3. Use the Direction pad to navigate to **Active folder** and press the ► key on the Direction pad or press the

⁶⁰ I can think of one legitimate reason to start renaming folders: you own multiple D90 bodies and want to track which images came from which camera. Newspapers and other organizations that use “pool cameras” often rename folders so that they can track which images came from which photographer; this also helps them to backtrack if they find that they're seeing problems with images from one camera. The D80 provides a better facility for that, though: the **Image comment** field (see “Programming a Comment” on page <204>). Since this field follows the image around regardless of the folder or file name, you could track what camera produced the image by simply looking at that value. So I'll stick by my recommendation: stay away from the folder options.

OK button to select this option.



4. Use the Direction pad to navigate to **New** and press the **►** key on the Direction pad or press the **OK** button.



5. In the display that appears, enter the five-character name:



- a. Use the Direction pad to navigate to a letter or number (highlighted in yellow).
- b. Press the **QUAL** (Q) button to select that letter or number.
- c. If you need to move the cursor position, hold down the **ISO** button (Q) and press the

Direction pad to move the cursor to the appropriate position.

- d. To delete the current character, press the  button.
6. When done entering your five-character name, press the **OK** button to complete the entry.



Note new setting on right

To abort the new folder creation process, press the **MENU** button at any time prior to the last step.

New folders are created automatically by the camera when:

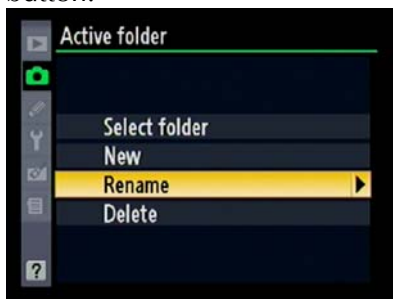
- The number of images in the current folder reaches 999. A new folder is created and images begin being stored in that new folder. (That's because there's a limit to 999 files in a folder in some of the real-time operating systems cameras use.)
- The last filename stored ended in **9999**. A new folder is created and images starting with **0001** begin being stored in that new folder. (That's to avoid any possibility of a new file overwriting an existing one.)
- Sometimes when you "touch" the card format or data with something other than a camera or other DCF device (e.g., you put the card into a PC and edit a file on the card). (That's because the camera sees that something has changed in the file structure on the card and it creates a new folder and starts storing images there to be safe.)

 To rename an existing folder:

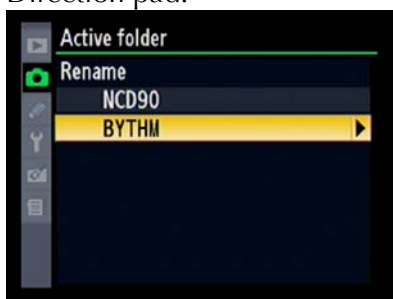
1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (yellow wrench icon).
3. Use the Direction pad to navigate to **Active folder** and press the **▶** key on the Direction pad or press the **OK** button to select this option.



4. Use the Direction pad to navigate to **Rename** and press the **▶** key on the Direction pad or press the **OK** button.



5. Use the Direction pad to navigate to the name of the folder you wish to rename and press the **▶** key on the Direction pad.



6. In the display that appears, enter the new five-character name:



- a. Use the Direction pad to navigate to a letter or number (highlighted in yellow).
 - b. Press the **QUAL** button (QUAL) to select that letter or number.
 - c. If you need to move the cursor position, hold down the **ISO** button (ISO) and use the Direction pad to move the cursor to the appropriate position.
 - d. To delete the current character, press the **DEL** button.
7. When done entering your new five-character name, press the **OK** button.

To abort the new folder renaming process, press the **MENU** button at any time prior to the last step.

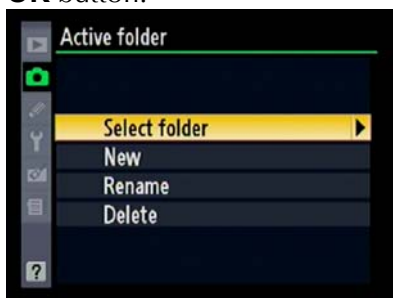
 To select a different folder from the current one:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (yellow wrench icon).
3. Use the Direction pad to navigate to **Folders** and press the **RIGHT** key on the Direction pad or press the **OK** button.

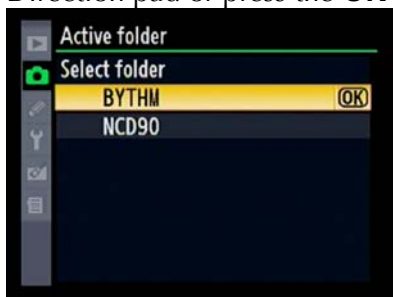
button to select this option.



4. Use the Direction pad to navigate to **Select folder** and press the **►** key on the Direction pad or press the **OK** button.



5. Use the Direction pad to navigate to the name of the folder you wish to use and press the **►** key on the Direction pad or press the **OK** button.



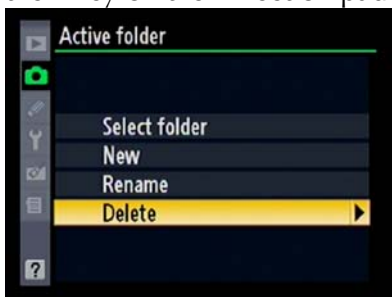
 To delete all folders that have no images in them (including the current folder, if it meets the criteria!):

1. Press the **MENU** button to show the menu system.

2. Use the Direction pad to navigate to the **SHOOTING** menu (yellow wrench icon).
3. Use the Direction pad to navigate to **Active folder** and press the **►** key on the Direction pad or press the **OK** button to select this option.



4. Use the Direction pad to navigate to **Delete** and press the **►** key on the Direction pad or press the **OK** button.



5. Use the Direction pad to navigate to **Yes**.



6. Press the **OK** button to complete the deletion process.

Note: If you delete the current folder it may still show up in the menus after you've deleted it, at least until you select another folder in which to store images.

To abort the folder deletion process, press the **MENU** button at any time prior to the last step.

Should you ever get to a folder name that is numbered 999 *and* a filename that contains the number 9999 or is the 999th file in the current folder, the D90 will lock up and refuse to take a photograph. In this situation you should:

1. Make sure you've transferred all your images off the card to your computer (see "Connecting to a Computer" on page <723>).
2. Set **File no. sequence** to **Off** (see "File Numbering Sequence" on page <190>).
3. Set **File no. sequence** to **Reset**. (Theoretically, you don't need to do this, but it appears that this step is required in some cases.)
4. Format the storage card (see "Formatting Cards with the Camera" on page <134>). (Or insert a new storage card.)
5. Set **File no. sequence** back to **On**. (I'm assuming that you've followed my other instructions and set this option to **On** in the first place.)

File Names

Individual files are normally named **DSC_####.XYZ**, where **####** is a sequential image number and "XYZ" is replaced by the appropriate three-letter file format extension (e.g. JPG or NEF). (The DSC stands for Digital Still Camera, by the way; some digital cameras can create movies, hence the three-letter usage). Thus after you've taken a few pictures on a Secure Digital card, the structure looks like this:

```
DCIM
+---100NCD90
      +---DSC_0001.JPG
      DSC_0002.JPG
```

DSC_0003.JPG

Etc.

The folder name and filename are displayed on the top line at the bottom left corner of the Color LCD when you review images (assuming you're on the main review page):



In this example, the folder name is **100NCD90** and the filename is **DSC_0003.JPG**. (The position of the **_** in the filename indicates that the Color Space the camera was set to. See “Color Profiles and Color Spaces” on page <636>.)

*Note: When I shoot with both a Fuji S5 Pro and a Nikon D90, I can immediately tell which images came from which camera: the Fuji uses an **F** instead of **_** in their filenames (e.g. **DSCF0001.JPG**). If you use more than one digital camera, do yourself a favor and note the different folder and file naming conventions of the two cameras. Some day you'll be glad you did.*

The D90 does not allow you to rename the “DSC” portion of the filename as do Nikon’s more advanced cameras (D200, D300, D700, D2 series, and D3). However, the D90 will sometimes use “CSC” instead of “DSC.” Images that have that CSC naming indicate that they’ve been created using one of the built-in camera modification abilities (see “The Retouch Menu” on page <684>).

Because the D90 doesn’t provide any options for file names, you need to develop a discipline in moving images from the camera to your computer. If you don’t, you’ll end up with

hundreds, perhaps thousands, of image files that have nothing else to distinguish them than a four digit number (and, of course, if you get to the tens of thousands, you're going to have duplicate file names).

Nikon Transfer, as well a growing number of third party programs, allows you to automatically transfer files from camera (or storage card in a card reader) to the computer with a renaming scheme of your own choosing (e.g. copy **DSC_0001.JPG** to **PhillyzooApril001.JPG**, **DSC_0002.JPG** to **PhillyzooApril002.JPG**, etc.). Other programs allow you to rename files once transferred (even Photoshop CS3 has decent renaming capabilities, for example.) If you use one of these programs, I suggest you do the following:

1. Leave the default folder intact on your D90. While you can create and name folders and move between them, capturing some images in one folder, some in another, etc., this can get confusing in practice⁶¹. If you need to organize images as you shoot, it's probably better to use multiple Secure Digital cards, though you'll need to be careful in labeling them.

For example, if in the morning you shot at the zoo, then in the afternoon went to a museum to shoot, save your zoo photos on one Secure Digital card. Then, before starting to shoot at the museum, take that card out and put in a new one. (If your memory is like mine, you probably ought to write this down and label your cards, just in case a few days pass before you can get the images off the Secure Digital card. The trick I use is to bring a bunch of small envelopes with me, and then I just put the card in the envelope, label the envelope, and seal it. Any sealed envelope I encounter obviously has a shot card in it.)

⁶¹ I think the primary reason most users change folder names is to distinguish between multiple cameras, but I'd argue the **Image comment** field is a better place to do this, as the information stays with the images.

2. On your computer, create descriptive folder names that match the locales you shot in (e.g. in the example, I'd create folders named **PhillyZooApril01** and **MomaApril01** on my computer; I add the month and year to the folder name because I often revisit the same sites; also, these folders live in a folder hierarchy that helps me re-find them: e.g.
US/PA/Philadelphia/PhillyZoo/PhillyZooApril01).
3. Put each Secure Digital card you shot into your computer's card reader and use a renaming-capable program like Nikon Transfer to move images from the card to your computer⁶². Recent versions of Nikon's software do this reliably and quickly on both Macs and PCs.

Some Nikon shooters swear by other software that supports direct transfers, such as DigitalPro, Photo Mechanic, Breezebrower, or Image Ingester. The key is you really need to use a program that'll rename files *during* the transfer. If you merely use an operating system copy from card to computer, you can't easily automate the renaming of the files as they're copied, which I highly recommend. The reason you want to rename: eventually you'll take more than 9999 photos and you'll end up with duplicate file names that can confuse you and your computer. If you don't use Sequential File Numbering and also don't use file renaming during transfer, I'd say you're headed for a massive file naming confusion on your computer. I've seen one fellow's computer where he had *several*

⁶² One nice thing about Nikon Transfer's renaming is that it correctly assigns the same name to both files when you shoot **NEF(RAW)+JPEG fine**. Thus, you end up with file names such as **PhillyZoo_0001.JPG** and **PhillyZoo_0001.NEF**. One bad thing about Nikon's transfer functions is that it always place both files in the same folder (Photo Mechanic allows you to place them in different folders). I prefer having my preview files (JPEGs) in a different folder than my "negatives" (NEFs). Macintosh users have an answer, though: download the **SeparateJPEGs** Automator action from the Apple Web site.

dozen files all named **DSC_0001.JPG**! Good luck finding the right image, buddy.

4. If any of the files you copied in Step 3 are JPEG files⁶³, you should also consider immediately using a product that'll resave them in a form without compression (you can set up a Photoshop Action, for example, to take all the files in a folder and save a **.TIF** or **.PSD** version for editing). If you don't perform this step, then you'll need to be attentive when you open files for manipulation, since some software applies JPEG compression every time you save a file in the JPEG format (i.e. you could end up compressing previously compressed files, adding artifacts). Fortunately, Photoshop versions 6.0 and later don't do that, but beware of touching your JPEG files with other products. (Note also that some programs can perform image rotation without recompressing JPEG images, and some don't. I find it safer to avoid the problem entirely by moving my files out of JPEG format as soon as possible, even before rotating them.)
5. After verifying that the files you copied in Step 3 are on your computer intact, put the Secure Digital card back in your camera and reformat it so that it is cleared of image files and ready for your next shooting session. If you delete individual files and leave folders instead of reformatting, you'll eventually end up with file fragmentation on the card, which reduces size and performance. Formatting is the only option that guarantees that the card is optimized for storing new data.

These steps are part of what is sometimes called "digital workflow," the consecutive actions you make on an image after taking that picture with the camera. The above steps are a simple form of workflow. I go into more detail on this in

⁶³ If you're shooting **NEF(RAW)+JPEG** you can safely ignore this advice, as you have a NEF file that isn't affected in this way.

Introduction to Nikon Software, which you'll find on this eBook's CD. What I've just described is about the minimum you should do with your image files.

While file names are generally created consecutively (e.g. **DSC_0001.JPG**, **DSC_0002.JPG**, etc.), a number of things *may*⁶⁴ cause the camera's numbering to reset:

- Creating a new folder (if File Numbering Sequence is turned OFF; see "File Numbering Sequence" on page <190>).
- Using the **File no. sequence** option on the CUSTOM SETUP menu (#D7) to **Reset** the file numbers.
- Using the camera reset option (see "Resetting the Camera" on page <215>).
- Moving a Secure Digital card that already has images on it between different cameras.
- Writing to a Secure Digital card when it is mounted in a card reader attached to a PC.
- Removing the battery without first turning the power switch to the OFF position (same with power supplied to the **DC In** socket on the front of the camera).

Whatever the cause, you should see that having a camera reset the numbering is not a trivial event. If you develop bad habits that trigger frequent numbering resets, you could end up with a computer filled with images all numbered the same! I can't say this strongly enough: develop a discipline with your camera use and workflow so that you don't unintentionally trigger numbering resets, and rename your image files to meaningful names as soon as possible. It'll save you a lot of grief later.

Yes, Nikon's defaults and the D90's default behaviors make no sense in regards to file numbering. Some of that is the

⁶⁴ Other than the three items listed previously, a file numbering reset doesn't necessarily happen every time these other events occur.

standard the D90 follows. Because the file structure of the Secure Digital card is the old DOS-style FAT, file names are limited to eight characters and a three letter extension⁶⁵, and because the standard takes up four (!) of those characters to designate that the file contains an image (hey guys, that's what the extension was for!), that didn't leave much for the camera manufacturers.

Did I say develop a discipline with your camera use and workflow loudly enough? Those of us who shoot tens of thousands of images a year for a living are forced to do so by the camera's behavior. Don't let losing an image be the catalyst for getting serious about file renaming on transfer. As Nike's slogan says: just do it!

File Numbering Sequence

The D90 allows you to specify when file numbers are reset. You have three choices:

- **Off.** File numbers are always started at 0001 whenever a new folder is created, when the storage card is formatted, or a new storage card is inserted into the camera.
- **On.** File numbers are incremented until they reach 9999, at which point a new folder will be created and the file numbering will begin again at 0001.
- **Reset.** The file number is reset to 1+the current file number in the current folder (if there are no images in the current folder, numbering is reset to 0001).

Of these options, **On** makes the most sense, and is the one I use on all my Nikon DSLRs. That's because file name duplication is dangerous—you could accidentally erase or overwrite a file you wanted to keep. If you leave the camera set to the default of **Off**, you'll generate a new **DSC_0001.JPG**

⁶⁵ Even the Microsoft programmers found ways around this limitation in the days of DOS, by the way, so there really isn't any excuse for the standard to limit itself like this. As it is, I'm surprised an enterprising camera company hasn't figured out that they could use an EXIF tag to store long, meaningful file names and then have their transfer software simply substitute it for the short name when the file is moved!

(or .TIF or .NEF) file every time you format the card and start shooting again.

*Note: If you use any of Nikon's recent pro cameras (D300, D700, D3), you're going to be surprised to see that the D90 sets the File Sequence Numbering to **Off** while the pro cameras set it **On** by default. Be sure to set this to my recommendation of **On**. And if anyone at Nikon is reading this: why the heck is the default for a consumer camera "you might lose some files if you're not paying attention" while the default for the pro cameras is "you won't lose some files if you're not paying attention"? Are you really saying that it's okay for consumers to lose photos, but not pros?*

See "Setting the File Numbering Sequence" on page <190> for how to set this option.

Camera Setup

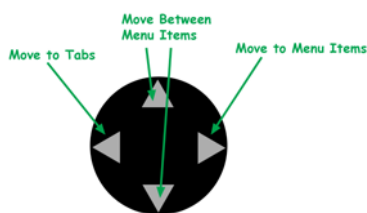
Before using your D90, you need to make a few settings to establish some basic information the camera needs. In this chapter I'll introduce the **SETUP** menu, then take you through a few of the things you ought to set the first time you use the camera.

How Menus Work

Many of the D90 settings you'll want to make require navigating options displayed on the color LCD (see "D90 Color LCD" on page <226>). When you press the **MENU** button on the back of the camera, the color LCD displays a menu of selections to choose from.



Color LCD



Autofocus Direction Pad

The menu system consists of three elements: Tabs, Menu Items, and the Current Selections for the Menu Items. Tabs—also called menus—are grouped categories of *Menu Items*. The Tabs from top to bottom are:

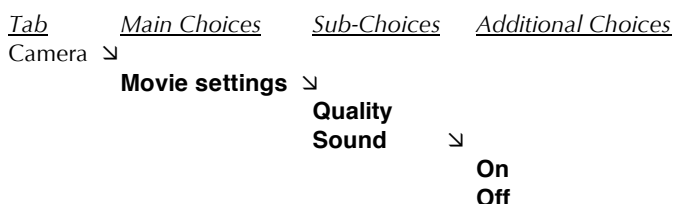
<u>Icon</u>	<u>Menu Name</u>
Play button	PLAYBACK menu
Camera	SHOOTING menu
Pencil	CUSTOM SETTING menu
Wrench	SETUP menu
Brush	RETOUCH menu
List	MY MENU (check mark) or RECENT SETTINGS

Note: In this eBook, I'm consistent about always capitalizing the names of the menus (followed by the word "menu"). The

camera uses capitalized menu names, too. I've elected not to capitalize the word "menu" the way the camera does, however.

One last thing that sometimes appears in the Tabs column is a question mark icon. This isn't a menu you can reach, but simply indicates that if you press the **?** button on the camera you can get help for the currently displayed Menu, Menu Item, or Setting. If the question mark icon doesn't appear, there is no help for the current point you're at in the menu system.

The menu options themselves lead to individual choices or sub-options. The entire system is simply a hierarchy of choices. For example:



Put another way, to turn off audio recording in movies, you must navigate to the SHOOTING menu (camera icon), select **Movie settings**, then select **Sound**, then select **Off**. To accomplish this navigation, you use the Direction pad (just to the right of color LCD) to move through the menu system:

- Use the **▲** and **▼** keys⁶⁶ on the Direction pad to navigate up and down between Menu Items, or up and down between Tabs. The currently selected Menu Item or Tab is highlighted in yellow.

⁶⁶ While I refer to these as "keys," they aren't actually separate buttons, but merely sides of a bigger button, the Direction pad. If you look closely at the Direction pad you'll see little arrows engraved on it. So when I say press the **▶** key on the Direction pad, I mean press the Direction pad in the area labeled with the **▶** engraving.

- Use the **▶** key to move from the Tabs area to the Menu Item area, or to select the currently highlighted Menu Item.
- Use the **◀** key to move from the Menu Items area to the Tabs area at the left of the menu system display.

If there are sub-choices for any Menu Item, you again use the **▲** and **▼** keys to navigate up and down between choices, then use the **▶** key to select one.

The D90 displays **OK** at the end of an option to indicate that you should press the **OK** button to complete your selection⁶⁷. If only a **▶** appears at the end of the Menu Item, that means that there are more choices in a sub-menu; you may press either the **▶** key on the Direction pad or the **OK** button to make your selections.

Before you move on, make sure that you understand how you navigate between menus (Tabs), and within menus (Menu Items). In practice, you'll find that you quickly adapt to using this navigation and selection method, but it does throw some first time users off, as the menus can be relatively deep (have lots of sub-items) at some points in the system.

The SETUP Menu

The SETUP menu is where you go to change things that you rarely change on your camera, but need customization, such as the language the camera uses to display information.

 To get to the SETUP menu, press the **MENU** button, then use the **▲** and **▼** keys on the Direction pad to navigate to the tab for the SETUP menu (yellow wrench icon near the bottom left of the display—remember that you may have to use the **◀** key to get over to the Tab area first!). Press the **▶** key on the

⁶⁷ To be consistent with previous Nikon bodies, the D90 *usually* accepts pressing the **▶** key on the Direction pad, as well. However, this isn't universal, as some destructive actions require you to press the **OK** button only.

Direction pad to get to the individual options within the SETUP menu.

You'll see a short list of options:



Format memory card

Wipes all information stored on the Secure Digital card (see “Using Secure Digital” on page <130>).

LCD brightness

Sets the brightness of the color LCD on the back of the camera (see “Setting the LCD Brightness” on page <207>).

Clean image sensor

Sets the built-in sensor shake cleaning method options and triggers a cleaning (see “Keeping the Sensor Clean” on page <654>).

Lock mirror up for cleaning

Enables the mirror to be locked up out of the way for sensor cleaning. This option is grayed out unless the camera is running off power connected to the **DC IN** socket (e.g. the EH-5a AC Adapter) or has a full battery. See “Keeping the Sensor Clean” on page <654>.

Video mode

Sets the video format (see “Television Playback” on page <739>).

HDMI

Sets the type of HD output the camera presents on the HDMI interface (see “Television Playback” on page <739>).

World time

Sets the date and time (see “Setting Date and Time” on page <197>).

Language

Sets the language used for the menus on the color LCD (see “Setting Language” on page <203>).

Image comment

Allows a comment to be appended to your image files (see “Programming a Comment” on page <204>).

Auto image rotation

Enables or disables the automatic image rotation sensor (see “Rotating Images” on page <465>).

Image Dust Off ref photo

Allows you to take a dust removal reference photograph for use with Nikon Capture NX2. See the supplemental eBook *Introduction to Nikon Software*.

Battery info

Displays additional information about the battery status (and how many pictures you obtained with the battery). See “Battery Notes” on page <119>.

GPS

Sets the options for use of a GPS receiver connected to the camera, and displays the current position (if connected). See “Connecting to a GPS” on page <421>.

Firmware version

Displays the current firmware version of the camera (see “Firmware Version” on page <217>).

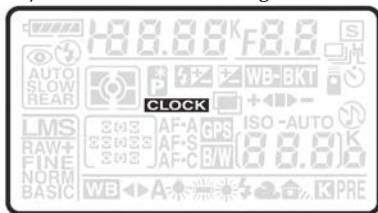
Despite the name “SETUP”, not all of the items grouped on this menu are things that you do when you initially set up the camera. I’ll tackle the items on this menu in the order and organization I think more appropriate.

In this section of the eBook, we’re simply looking to get the camera set up properly for shooting. Individual settings we might change in response to the scene we’re photographing or other actions will be dealt with later (note the “see...” pointers after each item).

Date, Time, and Language

As noted in the section on power, an internal battery powers a clock/calendar function within the D90. The clock/calendar is used to add information to the EXIF header about when a picture was taken.

*Note: If the **CLOCK** icon is blinking near the middle of the top LCD, then the internal battery ran low on power and the date and time were reset. Make sure that the camera is either on AC power or has a fully charged battery in it for the next two days in order to recharge the internal battery.*



Setting Date and Time

🔧 Set the date and time using the following steps:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the SETUP menu (yellow wrench icon).
3. Use the Direction pad to navigate to the **World time** option. Press the **▶** key on the Direction pad or the **OK**

button to select it.



4. Use the Direction pad to navigate to **Time zone**. Press the **▶** key on the Direction pad or the **OK** button to select it.



5. In the screen that appears, use the **◀** and **▶** keys on the Direction pad to place the highlighted area in your time zone (names appear at the top of the screen). Press the **OK** button to select the currently highlighted area.



6. Use the Direction pad to navigate to **Date and time**. Press the **▶** key on the Direction pad or the **OK** button

to select it.



7. Use the $\blacktriangle$ and $\blacktriangledown$ keys on the Direction pad to set the **Year** value. Press the $\blacktriangleright$ key on the Direction pad or the **OK** button to move to the next field.



8. Use the $\blacktriangle$ and $\blacktriangledown$ keys on the Direction pad to set the **Month** value. Press the $\blacktriangleright$ key on the Direction pad or the **OK** button to move to the next field.



9. Use the $\blacktriangle$ and $\blacktriangledown$ keys on the Direction pad to set the **Day** value. Press the $\blacktriangleright$ key on the Direction pad or the

OK button to move to the next field.



10. Use the **▲** and **▼** keys on the Direction pad to set the **Hour** value. Press the **▶** key on the Direction pad or the **OK** button to move to the next field.



11. Use the **▲** and **▼** keys on the Direction pad to set the **Minute** value. Press the **▶** key on the Direction pad or the **OK** button to move to the next field.



12. Use the **▲** and **▼** keys on the Direction pad to set the **Second** value.



13. Press the **OK** button to save the data you just entered.

Note: If you pause for 20 seconds or more during Steps 6 through 13, the D90 automatically turns off and cancels any changes you've made up to that point. Alternatively, you can press the shutter release halfway (or more) during Steps 6 through 13 to cancel the operation.

You can also change the format in which the date appears:

14. Use the Direction pad to navigate to **Date format**. Press the **►** key on the Direction pad or the **OK** button to select it.



15. Use the Direction pad to navigate to your choice of formats and press the **►** key on the Direction pad or

the **OK** button to select it.

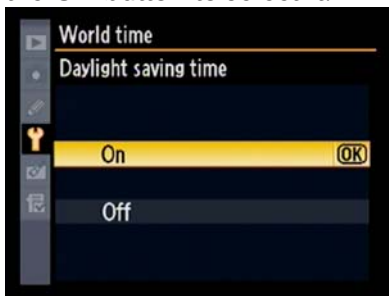


Finally, you can tell the camera whether Daylight saving time is active:

16. Use the Direction pad to navigate to **Daylight saving time**. Press the **►** key on the Direction pad or the **OK** button to select it.



17. Use the Direction pad to navigate to your choice of **On** or **Off** and press the **►** key on the Direction pad or the **OK** button to select it.



Note: The camera's internal clock does not maintain accurate time settings, and should be periodically checked to ensure that

*the time is accurate. If your computer's clock is synced to a network time source, you can update your D90 by using **Camera Date and Time** in Camera Control Pro 2 and pressing the **Use Current Date/Time** button. You can also set the preferences in Nikon Transfer to synchronize camera and computer automatically.*

Setting Language

The D90 can display menus on the color LCD in sixteen languages: Chinese (simplified or traditional), Danish, Dutch, English, Finnish, French, German, Italian, Japanese, Korean, Norwegian, Polish, Portuguese, Russian, Spanish, and Swedish. If you've purchased an official import of the D90 (i.e. not a gray market⁶⁸ model), it should already be set to the appropriate language.

📷 If you'd like to change the camera's displayed language:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the **SETUP** menu (yellow wrench icon).
3. Use the Direction pad to navigate to **Language** (the second item on the second page of options, and whose current value is shown as a two-letter abbreviation) and press the **▶** key on the Direction pad or the **OK** button to select it.



⁶⁸ Gray market products are those that are brought into a country by someone other than the official importer. Nikon's warranties generally only apply to officially imported cameras. In the US, especially, Nikon is particularly careful to only repair officially imported cameras.

4. On the new menu that appears, use the Direction pad to navigate to the language you desire (the languages are in rough alphabetical order (if you use their International spelling)—Danish, German, English, Spanish, Finnish, French, Italian, Dutch, Norwegian, Polish, Portuguese, Russian, and Swedish, followed by the Asian languages. Press the **OK** button to lock in your choice.



Note: Changing the camera's language only applies to the menus displayed on the color LCD. Information displayed in the viewfinder and on the top LCD and viewfinder remains in Anglo-based icons.

Programming a Comment

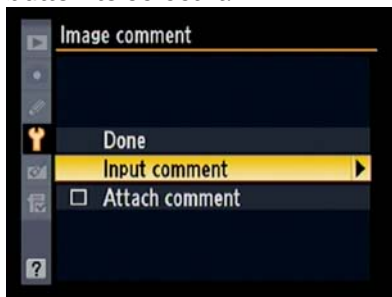
 The D90 allows you to place a short comment in the EXIF data of every photograph you take. I suggest that you use it to enter a Copyright notice on your images:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the SETUP menu (yellow wrench icon).
3. Use the Direction pad to navigate to **Image comment** (before you set it, the current value is shown as **OFF** rather than **ON**) and press the **▶** key on the Direction

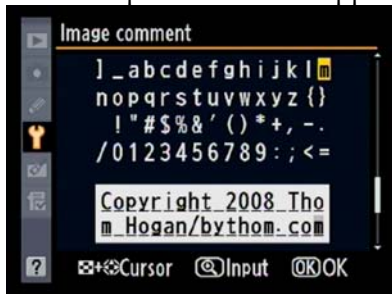
pad or the **OK** button to select it.



4. Use the Direction pad to navigate to **Input comment** and press the **►** key on the Direction pad or the **OK** button to select it.



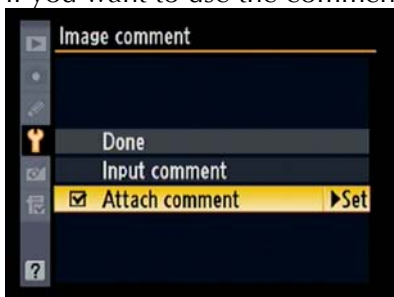
5. On the input screen that appears:



- a. Use the Direction pad to navigate to the next letter you want to enter (white letters on gray background; the current selection is highlighted in yellow).
- b. Press the **QUAL** button (⌂) to enter the letter selected in Step 5a into the current position in the bottom box (highlighted slightly with a

light gray background and a darker letter if one is already entered).

- c. If you need to move the cursor in the bottom box back to fix something, hold down the Thumbnail/Zoom Out button (Q) and use the Direction pad keys to move the cursor.
 - d. Use the Delete button to remove the currently highlighted letter from the bottom box.
 - e. If you have more letters to enter, return to Step 5a, otherwise press the **OK** button to return to the previous menu.
6. Use the Direction pad to navigate to **Attach comment** and press the **OK** button to select it. The box should be checked if you want to use the comment.



7. Navigate to **Done** and press the **OK** button to finish.



Note: Step 7 is necessary. Just performing Step 6 does not actually attach the comment!

Tip: As you can guess from the sample screens, I use the comment **Copyright 2008 Thom Hogan/bythom.com** on my D90. You can enter up to 36 characters in your comment. Choose wisely grasshopper. (One person has suggested that you enter **IF FOUND CALL ###-####**, but remember this is what appears on your images—it doesn't normally show on the camera itself except during setting. It might make sense to put something like **Thom Hogan ###-###-####** though.)

Tip: A proper Copyright notice has three elements: (1) the word Copyright, the abbreviation Copr., or the symbol © (which you can't assign on the D90); (2) the year of first publication; and (3) the name of the owner of the Copyright. That's it. There is no date range (e.g. don't use © 1999-2008 Thom Hogan), you can't use the (c) construct instead of ©, and you shouldn't omit the year for photographs (a number of people have misconstrued the "may be omitted when a pictorial..." clause, not noting that it has a dependency of "is reproduced in or on...". Thus, there are the only two forms that you should enter into the **Copyright** field:

Copyright YYYY Owner
Copr. YYYY Owner

where YYYY is either the year the image was shot or the year you expect to first publish it, and Owner is the legal entity claiming Copyright.

Setting the LCD Brightness

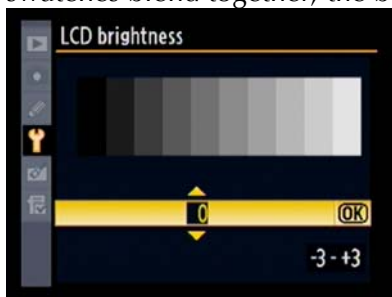
 The D90 allows users to set a brightness value for the color LCD screen on the back of the camera:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the SETUP menu (yellow wrench icon).
3. Use the Direction pad to navigate to **LCD brightness** and press the **▶** key on the Direction pad or the **OK**

button to select it.



4. Use the ▲ and ▼ keys on the Direction pad to select brighter or darker display. You'll see a swatch of patches from black to white to help you assess your adjustment. You should see every ramp position in the swatches; if the two whitest swatches blend together, the brightness is too high, while if the two darkest swatches blend together, the brightness is too low.



Note in this sample screen how the patches are clearly distinguished from each other (reproduction may have the two darkest patches slightly blocks up, but on my screen, the patches are distinguished). If two bright or two dark patches look nearly identical, you've set the brightness incorrectly.

5. Press the **OK** button to confirm your choice.

Novice DSLR users have a tendency to “crank up” the brightness of the color LCD. Moreover, they rely upon it too much to make visual assessments of the photo they just took. Unfortunately, both of these things are wrong.

The swatch of patches shown in Step 4 is there to help you get a full tonal range display from black to white with a complete gradation in between. If you arbitrarily set the

brightness higher, you'll note that several of the patches on the right side become all white (the opposite, setting too low, would produce multiple black patches on the left side). You've effectively told the display to show all bright tones as white—you'll never be able to see what's going on in the highlight regions of your image.

The correct setting for the LCD brightness is to see all 10 of the tonal patches distinctly from one another and with even gradations, which almost always means a setting of **-1** or **0** on the D90 in normal and outdoor light.

But the bigger problem is that the color LCD is not color or brightness (gamma⁶⁹) profiled⁷⁰. If something looks too bright or too red on the color LCD, it may or may not be in your actual photo data. It's actually worse than that: the color LCD comes closer to reproducing the sRGB gamut than the AdobeRGB gamut. If the camera is set to sRGB as the Color Space, the colors you'll see are slightly more accurate. Many users who've set AdobeRGB complain of a slight green cast, though in looking at ColorChecker charts on my color LCD and moving between the various options I see very little meaningful difference.

I'll repeat: the *only* way to visually assess an image accurately is to display it on a color-calibrated monitor using the correct color space profile.

Setting the File Numbering Sequence

The D90 allows you to specify when file numbers are reset (as a reminder, the importance of file numbers was discussed in "File Names" on page <184>). As mentioned in the section

⁶⁹ Gamma refers to how the middle gray setting is determined. In general, the D80's color LCD seems to have too low a gamma setting, and the tones on either side of middle gray are not perfectly symmetrical.

⁷⁰ Nikon makes a claim that the D90's LCD is "calibrated" in the factory, but this refers to the fact that all the LCDs are set exactly the same in the factory, not calibrated in the manner you do with a your computer monitor.

labeled “File Numbering Sequence” on page <190>, you have three choices:

- **Off.** File numbers are always started at 0001 whenever a new folder is created, when the storage card is formatted, or a new storage card is inserted into the camera. Nikon’s default choice.
- **On.** File numbers are incremented until they reach 9999, at which point a new folder will be created and the file numbering will begin again at 0001.
- **Reset.** The file number is reset to 1+the current file number in the current folder (if there are no images in the current folder, numbering is reset to 0001).

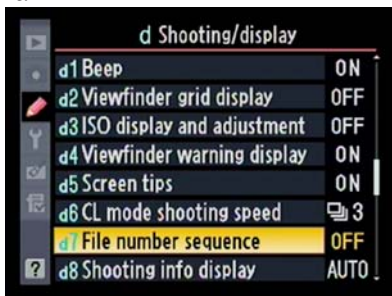
Of these options, **On** makes the most sense, and is the one I use on all my Nikon DSLRs. That’s because file name duplication is dangerous—you could accidentally erase or overwrite a file you wanted to keep.

📷 To set File Sequence Numbering we have to use the CUSTOM SETTING menu (this option was on the SETUP menu for the D80):

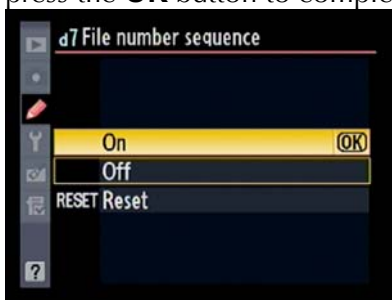
1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the CUSTOM SETTING menu (yellow wrench icon).
3. Use the Direction pad to navigate to the **Shooting/display** option and press the **▶** key on the Direction pad or the **OK** button to select it.



4. Use the Direction pad to navigate to the **File number sequence** option (Custom Setting #D7) and press the **►** key on the Direction pad or the **OK** button to select it.



5. Use the Direction pad to navigate to the option you wish to set (**On** is my *strong* recommendation) and press the **OK** button to complete the action.



Note that the file numbers you're configuring with this menu option are what the *camera* sets. If you follow my advice in the *Introduction to Nikon Software*, you'll have Nikon Transfer (or whatever other program you use to transfer files from camera to computer) rename and renumber your images. In those software programs you're *not* limited to four digits, plus you might want to name images sequentially from a shoot (e.g. PhillyZoo0001, PhillyZoo0002, etc.).

Set Up Recommendations Summary

I have strong recommendations about how to set up your D90 before starting to shoot with it. These recommendations cover things that get your camera configured for everything except the photo decision choices (image quality, shooting options,

etc.). These items control functions that set the camera up for recording or displaying information the way you'll usually want it done.

Things you need to set because the camera's defaults aren't optimal or haven't been set yet:

World time set to the current date, time, and time zone

Language set to your preferred language

Image comment set to **Copyright YEAR Your Name**

LCD brightness set to **-1** or perhaps **0**

File number sequence (Custom Setting #D7) set to **On**

Display mode (covered in "Options for Evaluating Exposure" on page <248>) set with options to appear

Things that you may need to reset back to the camera defaults if you've been tinkering with the camera before you got to this section of the eBook:

Image review (covered in "Image Review" on page <455>) set to **On**

Auto image rotation set to **On** (covered in "Rotating Images" on page <465>)

Note that *none* of these things show up on the Top LCD or while you're shooting—everything we've set so far really only impacts data recorded with the image (date, time, comment, file number sequence, and rotation) or how the menus appear (language, brightness, etc.).

I'll deal with the remaining setup items elsewhere in this eBook, mostly in the section on CUSTOM SETTINGS that begins on page <477>, as a few items require you to make an intelligent decision about how *you* want the camera to operate.

Viewfinder Adjustment

The D90 allows you to adjust the viewfinder to help accommodate small differences in vision.



Just to the right of the viewfinder eyecup (green arrow points to it in above image) you'll find a small knob marked **+ ---- -**. What this knob controls is the diopter value used for the viewfinder. Diopter is a unit of measurement that describes the refractive power of a lens. The default value (the center click stop on the dial, where **-** is exactly at 12 O'clock and **+** is at 6 O'clock) is set at -1 diopter, and the range that's supported directly by the viewfinder goes from -2 diopters to $+1$ diopter.

In prescriptions for glasses, negative diopter numbers indicate correction for nearsightedness. In camera viewfinders, the diopter value controls the apparent distance at which the viewfinder appears (the default is 1 meter away, the equivalent of -1 diopter). If your vision isn't sufficiently able to (or corrected to) focus on objects at that distance, you'll need to adjust the diopter value.

📷 To adjust the diopter value:

1. Defocus the lens on the camera until the scene in the viewfinder is completely blurred.
2. Point the camera at something plain, like a clear blue sky.
3. Look carefully at the *focus brackets* in the viewfinder. Are they sharp and distinct? If not, rotate the Diopter Adjustment knob until the focus brackets are sharp.
4. Verify the setting by having the camera focus on a subject and checking to see that the image in the viewfinder appears sharp (it may not be perfectly so, as the viewfinder glass tends to diffuse detail slightly,

but you should still be able to verify that focus is sharp).

If you wear glasses or contact lenses, make sure to let your optometrist know that you're a photographer, and that the viewfinder image is formed at a distance of 1 meter with an eyepoint relief of 19.5mm. He may make slight adjustments to your prescription that helps you see the image in the viewfinder more clearly.

If you need more correction than the built-in adjustment allows, you can purchase alternative eyepiece correction lenses. You can buy DK-20C -3, -2, 0, +1, or +2 lenses to add to the viewfinder, and it's easy to do (they mount in place of the standard DK-21 rubber cup). The range of adjustment remains the same. In other words, if you add a -3 lens, your adjustment range would be from -5 to -2.

Note: When you use the optional correction diopters, you can't use the DK-21 rubber eyepiece that comes with the camera, nor can you use the optional DR-6 right-angle finder or any of the other options that mount into the viewfinder eyepiece socket.

Focus Screens

The D90 comes with a focusing screen installed, and things like grid lines, which are usually supplied by substituting an E-type screen on other high end Nikon bodies, are instead done electronically (with an LCD overlay on the focusing screen; Custom Setting #D2 on page <507>).

If you'd like a more traditional split prism focusing screen, you can get one from third parties, such as Katz Eye: http://www.katzeyeoptycs.com/item--Nikon-D80-Focusing-Screen--prod_D80.html. They can also provide various etched cropping aids (one-third lines and 8x10 format lines, for example).

Resetting the Camera

Because the D90 has an enormous number of user-settable options, Nikon has provided a quick reset system to bring the camera back to the factory default settings.

Resetting Basic Settings

 To reset the basic camera settings, hold the **AF** and Exposure Compensation buttons (both marked with a green ●) for more than two seconds. The following basic camera settings are returned to their defaults (the first five items apply to SHOOTING menu options; see “SHOOTING Menu” on page <431>):

Settings after Reset

<u>Setting</u>	<u>Default</u>
Image quality	JPEG normal
Image size	Large
ISO sensitivity	200 (P S A M) AUTO (Scene)
White balance	Auto with 0 adjustment (e.g. + and – adjustments are cancelled), 5000K (Choose)
Picture Controls	Modifications cancelled
Focus	AF-A
Focus Point	Center
Live View Focus	Face-priority (Portrait, Night Portrait), Normal Area (Macro), Wide Area (all other exposure modes)
Metering	Matrix
Flexible program	Cancelled (e.g. camera follows regular program table)
Exposure lock	Off
Exposure compensation	0 stops (e.g. no exposure compensation set)
Flash exposure compensation	0 stops
AE/AF lock hold	Off
Multiple Exposure	Off

Bracketing	Off (bracketing increment is also reset to 0.3 stops or 1 for white balance bracketing)
Flash options	Front curtain sync (e.g. no Slow or Rear Sync option is set except Scene Exposure mode is set to Night Portrait), FV lock Off

Resetting Other Settings

The two-button reset just described doesn't reset every menu option, nor does it reset Custom Settings (see "Custom Settings Reset" on page <482>).

The Last Resort Reset

The D90 contains considerable electronics, including a CPU and dedicated digital processors. Like a computer, it can sometimes get confused. If the camera is locked up or displaying unusual or garbled characters, you've got one last option for resetting the camera:

1. Turn the camera OFF.
2. If you're using battery power, remove the main battery. If you're using AC Power, unplug the adapter.
3. If possible, let the internal clock battery discharge (this normally takes days).
4. Turn the camera ON for several minutes.
5. Turn the camera OFF.
6. Replace the batteries taken out in Step 2.
7. Turn the camera back On.

If the camera is now working normally, set the date, time, and any other settings you may have lost (the camera should be set back to the way it came from the factory). If the camera still isn't working properly and you've checked to make sure that you haven't made a setting that is causing a problem,

you'll have to return it to Nikon for servicing (see "Getting Service" on page <756>).

Why turn the camera On in Step 4? We want the camera to exhaust any internal capacitors that are storing charge and holding values that need to be reset. We want the camera to come up in a "clean" state when we restore power.

Firmware Version

The D90 shipped with firmware labeled A1.00, B1.00, and L1.000. As of this writing, no updates have been made.

📷 To determine which version you have:

1. Press the **MENU** button to see the menu system.
2. Use the Direction pad keys to navigate to the **SETUP** menu (yellow wrench icon).
3. Use the Direction pad keys to navigate to **Firmware version**.



4. Press the **▶** key on the Direction pad or the **OK** button to display the firmware version.



To update your D90⁷¹:

1. First, download the firmware updates from one of the Nikon Web sites.
2. Even though the firmware file is relatively small, Nikon usually chooses to compress the file, so you'll need to use Winzip (Windows) or Stuffit (Macintosh) or equivalent programs to expand the archive into the update files. The names for the update files will be something like **AD90####.BIN** and **BD90####.BIN**. *Note:* Be sure to verify the exact name from the Nikon Web site. If it's different than the above, you'll need to substitute the right name in the steps below.
3. Copy only the **AD90####.BIN** file to the *top level* (root level) of a Secure Digital card. Do not place it in the **DCIM** folder!
4. Put the card you created in Step 3 into the camera.
5. Make sure the camera battery is fully charged or you are using AC power via the AH-5a.
6. Press the **MENU** button to see the menu system.
7. Use the Direction pad keys to navigate to the **SETUP** menu (yellow wrench icon).

⁷¹**Warning:** These instructions are predicated on how Nikon has done D80 and other DSLR updates. It's quite possible that the update routine may change in the future, so please double check the instructions on Nikon's Web sites before attempting any firmware installation. Also note that sometimes only an A or B update is done, not both simultaneously as described here. Finally, the order in which the A and B updates are done could change in the future. *Always look at Nikon's instructions and follow them if they differ from the ones shown here.* However, Nikon usually gives update instructions that require your camera to be connected to your computer via the USB cable, and that's not the only method possible of getting information to the camera.

8. Use the Direction pad keys to navigate to **Firmware version**.



9. Press the **▶** key on the Direction pad or the **OK** button to display the firmware version. Navigate to **Version up** and press the **▶** key on the Direction pad or the **OK** button a second time and you should see a firmware update dialog.
 - a. Use the Direction pad to navigate to **Yes**.
 - b. Press the **OK** button to start the update.
 - c. Wait until you see a message on the color LCD that indicates that the update has been completed.
 - d. Turn the camera OFF and remove the card.
 - e. Turn the camera ON, press the **MENU** button, navigate to **Firmware version** on the SETUP menu, press the **▶** key on the Direction pad or the **OK** button and verify that the updated version appears in the screen that appears.
10. Erase the **AD90####.BIN** file from the card, and then repeat Steps 3 through 9, except with the **BD90####.BIN** file.

Shooting Pictures with the D90

Camera and Shooting Controls

Now that we've gotten some basics and initial camera set up out of the way, let's look at the specific controls that come into play as you take pictures.

This section of the eBook is the portion you'll want handy when you're out shooting, as it examines each of the D90's main controls and tells you when and how to use each.

We'll start off the section by locating and labeling all the controls (buttons, switches, and dials), then drop down into the various sub-components in detail.

D90 Controls

Front View



1. Focus Mode Selector switch
2. Lens Release button

3. Infrared receiver
4. Self-Timer, Autofocus Assist, Red-eye Reduction lamp
5. **FUNC** (user-assignable) button
6. Depth of Field Preview button
7. Front Command dial (called sub-command dial in Nikon manuals)
8. Shutter release
9. Lens Alignment mark
10. Camera Strap attachment points
11. Microphone
12. EE Coupling post⁷²

Top View



13. Metering Method button (doubles as **Format** button)
14. Exposure Compensation button (doubles as Reset button)
15. Flash hot shoe (under removable plastic protector)
16. Power switch (extreme position is LCD illumination)
17. Top LCD Display panel
18. Focal Plane⁷³ indicator ϕ

⁷² This is how the camera detects whether a lens with an aperture ring is set to the smallest aperture. This is the piece that's usually damaged if you put a pre-AI lens on the camera.

19. Exposure Mode dial (Mode dial in Nikon manual)
20. Shooting Method button
21. **AF** button (doubles as Reset button)

Back View



22. Delete button (doubles as **Format** button)
23. Color LCD display
24. Viewfinder eyepiece (DK-20 slides up to remove)
25. Diopter Adjustment knob
26. **AE-L/AF-L** button
27. Rear Command dial (main command dial in Nikon manuals)
28. Autofocus Area Direction pad (doubles as Autofocus Sensor selector and Direction pad for the menu system)
29. Direction Pad Lock lever (**L** position locks pad)

⁷³ What's a focal plane? It's the point at which the image is focused (i.e. the surface plane of the sensor for a D90 or the surface plane of the film for a 35mm film camera). In close up (macro) work, it's sometimes necessary to measure distances from the focal plane, thus the mark.

- 30. Playback button
- 31. **MENU** button
- 32. Protect button (doubles as Help and **WB** button)
- 33. Thumbnail button (doubles as Zoom Out and **ISO** button)
- 34. Zoom In button (doubles as **QUAL** button)
- 35. **OK** button
- 36. Secure Digital Card Access lamp
- 37. Live View button
- 38. **INFO** button

Side Views



- 39. Secure Digital Card Access Door (door slides towards back of camera—two green arrows—and then springs to open position shown)
- 40. Flash Release button; doubles as Flash Options button (Flash Sync Mode in Nikon manual) and Flash Exposure Compensation button
- 41. Bracketing button
- 42. Wired remote connector (under bottom rubber flap)
- 43. Mini-HDMI connector (under top rubber flap)
- 44. Video Out connector (under top rubber flap)
- 45. USB connector (under top rubber flap)

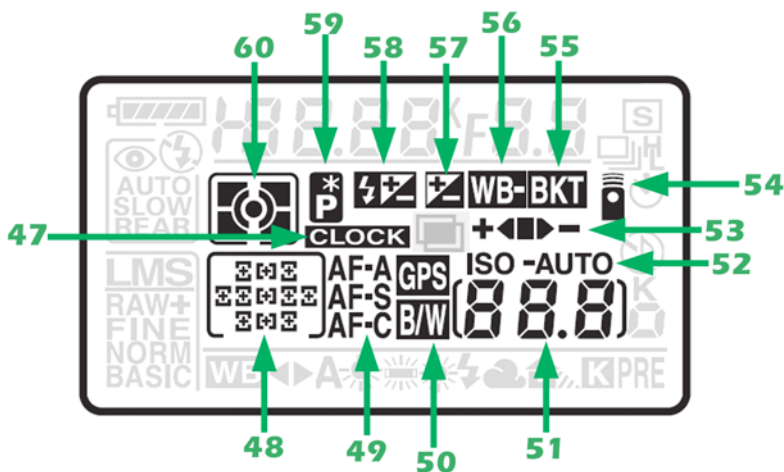
46. DC In connector (under top rubber flap)

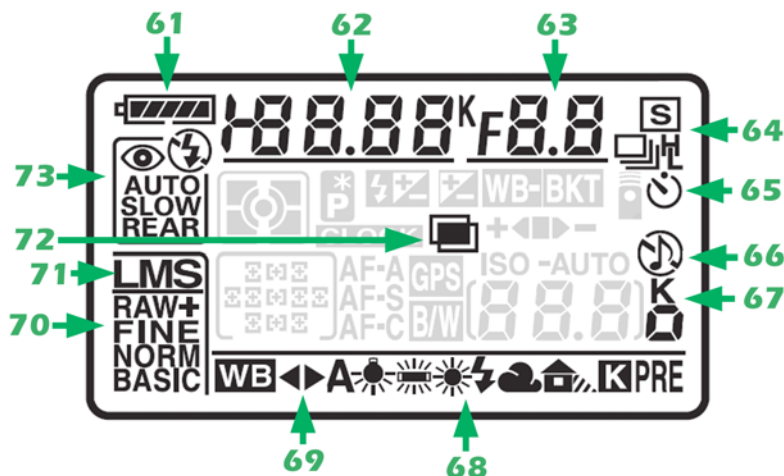
D90 Displays

The D90 features three displays, all of which can present information about the current camera settings.

On the top of the camera is the familiar (to 35mm film users) LCD panel (called the Top Control Panel by Nikon), though it displays additional information not found on the film bodies. This monochrome LCD is primarily used to show the camera's main shooting modes, exposure settings, frames shot and remaining, and active primary features. Most of the information on the top LCD is associated with camera controls on or near the top of the camera. A few of the areas on this LCD have multiple uses, so pay close attention to the information being presented. In this book, whenever I refer to "top LCD," I'm referring to this display.

D90 Top LCD





- 47. Internal Clock Battery Condition indicator
- 48. Focus Area and Focus Area mode indicator
- 49. AF mode indicator **AF-S, AF-C, AF-A**
- 50. Black & White and GPS indicators **B/W GPS**
- 51. Frame Count indicator *Note: remains displayed even when camera is turned OFF.* **888**
- 52. Auto ISO indicator **ISO-AUTO**
- 53. Bracketing Progress indicator **+ -**
- 54. Wireless Remote indicator
- 55. Exposure Bracketing indicator **BKT**
- 56. White Balance Bracketing indicator **WB**
- 57. Exposure Compensation indicator
- 58. Flash Exposure Compensation indicator
- 59. Flexible Program indicator **P***
- 60. Metering Method indicator
- 61. Battery Condition indicator
- 62. Shutter Speed indicator/Exposure Compensation value/Shots in Bracketing indicator/ISO indicator **H88.88**
- 63. Aperture indicator/Bracketing Increment indicator/PC Connection indicator **F8.8**
- 64. Frame Advance indicators
- 65. Self Timer indicator
- 66. Beep indicator
- 67. Over 1000 Frames indicator **k**

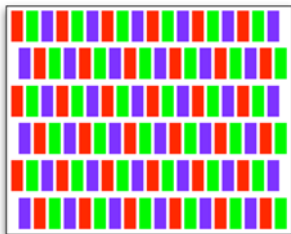
- 68. White Balance indicators 
- 69. White Balance change indicator ( indicates you've altered the basic value)
- 70. Image Quality indicators (**RAW**, **FINE**, **NORM**, **BASIC**)
- 71. Image Size indicators (**L** = large, **M** = medium, **S** = small)
- 72. Multiple Exposure indicator 
- 73. Flash Options indicators   **AUTO**, **SLOW**, **REAR**

D90 Color LCD

On the back of the camera is a large (~3") color LCD (Nikon refers to this as the "Monitor"), which can be used to review images taken with the D90 or to display shooting information.

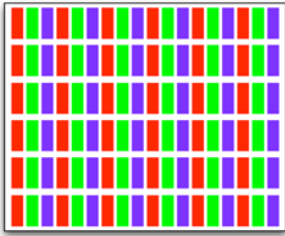
The color LCD, besides being larger than previous Nikon DSLR color LCDs, has another key attribute: it has more dots arrayed in a different pattern.

For example, the D80 color LCD had 230,000 dots arrayed in what is known as a delta array. A delta array uses offsetting colors in a mosaic similar to what sensors use in order to provide the appearance of a colored pixel via somewhat adjacent Red, Green, and Blue dots.



delta array

The D90 uses a color LCD with 920,000 dots arrayed in a stripe pattern:



stripe array

This is the way in which most LCD TVs display colored information. Indeed, the screen on the D700 is essentially a small VGA-sized television (640x480 pixels⁷⁴).

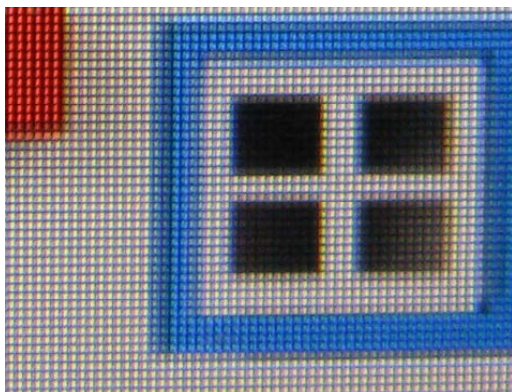
You'll note the strange terminology (dots instead of pixels). It takes three colored dots to make up what we interpret as an RGB pixel. The old delta array of the D80 and other earlier Nikon DSLRs fools us into thinking a low definition device (320x240) is really a set of pixels, but the offset used in the colors and the large dot size make for a visibly crude image.

Go ahead, take a magnifying glass to a D80 color LCD and you'll see something like this:



The higher density of the D90 color LCD and the use of the stripe array makes for a visibly better image on which it's easier to evaluate sharpness:

⁷⁴ In actuality, due to the striped nature, the dots are arrayed as 1920 x 480. Three horizontally adjacent dots form a visible "pixel." You'll note that the dots are tall and narrow because of this design.



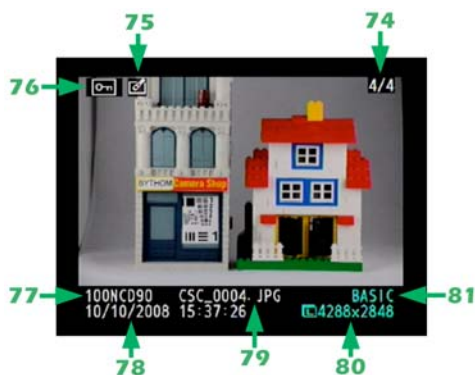
The difference is most noticeable when you're zooming in on images to assess the focus. Even with the side-by-side colors, the implied pixel pitch of the D90's color LCD is 266 dots per inch, which is about as high as it gets right now on displays. On the older display technology, it's often difficult to see how much acuity is in the image. On the D90's newer display technology, it's much easier to make that assessment.

The color LCD also allows you to see the image well from 170°, essentially any angle that you can manage to see the display from.

Finally, the color LCD on the D90 comes with a BM-10 protector. Unlike the D3 and other high-end models using the same LCD, the coating on the D90 LCD is not tempered glass, but a plastic. My recommendation is to leave the BM-10 cover on the LCD all the time.

The color LCD displays 100% of the picture when viewing images. If you've turned on automatic rotation of vertical images for playback (PLAYBACK menu, **Rotate tall** option), the color LCD rotates those images.

In this book, whenever I refer to the "color LCD," I'm referring to this display.



The color LCD is okay for casual previews of images, but don't count on using it to critically evaluate sharpness or color balance. It's most useful function is for judging composition and for analyzing information from the image (histogram, highlights, etc.).

74. Frame Number indicator (upper right corner) **4/4**

75. Modified Image Icon (RETOUCH menu used)

76. Protected File indicator

77. Folder Name **100NCD90**

78. Date and Time **10/10/2008 15:37:26**

79. Filename **CSC_0004.JPG**

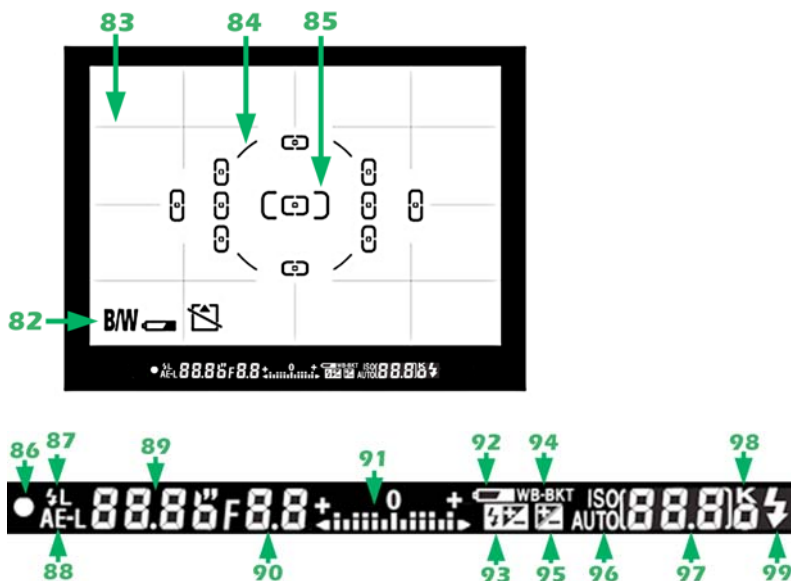
80. Image Size (L, M, or S) **L 4288x2848**

81. Image Quality **BASIC**

Note that other information about the photo appears on separate information pages (selected by pressing the ▲ or ▼ keys on the Autofocus Area Direction pad while viewing images). See "Image Review" on page <455>.

D90 Viewfinder

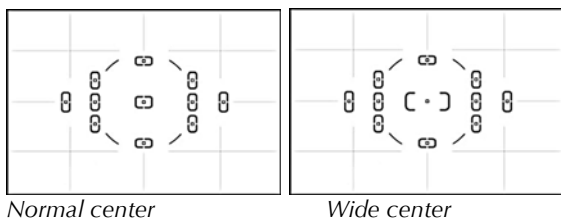
When you look through the viewfinder, you'll see an information display below the image area. This lighted display is activated when you press the shutter release partway, and turns off automatically with the metering timeout to conserve power. In this book, whenever I refer to the "viewfinder display," I'm referring to this information.



82. B&W, battery, no card indicators (Custom Setting #D4 must be On to appear) **B/W**  
83. Viewfinder grid lines (Custom Setting #D2 must be On to appear)
84. Center-Weighted Metering area
85. Autofocus Sensor positions (outer brackets appear when selected, only inner square appears if not or in an auto selection mode) 
86. Focus Confirmation indicator •
87. Flash Lock indicator **L**
88. Exposure Lock indicator **AE-L**
89. Shutter Speed value **88.86**
90. Aperture value **f8.8**
91. Manual Exposure display/Exposure Compensation setting 
92. Battery Condition indicator 
93. Flash Exposure Compensation indicator 
94. Bracketing indicators **WB-BKT**
95. Exposure Compensation indicator 
96. Automatic ISO indicator **ISO-AUTO**

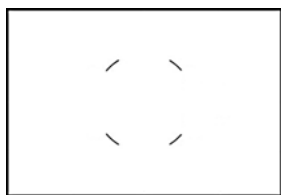
97. Frame Count indicator/Frames Remaining indicator/Exposure Compensation value/PC Connection indicator **88.8o**
98. Over 1000 Images indicator **k**
99. Flash Ready light **z**

Autofocus Sensor indicators that double as spot meter targets are superimposed over the image. Note that two kinds of AF indicators can appear: normal central and wide central area (chosen with Custom Setting #A2, see page <488>).



The highlighted area indicates the active autofocus sensor (or sensors). I'll have a lot to write about this in various sections of the eBook, but pay close attention to spot metering (see "Spot Meter Point" on page <242>).

The large circle partially superimposed over the image in the viewfinder helps you estimate the area used for center-weighted metering.



The area used for center-weighted metering can be changed using Custom Setting #B3 (see page <497>). The displayed circle corresponds to the 8mm setting (if you change the setting, you have to guess at the circle size in the viewfinder).

The image area you see in the full viewfinder is approximately 96% of the area that is seen by the sensor when shooting normally. I personally would have preferred 100%.

Metering and Exposure

Cameras need some way to adjust the amount of light that gets through to the imaging sensor. In very bright scenes, for example, we may need to limit the total amount of light or the time that the light hits the sensor. In dark scenes, we may need to increase the total amount of light or time the light gets into the camera. Such control is called “setting an exposure.”

For any fixed amount of light and camera ISO setting, there is one or more aperture opening (size of the hole in the lens) and shutter speed combinations (length of time the sensor gets light) that can be used to get a “correct exposure.”

Back in the early days of film photography we used to have to measure the amount of light by using an external (handheld) meter, and then manually set both the aperture and the shutter speed on the camera. Today, all SLR-type cameras such as the D90 have multiple automatic ways to do the same thing.

First, the D90 has an internal and automatic metering system (see “Metering Methods” on page <232>), and this system has a variety of settings to control how the metering is accomplished. Second, the D90 has multiple methods of interpreting what the meter says is the proper exposure, called *exposure modes* (see “Exposure Modes” on page <259>). We need to examine both things, as they directly contribute to getting the right exposure.

Metering Methods

The D90 has three metering methods available: matrix, center-weighted, and spot. The next sections will describe each separately.

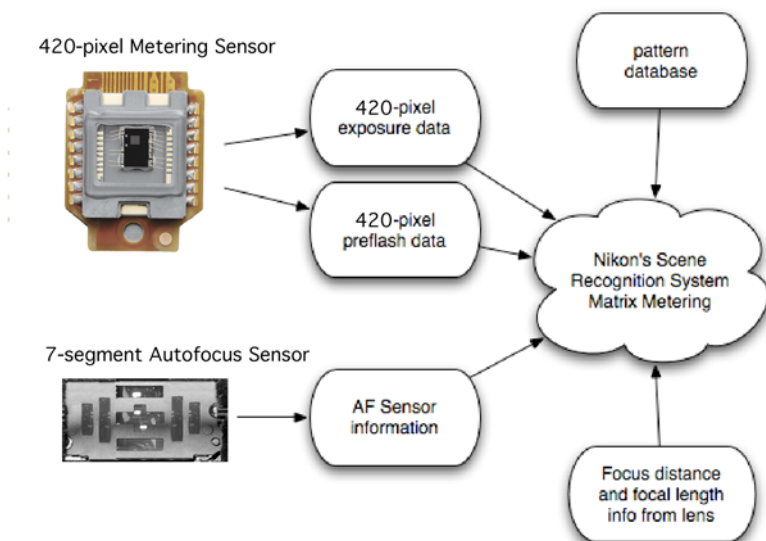
Matrix

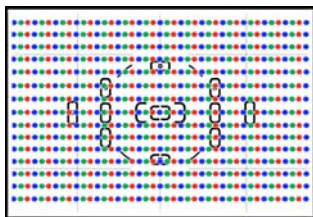


Matrix metering is a system that divides the image area into pieces (the “matrix”) and analyzes the differences between them. The brightness pattern seen in the matrix is compared against a Nikon-proprietary database of image patterns stored in the D90’s internal memory, and the exposure is set accordingly.

The D90 uses a dedicated 420-pixel sensor in the viewfinder to provide metering (higher-end Nikon bodies use a 1005-cell sensor). The “brains” behind the matrix metering has been significantly improved over the years since the basic system of using a digital sensor was introduced on the F5.

Nikon used to call this system 3D Color Matrix II. However, starting with the D3, D300, D700, and now the D90 Nikon is now touting it as a Scene Recognition System. That’s because the sensor in the viewfinder is more integrated with the other components in the camera:





The 420-pixel⁷⁵ CCD covers most of the image frame. The matrix consists of alternating color sensors (RGB; but it's not the Bayer pattern described in the section on the sensor).

If a D-type or G-type lens is used (with or without flash), matrix metering also takes into account the focus distance (the “3D” in the name) to help guess where the subject is and what kind of shot you’re taking. *Example:* normally, the matrix meter discounts brightness in the upper half of the scene, as it thinks this is sky, and unimportant; however, if you’re using a wide angle lens and are focused near infinity, the camera thinks that you’re taking a landscape photo and doesn’t discount the sky exposure as much.

However, if you’re used to the way older Nikon matrix meters worked (other than the D80, which we’ll get to in a bit), you may find that the D90 doesn’t quite meter the same way. The integration of the autofocus sensor information adds another twist into the complex decision the matrix metering system applies, as it tries to reconcile what you’re focusing on with what it thinks you might be taking a picture of. Simply put, the matrix metering system is subject to biasing the exposure towards what’s underneath the selected autofocus sensor. If what’s under that sensor is dark, exposure may be increased; if what’s under that sensor is bright, exposure may be decreased. This is similar to the way the D80 behaved, though the D90 is less prone to the large swings the D80 matrix meter produced. One difference on the D90 is that the exposure swings occur mainly in Single Point and Dynamic Area AF, not in Auto Area or 3D-tracking AF.

⁷⁵ Actually, I’m a little unsure of this. While Nikon’s literature says 420 pixels, close examination of the actual part appears to show 13 rows of photosites, which, of course, doesn’t divide into 420 equally. I also count 14 RGB clusters across the part, which would give us a total pixel count of only 182. I suspect that the sensor is 546 photosites, of which 480 are used for metering.

You can test this yourself. Find a scene that is highly variable in brightness from side to side. Put the camera in Single Point AF, Matrix metering, and Manual exposure mode. Select an autofocus point on one side of the scene and zero the exposure metering bar (i.e. set a correct exposure). Now without changing anything else move the focus selection to a sensor on the other side of the scene. Note that your exposure changes. Now change to 3D-tracking AF and do the same thing: the exposure stays the same.

But we're not done yet. The D90 matrix metering system also relies on four other key data points:

1. The overall brightness of the scene.
2. The differences in light measured across the 420-pixel sensor data (i.e. the "patterns").
3. Distance and focal length information from the lens.
4. The color (or colors) of the areas measured.

The key word in item #2 is "differences." Sky, for example, is usually very bright; near subjects we photograph tend to be less bright⁷⁶. You can probably guess that if the upper left and upper right areas metered are considerably brighter than the lower left and lower right areas and are mostly blue, then the camera is going to use #2 and #4 to determine you're taking a picture of someone with sky in the background. If it sees a flesh tone under the current AF sensor, consider that assessment confirmed. In such a case, the sky usually isn't considered as important to the exposure, so the camera adjusts its exposure to match what it sees in the other areas. Just remember that it's the *difference* in brightness between areas that is a primary key to the matrix metering system, not the actual values measured.

⁷⁶An early Kodak study showed that most outdoor scenes tend to form a bell curve in overall exposure range, with something around 7.5 stops being the peak (160:1).

However, note that no meter can perfectly deal with any situation that has a higher contrast range (large variation in brightness; remember I call this *exposure dynamic range*) than the camera's dynamic exposure (which, by the way, describes about half of the daylight scenes you might shoot). In scenes with a large exposure range either the bright portions of the scene will have to be overexposed or the dark portions underexposed.

One thing that catches many by surprise is that the D90's matrix meter sometimes tries to preserve highlight detail over shadow detail in high contrast situations, especially if you've selected Auto Area Autofocus. That's because a highlight, once overexposed, is unrecoverable on a digital camera (on print film, you could often recover something that was as much as three stops overexposed). By "tries to preserve" I don't mean that the meter necessarily keeps the image from having blown highlights, but that it will keep such blowouts from being too dramatic.

Whether the camera picks the right thing to expose properly depends upon a number of things:

- If the difference in brightness across the entire matrix meter is minimal (by definition, a low contrast scene), the matrix metering is nearly perfect (and the meter tends to use what it sees in the central region as the primary measurement, almost like center-weighted metering).

Indeed, even color variations and white or black objects tend to be exposed correctly in this situation⁷⁷.

- Nikon's matrix meters tend to underexpose off-center subjects in very high contrast situations, especially so if the subject is outside the autofocus sensor areas. The D90 seems much less prone to this than previous Nikons, probably because the scene recognition system is now better at recognizing things like skin tones.
- Overall scene brightness plays a part in the final camera metering decision. Nikon once tried to build a diagram of how brightness and contrast information interacted, but it was very confusing and didn't reveal much detail useful to the casual photographer. The key point that diagram revealed was that in very bright and very dim scenes the camera sets exposure differently than in "normally" lit scenes. If I had to characterize this, I'd do so as follows:
 - In very *dark* scenes, the central region (e.g. the center-weight circle) is often considered the most important, and exposure is sometimes biased towards what is seen there. *Lesson: be careful with very off center subjects in low light. Anything outside the autofocus sensing areas is what I consider off-center, so keep the AF sensors over the critical area for exposure.*
 - In very *bright* scenes, the camera sets exposure either biased towards the lowest value it sees (usually only when contrast is low), or towards an average across the scene (when contrast is very high). My observation is that Nikon has modified that latter point to be "towards a setting that will hold the majority of the highlight detail," which can be lower in exposure than

⁷⁷ A "middle yellow value" doesn't have the same reflectance as a "middle gray value," or a "middle red value" for that matter. The color ability of the Nikon matrix meter corrects for this, however. If your subject is a big gray blob filling most of the image area, the gray blob will be placed near the midpoint in the dynamic range of the camera. If your subject is a yellow parakeet filling most of the image area, the parakeet's yellow will be placed near the midpoint in the dynamic range of the camera. Why "near" and not "at"? Because Nikon tries to account slightly for perceptual differences between colors.

the average in some situations. *Lesson: when it's bright, highlights are at slight risk, especially if the contrast is high, while mid-tones and shadows are more likely to be underexposed.*

- The camera biases exposure slightly towards the brightest area in a scene when contrast between regions it is measuring is seen as low, and you're in "normal" lighting (not too bright, not too dim). *Lesson: low contrast scenes get exposed right most of the time.*
- If the contrast between matrix regions is very low, there's always a tendency for the matrix meter to set an exposure based upon the central area, regardless of brightness. *Lesson: watch exposure with off-center subjects when contrast is low. Again, keep the autofocus sensors over the critical exposure area, if possible.*

Don't panic. While that was a lot of detail, we'll make a bit more sense of how to evaluate an exposure in the Histogram description coming up later in this section. And I should point out that the latest iterations of Nikon's matrix metering provide excellent exposures most of the time. I'm only trying to point out conditions where the system might set less than optimal exposure.

Before leaving the matrix metering, we need to discuss one other thing: gamma. One relatively common complaint by first-time D90 users coming from older Nikon DSLRs is that the camera "overexposes." But if you look at some of the images these people are objecting to, the image isn't actually overexposed (i.e. the highlights aren't blown out).

It appears to me that Nikon's interpretation of mid-range brightness changed with the introduction of the D3, and thus now with the D90, as well. The **Standard** Picture Control has a default **Brightness** setting of **0**. But this produces mid-range tonalities that are somewhat higher in exposure than the D2 series produced. Where a D2xs might have placed a value at 122,122,122 the D90 is placing that same value at

something more like 128,128,128, which appears visually brighter. Yet values in the extreme highlight realm are pretty much the same. Essentially, the mid-range is getting a bit of a boost, visually.

The reason for discussing this with the metering system is that you need to be careful to assess exposure separately from tonal placement when you're trying to figure out the metering system. Those new Picture Control settings are a little tricky, and interact with exposure settings a bit.

I have a couple of final comments about the matrix metering system after having used it now in the field for awhile:

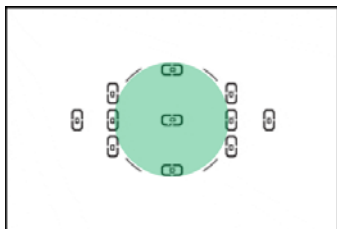
- *Watch the AF sensor!* Especially in Single Point AF mode the D90 is prone to compensate somewhat for what's under the autofocus sensor you pick. If that's darker than middle gray, your exposure may be "brightened," while if it's brighter than middle gray, your exposure may be "lowered." Most of the inconsistent metering complaints I've heard can all be traced back to this.
- *Snow good!* More so than any previous Nikon matrix system, the new one in the D90 seems to capture snow and very bright scenes more like we would using traditional spot metering and compensation. If you're used to dialing in compensation in bright situations, back away from that control and let the camera do its thing if the overall contrast range isn't too great. Having shot on glaciers and in snow several times now, I'm impressed at how much better the D90's meter is at getting it right (or at least close) than previous matrix meters were. If you're coming from a D80, the matrix meter is going to be more reliable for you than the D80 was.

Center-weighted



Nikon's center-weighted metering system measures the entire frame, but effectively separates it into two zones, the central area and the outer area. The exposure is based 75%

on the central area, 25% on the outer area. (Note that the manual text doesn't mention 75/25, but Nikon's technical specifications do.) In other words, if the central area metered $f/4$ at $1/125$ and the outer area metered $f/16$ at $1/125$, the exposure would be set somewhere around $f/5.6$ at $1/125$.



Center-weighted metering normally uses an area about the same size as the circle you see etched in the viewfinder (green area in illustration at left) for 75% of the metering value. The remaining 25% of the meter value is based on the area outside this circle (white area in illustration)

The central measuring area is normally about the same size (0.31" [8mm]) as the area indicated by the large circle etched in the viewfinder (the one that touches the top and bottom autofocus sensor indicators). You can change the size of the central area by using Custom Setting #B3 (see "Center-weight Circle Size" on page <497>), though I personally don't find this to be an overly useful feature.

One throwaway note in Nikon manuals should be noticed by all: if you're using a filter that has an exposure factor of one stop or more, use Center-weighted metering instead of matrix metering. That would, for instance, apply to polarizing filters.

The reasoning behind switching metering types with strong filters is simple: the matrix patterns were created using no filtration. Strong filters, especially ones that alter color, can greatly alter what the matrix sees. For example, a polarizing filter brings down a bright sky value quite a bit without affecting foregrounds at the same level. That means that the matrix pattern for "landscapes with sky" might not be recognized as being the one to use.

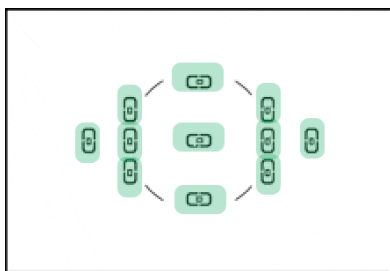
Spot



Most professionals tend to use spot metering when they have enough time to do a critical evaluation of a scene. That's because they can isolate individual bright and dark objects to help make critical exposure decisions.

Nikon claims that Spot metering targets a tight 3.5mm area (approximately 2.5⁷⁸% of the frame). The spot area is always centered on one of the autofocus sensors and tends to be elliptical in shape.

The spot metering point usually follows the autofocus sensor being used. Most photographers use the outer edges of the autofocus brackets to envision the circle of what's being metered. This gets them into trouble sometimes. The actual area is a bit larger than the brackets in size, and a slightly different shape (see illustration, below).



Spot metering occurs centered on one of the autofocus sensor areas. Note the area metered is larger than the autofocus sensor brackets indicate.

Note: Some metering nuances that catch users by surprise. Like most other recent Nikon bodies, the D90's spot meter uses the currently selected autofocus sensor most of the time (see "Metering Compatibility," below).

The D90 normally uses the autofocus sensor you selected using the Direction pad as the initial sensor. But in Dynamic Area autofocus mode, if the camera detects that the subject has moved it also moves the autofocus sensor being used

⁷⁸ Nikon appears to be rounding in their manuals again. They claim 2% on the D90, but 2.5% using the same 3.5mm area for the D80.

and spot metering follows! But in Single Area autofocus, the spot metering will stay put. Switch the camera to manual focus and it will use the currently selected autofocus sensor for spot metering.

Spot Meter Point

Focus Setting

Manual focus
Single Area AF
Dynamic Area AF
Auto Area AF
AI or AI-S lens Used

Spot Metering occurs at

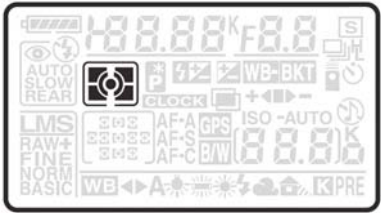
Highlighted AF sensor
Highlighted AF sensor
AF sensor actually used for focus
Center sensor
No metering!

Metering Compatibility

<i>Lens Type</i>	<i>Matrix</i>	<i>Center-weighted</i>	<i>Spot</i>
AF type D or G	Yes (3D)	Yes	Yes
AF-S or AF-I	Yes (3D)	Yes	Yes
AF-I Teleconverter	Yes (3D)	Yes	Yes
AF (non-D)	Yes	Yes	Yes
AI-P (non-shifted)	Yes	Yes	Yes
AI-P (shifted)	No	Yes	Yes
AI, AI-S, or AI upgraded	No	No	No
AI Teleconverters	No	No	No

Setting the Metering Method

📷 Just in front of the top LCD press the Metering Method button (📷) and rotate the Rear Command dial until the top LCD displays the icon for the metering method you desire.



Top LCD:

The D90 viewfinder does not display the metering method icon, so unlike the higher end Nikon bodies, you'll usually have to take your eyes from the viewfinder to make a metering change (*tip*: if you need to change back and forth between two metering systems a lot, use the **FUNC** button

assignment to activate the second metering method; see page <530>).

So Which Metering System Should You Use?

Short answer: matrix for most situations; center-weighted or spot metering for backlit subjects in very bright light (snow, sand, etc.).

Given that matrix metering is accurate most of the time and that the other methods require some knowledge of exposure and how to set it accurately, ask yourself whether or not you have enough knowledge to do a better, more consistent job than the matrix metering system is producing. I see three instances where this is likely:

- *Very high contrast and bright scenes.* The matrix metering pattern sometimes has problems with very bright scenes with a great deal of contrast in them. Part of this is that the matrix meter itself has a brightness limit of 17.3EV. The other part is that the matrix does try to keep from blowing out highlight detail.
- *You're using Single Point autofocus.* As noted earlier, the matrix system tends to overemphasize the value it sees under the current autofocus sensor if you're in Single Point autofocus. Thus, if you focus on something darker or brighter than a middle tone, the exposure may be off.
- *Some flash situations.* While the matrix meter is generally very good with on-camera flash, it does less well with off camera flash. **Note that FV Lock actually changes to a spot-type of measurement with on-camera flash**, even if you've set matrix metering.

Remember, you have the Histogram information and Exposure Compensation to help "tune" your exposures (see "Options for Evaluating Exposure" on page <248> and "Exposure Compensation" on page <297>).

Using other metering methods boils down to three situations, basically:

1. In very bright situations (snow, sand, etc.), the matrix meter's ability to measure light accurately can be compromised by its upper brightness limit. Center-weighted metering may give you slightly more accurate results, assuming you're using this method correctly.
2. You're coming from a film camera that sets exposure using the center-weighted method, and you're more comfortable keeping the same system on your new DSLR. If that's the case, by all means change the metering system of your D90 to Center-weighted. With Custom Setting #B3 (see page <497>) you can even tune your weighting to more closely match that of the camera you used to use. Be aware, however, that the Custom Settings reset (see page <482>)—may change the center-weight circle size back to 8mm if you've changed it using Custom Setting #B3.
3. You understand exposure and tonal values well and encounter situations where a precise setting for a particular object is necessary (metering off a gray card so that a particular object falls to a specific differential exposure value; for example, you want a very dark bison to be the very dark color he really is, not exposed to become more like a middle tone value⁷⁹). If you've got the knowledge of how exposures work and need to make specific readings of small portions of the scene, by all means try spot metering. Just be aware that the "spot" follows the focus point selected (see "Spot" on page <241>).

⁷⁹ Not to be condescending, but if you didn't understand what I wrote there, spot metering probably isn't for you. Spot meters allow you to isolate one particular thing in a scene and then use the information you obtain to place the tonal value for that object at a particular place within the dynamic range of the capture device. As the previous sentence implies, you have to understand and master quite a few bits of information to use a spot meter well. Indeed, entire books have been written on the subject.

Metering with Digital Requires Care

For some of you reading this eBook, the D90 is your first excursion into digital SLR cameras. If you've previously used a 35mm SLR body with print film, you're likely going to be a bit frustrated with exposure when you first start using the D90.

Print film has advantages that you may not have known about, but certainly benefited from:

- *Print film has a wide “latitude,” or tolerance to exposure error.* Indeed, overexposing print film is something that professionals tend to do routinely, as it has little consequence on highlight detail but increases density of shadow areas for most films.
- *Print film has a wider dynamic range.* Print film holds a wider range from dark to bright than does a digital camera. Views differ on the exact difference, but it could be as much as three stops.
- *Automated print processors “fix” most minor problems.* Besides correcting for exposure errors of from -2 to $+3$ stops, they also rebalance colors.

When you use a DSLR, you lose these advantages. Exposure for digital cameras has to be precise—there is virtually no margin for error⁸⁰.

Consumer digital cameras such as the Coolpix do a great deal of image post-processing (a bit like those automated print machines used in the lab where you had your film developed), and often make substantive contrast changes to deal with exposure errors. In some more sophisticated cases, the highlight values are “compressed,” sacrificing bright detail

⁸⁰ You'll hear that NEF files (raw files) can have their exposure adjusted after the fact. That's not exactly true. When you use a conversion program to change NEF exposures you don't actually change the exposure, you mostly change the way the underlying data is interpreted (similar to using a Curve in Photoshop). Since NEF data stays in the 12-bit realm, it may sometimes seem like you're recovering “lost” highlight detail while making a post processing “exposure adjustment,” but you're not.

for overall contrast. For snapshot shooting and small print sizes, that's a tolerable tradeoff.

But one reason to move to a DSLR is to get away from a key liability of the consumer digital cameras: propensity for noise (especially in shadow areas). Heavy contrast and exposure modification in camera tends to make any underlying noise properties more visible, thus DSLRs are less aggressive at "fixing" exposures, even though they have better noise tendencies than their consumer cousins.

So, by moving to a DSLR you get more control over what the camera does. Heavy post-processing of images by the camera would prevent you from exercising that control.

Let's cut to the chase: shooting with a DSLR like the D90 is akin to shooting with slide film on a 35mm SLR: to get the best possible image quality out of the camera, you'll need to be fairly precise in setting exposure. Overexposure results in loss of data (on slide film, clear acetate; in digital, values exceed the highest value that can be recorded by the bits available).

Nikon's DSLR designs, to date, all attempt to preserve some highlight detail with their matrix metering system. The D90 does, too. In digital, when more light photons hit the sensor than it can hold (i.e. overexposure), no additional data is recorded; the photosite is saturated. This is like a brick wall for exposure: any truly overexposed area will simply record as the maximum data value (255,255,255 for 8-bit data; 4095,4095,4095 for 12-bit data). This is called "blowing out the highlights." With inkjet printer technologies, no ink is put down on the paper in areas at the maximum data value, making for a visible discontinuity if you look carefully. Overexposure is therefore bad news.

Unfortunately, underexposing on any DSLR has the tendency to increase noise when you later adjust the image. Thus, you're often put into the situation of needing to choose

between preserving highlight detail or revealing noise. I'll discuss this again later in the eBook, but the short answer: almost always you should preserve the highlight detail, even if it'll eventually mean that you have to sacrifice some shadow detail.

I should also point out that individual color channels can be blown out. This actually is the most difficult thing to learn about digital exposures: your exposure may look correct, but if an individual color channel is blown out (a value of 255 for JPEGs or 4095 for NEFs), this will come back to bite your butt later. This is still true for those that shoot NEF. In particular, I've learned the hard way that the red channel is prone to blow out with red and near-red flower blossoms in bright light. What happens then is that you lose any chance of manipulating color after the fact without getting what I call "nuclear colors" (see petal of rose in shot, below [taken from a converter test in my newsletter]).



In my newsletter I pointed out that digital photographers need to learn the colors that trigger channel blow out. Bright red, bright green, and bright blue are easy to recognize, but learn to recognize the colors produced by maximum Red+Green, Red+Blue, and Blue+Green channels. See one of those six colors in the brighter areas of your scene? Check the color histograms to make sure you haven't blown out a channel (see "Options for Evaluating Exposure" on page <248>). Just so that you know which colors I'm talking about, here they are:



Yes, those are old favorites: red, green, blue (the primary colors picked up by the sensor) and yellow, magenta, and cyan (the alternate colors on the color wheel). Of the six, I find myself blowing out the Red channel a lot (red patch), and Red+Green channels a lot (yellow patch).

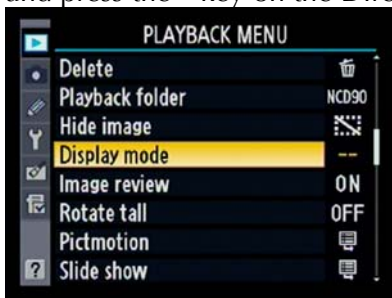
In short, take the time to learn how to control exposure with your D90. Fortunately, the camera has some useful tools that'll help you do just that, which I'll cover next.

Options for Evaluating Exposure

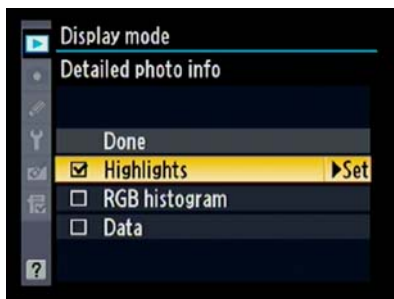
The D90 has two useful exposure evaluation features that analyze the exposure data after you've taken a picture: **RGB Histogram** and **Highlights**.

📷 To turn these features on:

1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the **PLAYBACK** menu (blue playback button icon).
3. Use the Direction pad to navigate to **Display mode** and press the **▶** key on the Direction pad to select it.



4. Use the Direction pad to navigate to each option you wish to set and press the **▶** key on the Direction pad to toggle it on or off (☑ indicates it is turned on).



Of particular interest to us is **Highlights** and **RGB histogram**. I recommend that you turn both on at first. If you don't turn **RGB histogram** on, you'll only get a smallish luminance histogram, and **Highlights** is useful initially—at least until you learn to pull up highlights on the RGB histogram page.

5. When you've selected all the options you want active, use the Direction pad to navigate to **Done** and press the **OK** to complete the selection. Note the options you picked in Step 4 *are not* applied until you complete this last step!



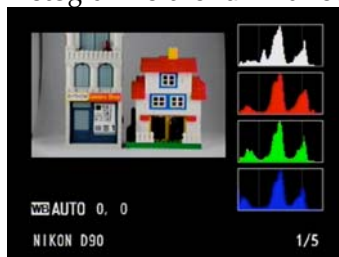
Here's what each option does:

Data

This option toggles the appearance of three additional information display pages for each image; these pages overlay the camera setting data (from the EXIF tags) over the image.

*Main settings**Picture Control settings**Miscellaneous settings*

RGB histogram Adds an information display page for each image that shows overall and individual channel histograms for the image. This helps you detect channel blowout. The individual channels are colored to match the channel (red = red, green = green, blue = blue). The white histogram is the luminance histogram.



Highlights Adds an information display page for each image that shows just the

luminance highlight information. The **Highlights** option shows locations of pixels that exceed a certain value by blinking them. If a large group of pixels is blinking, you may have overexposed the image (at a minimum, you're likely losing highlight detail).



*Note: **Highlights** worked slightly different on the original D1 than it does on all subsequent Nikon digital SLRs, which could be important to understand if you're upgrading from a D1 to the D90. On the original D1, only pixels that were 255, 255, 255 (absolute white) were blinked. On the D90, pixels "near" absolute white are also blinked (Nikon hasn't disclosed what level triggers blinking, but blinking starts when you're somewhere between 1/3 and 1/2 stop away from channel blowout). On a D90 I will often perform a trial and error on exposure until I just barely generate blinking on the highlights (with NEF files). Even if I'm a bit aggressive in doing this, the converters I use can usually pull back in the slight blowout.*

Note: The D90 has no way to show channel highlights, as do the higher-specified Nikon DSLRs. This makes it even more important to recognize colors that might blow out (which I discussed in the previous section of this eBook), and to look at the channel histograms when in doubt.

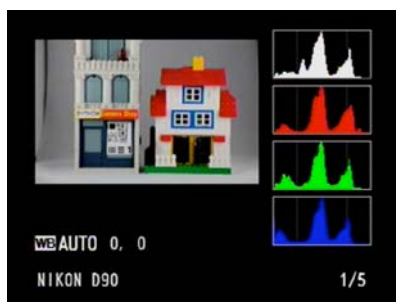
You may not want all of these options turned on once you've learned how to use the camera as they increase the number of key presses needed to cycle through the review pages for an individual image. However, as you're learning how your D90 works, I think it's important to have all of these options active and use them to review what the camera is doing.

Over time, you'll probably want to just select **RGB histogram** and **Highlights** (i.e. leave **Data** unselected).

How to Interpret Histograms

Much has been written about how useful it is to see the exposure histogram on the color LCD after taking a shot. However, not everyone understands exactly what he or she is seeing.

Each histogram's horizontal axis ranges from dark valued pixels (0=black) at the left to bright valued pixels (255=white) at the right. For the main histogram (white graph), the horizontal axis shows the *luminance* channel and does not tell you anything about the individual Red, Blue, and Green channels. Those channels have individual histograms (colored to match the channel) that appear on the side of the display:



The RGB Histogram page



The default Histogram page

The vertical axis for each histogram the D90 can display is the number of pixels in the image with a particular value. This

axis scales with the data, and is not particularly important (other than to identify what's happening with a particular tone vis-à-vis others).

So what does a well-exposed image look like? It's actually easier to define what constitutes a poorly exposed image. Here are some things to watch for:

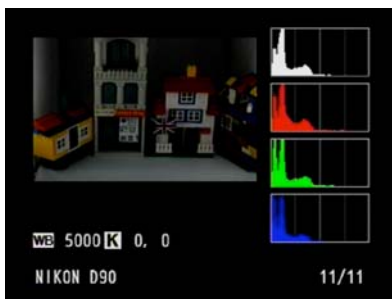
- *Most pixels skewed to the right of a histogram.* If a significant number of pixel values exist at the extreme right edge, it's likely the shot is overexposed or the channel blown out. Histograms that are “right-heavy” make it difficult to control highlight detail. Check the Highlights display to see *where* you've blown out highlight detail.



Spike at the extreme right and everything skewed to the far right? Overexposed! Note the washed out colors in the preview.

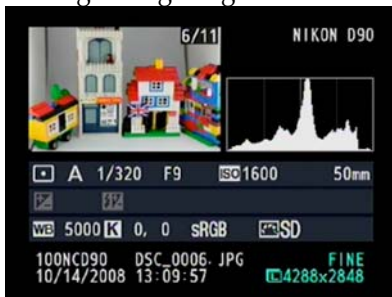
- *Most pixels skewed to the left of a histogram.* If a significant number of pixel values exist at the very left edge, it's likely the shot is underexposed or the channel has very little data in it (which happens in some types of light⁸¹). Histograms that are “left heavy” tend to have troublesome shadow detail. If there is also little or no exposure shown in the right side of the histogram, you need to add more exposure to the shot. Note that underexposed images are easier to recover detail from than overexposed images.

⁸¹ Incandescent light is usually low in Blue channel information, for example.



Everything skewed left and lots of unused histogram space at the right? Underexposed! Note the saturated bright colors (such as yellow), but also the lack of detail in the dark areas and how “drab” the overall look of the preview is.

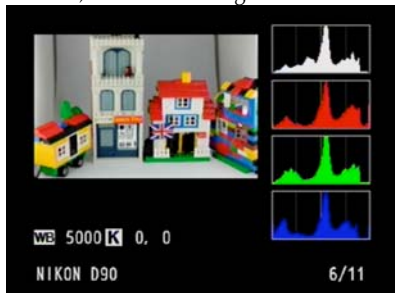
- *Pixels are scattered over the entire width of a histogram.* The overall image or channel is likely to be high in overall contrast. Consider varying the lighting, if possible; or consider using a **Tone compensation** value higher than **Normal**. While a broadly scattered pattern in the histogram is okay, you may or may not be satisfied with color saturation or contrast of the final image. Consider⁸² adding fill lighting in dark areas if you’re not.



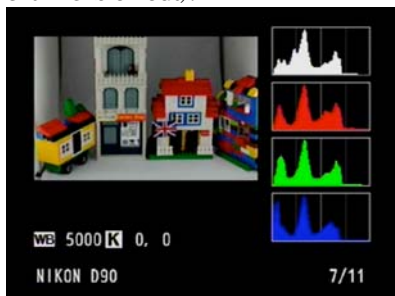
The big spike is the predominately background, and the fact that this is not at the right edge of the histogram means that detail in it will likely print. At the bottom extreme, there’s nothing going off the left edge of the histogram (note that there are some small black blocks and black squares in the test charts, so if they’re rendered correctly we should

⁸² Just to be clear: when I use the word “consider” I mean consider, not “use.” In other words, you wouldn’t automatically dial in a different compensation, but you *might* do so if you don’t wish to post process and have some experience in seeing how a compensation change impacts an image visually and that change is what you want.

have a small spike at the left edge of the luminance histogram (which don't quite have). Overall, the luminance histogram uses all the width of the histogram, just as I suggested you should expose. But wait a second, the RGB histogram for this same image tells a different story:



The luminance histogram is virtually perfect. The Blue and Green channel histograms are also near perfect. Only the Red channel histogram has anything of concern in it (there's a spike at the right of the Red channel histogram, indicating that there's Red channel blowout). Here's what the RGB histograms look like properly exposed (no Red channel blowout):



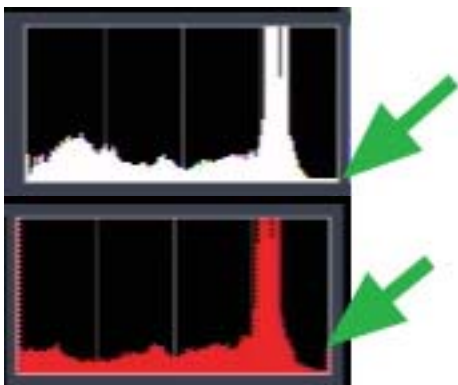
To produce this, I had to lower my exposure by a full stop! Note that the whites have gone a bit gray. We'll have to deal with that in post production (or using something like D-Lighting to fix). But if we were to let the reds blow out, we'd have that toxic color problem that's nearly impossible to correct for after the fact.

- *Pixels are mostly in a narrow band in a histogram.* The image is likely very low in contrast (or it could be monochromatic, as would be the case of taking a picture of a gray card). Consider using a **Tone compensation** value lower than **Normal**.



Here I've placed a big gray card in front of the previous scene. We expect to see a **lot** of the same gray values, and indeed we do see a big spike for them. The scene is now very low in contrast.

- Any spike at the right edge means lost highlight detail. This is probably the worst thing you can see in a histogram. The higher the line crawls up the right edge of the histogram frame, the more blown-out pixels you have in your image. What makes this bad is that our eyes immediately go to the brightest area of a photo when we view it, and all those pixels stacked up at the right edge of the histogram will eventually print as paper (yuck!). Worse still, a blown highlight in only one channel makes for real problems in post processing an image, as most software can't correctly adjust colors in highlight areas where one channel is blown out.



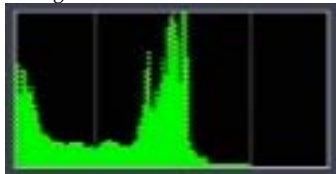
Compare the luminance histogram from a scene (top) with the Red channel histogram for it (bottom). The luminance histogram does not show any spike at the right edge (i.e. the luminance channel is not blown out) while the Red channel has a short spike at the right edge (look at the points of the green arrows). Luminance channel blow-out is bad, as it means you've lost significant detail in the highlights. Individual color channel blow-out **can** be just as bad, as it means a loss

of ability to render the correct color at those pixels, but sometimes you can ignore it. The primary red in this photo, for instance, is Lego blocks, which have no detail in them and already are pretty “nuclear” in color. In this case, I probably wouldn’t worry too much about the channel blow-out. But if the reds represented a rose, I would be worried, as I expect to see detail in the rose petal.

- *Any spike at the left edge means lost shadow detail.* Or it could simply mean you have some totally black areas in your shot. Our eyes aren’t bothered as much by dark areas in a picture (unless, I suppose, that area contains your subject).



This spike (green arrow) indicates that there are pixels that are going to record with no luminance in them (essentially, black). Unlike channel blow-outs, which you almost always avoid, black spikes are sometimes what you want. This particular scene has real blacks in it, so we’d expect to see a small spike at the left edge. But compare the above histogram to this one for a Green channel:



Here it should be clear that there are a lot of values stacked up against the left side of the histogram (and none in the right quarter), a clear indication of underexposure. That means that things that aren’t black may be rendered as black, which we probably don’t want. Remember, the size of the spikes give you some idea of how much of the image has that value. Big spikes at the left edge are usually not a sign of good exposure.

In general, you’re looking for a moderately wide distribution of the pixel values in all four histograms, with the largest peaks for the important portions of your scene somewhere in the middle three-quarters of the range. If you’re working in a scene that has many bright values (e.g., snow), the largest peaks may be to the right of the histograms. Likewise, if you’re working in a scene that contains many dark values (e.g., unlit, shadow areas), the largest peaks may be to the left

of the histograms. Either case is usually okay, as long as you have a wide distribution of pixels and neither extreme runs off the edge of the histograms.

Note: Most users find it easier to “fix” dark images (e.g., increase shadow detail) than to fix bright images (e.g., “pull back” highlight detail). This is even true of NEF images, where you can apply “exposure compensation” after the fact. However, note that due to the way digital images are captured, noise is more prevalent in the “dark” areas of your image than it is in the bright areas⁸³. Normally you don’t see the noise as it is buried in very dark areas that print at or near black, but when you use post processing techniques to “boost” shadow areas in an image to correct exposure, you’ll also be boosting noise, perhaps into visible range.

Note: Photoshop histograms are calculated a bit differently than those that the camera shows.

I’ve already touched on this, but it bears repeating: why are channel histograms important? Remember those nuclear colors I mentioned earlier? Well, channel histograms would be the one tool on the camera that might alert you to the fact that you’ve got one. But even in some situations where you might not be expecting it, the channel histograms can save you from an exposure error.

The classic example for my type of photography is the red rock country of the US Southwest (Northern Arizona and Southern Utah, for example). If you take a picture of a landscape feature that’s in bright sun, all that red in the rock has a tendency to push the Red channel up, often enough to blow the channel out completely. This has an impact after the

⁸³ Why? Because the signal to noise ratio for a pixel value of 1,1,1 is lower than one with a value of 254,254,254. Let’s examine a hypothetical example to find out why. Say that your camera has random noise “base” that averages 2 photons. Further assume that the 1,1,1 value represents a photosite that’s captured 100 photons. The signal to noise ratio for that pixel is 50:1. The 254,254,254 value represents capture of perhaps 10,000 photons, so the signal to noise ratio is 5000:1.

fact: when you go to post process that picture and perhaps try to alter the white balance a bit, the blown Red channel will prohibit you from many manipulations you might want to do, and the tonal ramp in the areas that have been blow out may be compromised.

Red rock isn't the only thing you have to watch out for, though, which is why you just have to pay attention to the channel histograms. Any Red or Blue channel blowout typically means you need to reduce exposure. Green channel blowouts are a little less problematic⁸⁴, but if you have a large expanse of green (like a lawn or a golf course) you still need to bring the tonal value down.

Exposure Modes

The D90 has four basic exposure modes plus seven Scene exposure modes. We'll deal with the basic ones first, because, as you'll soon discover, I'm not a fan of the Scene exposure modes.

P *Program*—In this exposure mode, the D90 automatically adjusts both the aperture and shutter speed to create a properly exposed image. The combination picked is based upon a predetermined table in the camera (see “Program Exposure Table” on page <262>). You may override the selection chosen by the camera by rotating the Rear Command dial (called *Flexible Program* by Nikon). **For most new-to-DSLR users, this is probably the exposure mode you should start with. It gives you “smart” automation backed with the flexibility to override. *Warning:* when you start using flash you'll want to avoid this exposure mode, though.**

A *Aperture-preferred*—You control and choose the aperture setting (using the Front Command dial) and the D90 automatically picks the correct shutter speed to create a

⁸⁴ That's because most color manipulations you'd make after the fact impact the blue and red channels more than the green, which is in the middle of the spectrum between the two.

properly exposed image. Note that the shutter speed the camera picks is incremented in 1/3 stops with the default camera settings in this mode. **As you get more serious about your photography you'll discover that the aperture you select has a great deal to do with what is in and out of focus. Most serious amateurs gravitate towards this exposure mode as they master concepts like depth of field. Many professionals use this exposure mode.**

S *Shutter-preferred*—You control and choose the shutter speed (using the Rear Command dial) and the D90 automatically picks the correct aperture to create a properly exposed image. The aperture chosen is incremented in 1/3 stops in this mode with the default camera settings. **When you shoot sports or other fast moving action, Shutter-priority exposure mode gives you the ability to set an action-stopping shutter speed and let the camera do the rest. Professionals who shoot sports tend to use this exposure mode.**

M *Manual*—You control and choose both aperture (Front Command dial) and shutter speed (Rear Command dial); the D90 advises you on exposure by activating an analog metering bar in the viewfinder and on the Shooting Information display showing what your current choices would produce. Here's what the viewfinder shows:



underexposure



correct exposure



overexposure

The number of bars indicate *how much* under or over exposed the camera thinks the image may be (in the default settings, as shown here, each bar is 1/3 of a stop, so the under and overexposures shown here are 1 1/3 stop—four bars from the center correct position). **Manual exposure mode gives you full control, much like the older “match-needle” cameras that were prevalent in the early days of SLRs. Many users gravitate to Manual exposure mode when they want to make sure that a particular combination of aperture and shutter**

speed is used (as when they meter off one area and compose in another). Some professionals use this exposure mode because it forces them to deal with both their aperture and shutter speed choice and can be a pragmatic way of “locking” exposure.

📷 To select the exposure mode, turn the Mode dial on the top left of the camera so that the indicator for the exposure mode you wish to use is aligned with the white line on the side of the viewfinder prism. For the basic exposure modes, these indicators are displayed as **P**, **A**, **S**, or **M** (in the following photo, the Mode dial is set to **M**):



Flexible Program

As noted earlier, the Program exposure mode uses a predetermined combination of aperture and shutter speed based upon how much light is in the scene and the maximum aperture of the lens. I call this the “program.”

You can override the program by rotating the Rear Command dial when the meter is active. Note, however, that the overall exposure remains the same; in other words, if your override increases the shutter speed, the aperture is decreased, and vice versa. A small icon (**P***) appears in the top LCD when you’ve overridden the camera’s program settings. Note also that once you override the program, *it remains overridden* by that same amount until you change the exposure mode, turn the power switch to OFF, use the Rear Command dial until **P*** no longer appears, or perform a camera reset.

Program Exposure Table (at ISO 200)

EV	<i>Focal Length</i>		
	<i><55mm</i>	<i>55-135mm</i>	<i>>135mm</i>
0	f/1.4 @ 2s	f/1.4 @ 2s	f/1.4 @ 2s
1	f/1.4 @ 1s	f/1.4 @ 1s	f/1.4 @ 1s
2	f/1.4 @ 1/2	f/1.4 @ 1/2	f/1.4 @ 1/2
3	f/1.4 @ 1/4	f/1.4 @ 1/4	f/1.4 @ 1/4
4	f/1.4 @ 1/8	f/1.4 @ 1/8	f/1.4 @ 1/8
5	f/1.7 @ 1/10	f/1.4 @ 1/15	f/1.4 @ 1/15
6	f/2 @ 1/15	f/1.4 @ 1/30	f/1.4 @ 1/30
7	f/2.4 @ 1/23	f/1.7 @ 1/45	f/1.4 @ 1/60
8	f/2.8 @ 1/30	f/2 @ 1/60	f/1.4 @ 1/125
9	f/3.5 @ 1/45	f/2.4 @ 1/90	f/1.7 @ 1/180
10	f/4 @ 1/60	f/2.8 @ 1/125	f/2 @ 1/250
11	f/4.8 @ 1/90	f/3.5 @ 1/180	f/2.4 @ 1/350
12	f/5.6 @ 1/125	f/4 @ 1/250	f/2.8 @ 1/500
13	f/6.7 @ 1/180	f/4.8 @ 1/350	f/3.5 @ 1/750
14	f/8 @ 1/250	f/5.6 @ 1/500	f/4 @ 1/1000
15	f/9.5 @ 1/350	f/6.7 @ 1/750	f/4.8 @ 1/1500
16	f/11 @ 1/500	f/8 @ 1/1000	f/5.6 @ 1/2000
17*	f/13 @ 1/750	f/9.5 @ 1/1500	f/6.7 @ 1/3000
18*	f/16 @ 1/1000	f/11 @ 1/2000	f/8 @ 1/4000
19*	f/19 @ 1/1500	f/13 @ 1/3000	f/11 @ 1/4000
20*	f/22 @ 1/2000	f/16 @ 1/4000	f/16 @ 1/4000
* Not possible with matrix metering, as it exceeds the meter's brightness range; camera reverts to center weighted. Bold Gray indicates exposures the kit lens can produce.			

There are bunch of things to note in the above chart (it really is an important thing to study):

- The <55mm column is basically the same “program” that is used in the professional cameras (D200, D300, D700, D2 series, and D3).
- If you’re using consumer lenses on the D90 (e.g. the 18-105mm kit lens) many of the table values can’t be reached! For example, at 105mm the kit lens is f/3.5 at maximum, so until you get to EV 9 or 14 you’re a bit stuck with the main program (the “program” will always pick

f/3.5 or 5.6 and have to compensate with setting a slower than usual shutter speed). I've highlighted the reachable exposures with the kit lens in bold gray text.

- The matrix metering system only extends out to 17.3 EV at ISO 200, so some of the upper limits of the table won't be used with that metering method and may result in overexposure.
- While Nikon doesn't specifically say so, this table is also the underlying exposure assumption for all the Scene exposure modes, as well.

Students who've been to my workshops know that I'm not a fan of Program exposure mode. That's mostly because Program exposure mode has some hidden liabilities when using flash, but also because most users don't take the time to understand exactly how the camera is making its exposure decisions or even that once they've overridden the "program" it tends to stay overridden.

Don't be a "lazy" photographer and use Program exposure mode casually. If you're serious about controlling depth of field, camera shake, subject motion, and a host of other factors that come up while making photographs, get out of Program exposure mode and take more direct control over what the camera is doing.

Scene Exposure Modes

Nikon calls the additional, special exposure modes "Scene Modes" in the D90 manual. I call them Scene exposure modes, a term that more specifically points out that they change the exposure mode setting to a variant of Program.

These Scene exposure modes are similar to the Program exposure mode in that the camera makes all the decisions, but each varies the way in which Program exposure mode works. They also change a few image quality parameters and place limitations on the camera settings that can be made.

I'm not a big fan of the Scene exposure modes for several reasons:

- *The Scene exposure modes dramatically limit other camera settings you can make* (see the table at the end of this section). Essentially, they treat the camera user (you!) as an idiot that doesn't know what they're doing, so they "lock out" many useful options. You get almost no ability to override the camera, and you'd better hope the camera gets the exposure right, because you don't get to control the metering method or override the selected exposure in any way. Ouch! Other examples: **Picture Control** settings are set to something Nikon thought was appropriate for the subject, **White balance** is set to **Auto**, and flash will be used automatically may many of these modes in low light (and set to balanced fill-flash mode).
- *None of the Scene exposure modes sets exactly what a professional would for the circumstance*; in essence, **none** of Nikon's choices make the kind of change a knowledgeable user would in each scenario.
- *The Scene exposure modes all have the liabilities of Program exposure mode*. When you use flash, those liabilities can become extremely problematic.
- *All Scene exposure modes set Picture Control settings*. Here's a table of what they are set to:

Setting	Scene Exposure Mode						
	Night Portrait	Sports	Close Up	Landscape	Portrait	No flash	Auto
Base	Portrait	Standard	Standard	Landscape	Portrait	Standard	Standard
Sharp	Auto	Auto	3	Auto	Auto	Auto	Auto
Contrast	Active D-Light	Active D-Light	Active D-Light	Active D-Light	Active D-Light	Active D-Light	Active D-Light
Brightness	Active D-Light	Active D-Light	Active D-Light	Active D-Light	Active D-Light	Active D-Light	Active D-Light
Saturation	0	0	0	Auto	0	Auto	Auto
Hue	0	0	0	0	0	0	0

- *All Scene exposure modes set **ISO sensitivity auto control** to **On** (though the menu is confusing about this)*.

You can override the ISO used, but you can't change the parameters of the automatic ISO setting.

That said, here's what the seven Scene exposure modes are and what they do:

Auto

This is what I call the "waiter mode." That's because the camera does *everything* automatically and doesn't allow the user to make any significant changes. In other words, put the camera in **Auto**, hand it to the waiter, tell him to press the big silver button...

Portrait

The primary change from the other Scene exposure modes is that the camera tends to select a physically larger aperture (e.g., f/4 instead of f/8). Settings use the **Portrait** Picture Control. The rationale behind this selection is to isolate the subject from the background with a shallow depth of field (large aperture) and to not highlight skin blemishes (Picture Control settings), but the camera doesn't really go far enough, in my opinion.

Landscape

Sort of the opposite of Portrait: smaller apertures are used (e.g., f/11 instead of f/5.6) and Picture Control settings are "punched up" (uses **Landscape** and more saturation). Here the idea is to increase depth of field and use saturation to increase color impact. Flash is turned off and not used.

Close Up

The big change here is that the autofocus sensor used is the central sensor. Standard Picture Control settings are used. It appears that Nikon chose to use a shallower depth-

of-field than most professionals would select.

- Sports** The camera tends to keep the shutter speed short (fast) in order to “stop” action. Surprisingly, the camera does *not* switch to Dynamic Area AF; instead it stays in Auto Area AF. Flash and the Autofocus Illumination lamp are disabled. Picture Controls are relatively standard.
- Night Portrait** Same as Portrait, except: Slow Sync is set so that long shutter speeds allow backgrounds to appear well exposed. This also means that you may get long shutter speeds, which is why you should consider using a tripod.
- No Flash** Same as Auto, but flash is never used.

Things You Can’t Set with Scene Exposure Modes

- White balance
- **Set Picture Control** items (see table, above)
- **Active D-Lighting** (always set to **On**)
- Metering Method (always set to matrix)
- Flexible Program
- Exposure Compensation
- Bracketing
- Flash Exposure Compensation
- **Multiple exposure** cannot be set
- Custom Settings #B2, #B3, #D11, #E1 through #E6. Also:

<i>Mode</i>	<i>Can’t Set</i>
No Flash	#A4, flash mode
Landscape	#A3, #A4
Sports	#A3
Close Up	#A4

When a Scene exposure mode overrides an existing camera setting that was previously made while using Program, Aperture-priority, Shutter-priority, or Manual exposure mode, that setting is restored when you return to those exposure modes.

The Bottom Line on Scene Exposure Modes

Avoid them. In virtually every case you'll eventually find that they limit you in some way that is important. Let's run through a better way of approaching the same things (some of these options we haven't discussed yet, but come back to this section once you've read the entire eBook):

Portrait

Use Aperture-priority exposure mode (**A**) and select the largest aperture (smallest number, as in f/2.8) you can. Focus on the eyes. In **Set Picture Control** choose **Portrait**, set a low **Sharpening** setting, set **Contrast** to **0** or **-1**. Use flash for fill light (set -1.0 stop of *flash* exposure compensation with external flash in Standard TTL, if possible).

Landscape

Use Aperture-priority exposure mode (**A**) and select a small aperture (largest number, as in f/16⁸⁵) you can. Use a hyperfocal distance table to set focus manually (see "Depth of Field Preview" on page <389>). In **Set Picture Control** choose **Neutral** (or **Landscape**), set a high **Sharpening** setting, set **Contrast** to **-1**. In high contrast scenes, consider turning **Active D-Lighting** to **On** for JPEG shooting.

Sports

Use Shutter-priority exposure mode (**S**) and select a shutter speed appropriate to stop the action of the sport you're photographing (e.g. 1/500 for basketball). If you don't have a lens with a very "fast" aperture, you probably

⁸⁵ However, note my comments about diffraction on page <393>.

should turn on the **ISO auto** function to maintain your shutter speed. Set Custom Setting #2 to **AF-C** (or use the AF button on the top of the camera). Consider setting Custom Setting #A2 to **Wide**. In **Set Picture Control** choose **Neutral** (or **Standard**), set a high **Sharpening** setting, set **Contrast** to **0** or **-1**.

Close up

Use Aperture-priority exposure mode (**A**) and select a small aperture (e.g. f/16). Set Custom Setting #3 to **AF-S**, or better yet, use manual focusing. In **Set Picture Control** choose **Neutral** (or **Landscape**), set a high **Sharpening** setting, set **Contrast** to **0** or **-1**. Use a **White balance** of **Pre** and measure it off a gray card if you're shooting flowers and the exact color is important.

Night Portrait

Same as Portrait recommendations, above, except set Rear Sync in the Flash Options. Pop up and use the flash (you may have to set Flash Exposure Compensation to keep flash from looking too artificial and overwhelming; try -1.0 to -1.7EV in flash exposure compensation).

Now that wasn't so much to deal with was it? Basically, the Scene exposure modes are saving you three to five simple steps, and even then they don't get everything right. Plus you no longer have to worry about the built-in limitations if you use my method.

ISO Sensitivity

The D90 allows user controllable ISO values from 200 to 3200, in as little as one-third stop steps. The D90 also has settings of **Lo 0.3**, **Lo 0.7**, and **Lo 1.0** and **Hi 0.3**, **Hi 0.7**, and **Hi 1.0**, which are approximately equivalent to ISO 160, 125, 100, 4000, 5000, and 6400 respectively. These last six values are not labeled with an ISO value because they're not finely

calibrated and thus only approximate values⁸⁶. The non-numbered ISO values are a warning to you that some aspect of image quality will be compromised:

- **Lo** values: the **Lo** ISO values can compromise highlights. What tends to happen is that if you use the same exposure highlight data gets “clipped” in *high contrast* scenes:



Think of it like this: the data from the ADC is given a different bias (gain). This has one primary effect: bright highlights that were near blowing out at ISO 200 now tend to be blown out and the camera has to bring them back. In my experience, **Lo** values work fine for low contrast scenes exposed normally, but are dangerous for high contrast scenes exposed normally due to the possible loss of highlight information. The available dynamic range is pretty much the same for ISO **Lo 1.0** as it is for ISO 200, thus if you slightly underexpose to make sure you don't clip highlights you get essentially the same dynamic range. Trying to find this “underexposure point” is a bit tough, as it tends to vary a bit with the contrast in the scene and how the channels are handling the highlights. I routinely use -0.3EV exposure compensation when I set ISO **Lo 1.0** as a starting place, then back off from my usual highlight clipping point.

- **Hi** values: the **Hi** ISO values compromise overall camera dynamic range. As you move ISO values up, the camera dynamic range decreases. Eventually, that range becomes suspect and it gets difficult to reproduce a wide range of tones. Nikon marks that changeover point by stopping the

⁸⁶ As you'll see in the examples coming up, noise starts to impact color intensity as you boost ISO value, and color intensity is something we would interpret as an exposure cue. Above ISO 3200, the color impacts of the noise are intense enough that you might not feel like you got the full benefit of the boost.

use of numeric ISO values:



The dynamic range goes down as you boost ISO because the ADC is using higher gain settings (amplification) on the underlying data. You're amplifying noise as well as signal, so the more you amplify, the more prevalent the noise becomes, lowering the dynamic range.

In table form, here's my measured *useful* dynamic ranges (rounded to nearest half stop):

<i>ISO</i>	<i>Dynamic Range</i>	<i>Comment</i>
Lo 1.0	8+ stops	But watch out for highlight clipping
200	8+ stops	Best of any Nikon DSLR
400	7.5 stops	Note that even a slight boost in ISO reduces dynamic range a bit; still quite good
800	7 stops	About as good as most early Nikon DSLRs at their base ISO
1600	6 stops	Still about as good as slide film
3200	5 stops	Some issues for even normal contrast scenes
Hi 1.0	4 stops	Definite issues with normal contrast scenes

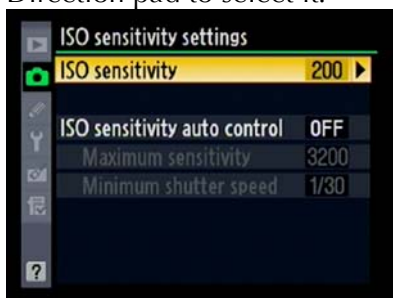
📷 To set ISO values on the D90:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).
3. Use the Direction pad to navigate to the **ISO sensitivity settings** option and press the **▶** key on the

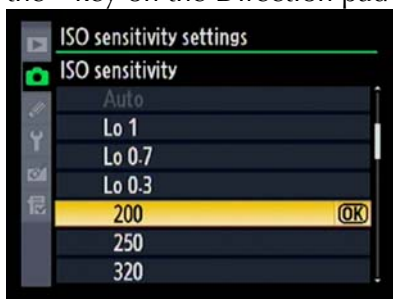
Direction pad to select it.



4. Use the Direction pad to navigate to the **ISO sensitivity** option and press the ► key on the Direction pad to select it.

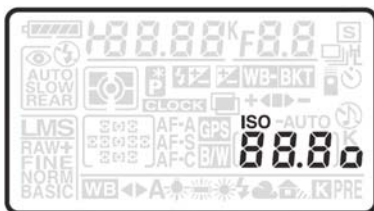


5. Use the Direction pad to select an ISO value and press the ► key on the Direction pad to select it.



📷 Alternatively: With nothing showing on the color LCD, hold down the **ISO** button and use the Rear Command dial to

select an ISO value.



Top LCD:

While it may seem that you should simply set the camera to the highest ISO value and leave it there (or use the **ISO sensitivity auto control** function available in the SHOOTING menu), don't. As you increase the D90's ISO value, your images lose dynamic range capability and potentially gain considerable digital noise. Much as using a higher ISO film in a 35mm film body results in increased visible grain. Added digital noise makes an image look rougher (most noticeable in large areas of a single color). Worse still, digital noise added by the D90 is not truly random, unlike film grain. And remember, dynamic range is impacted, too.

That said, the D90 is one Nikon camera on which I am perfectly happy to set a modest automatic ISO value, as noise is very well controlled at modest ISO values and dynamic range hits aren't terrible until you get above ISO 800.

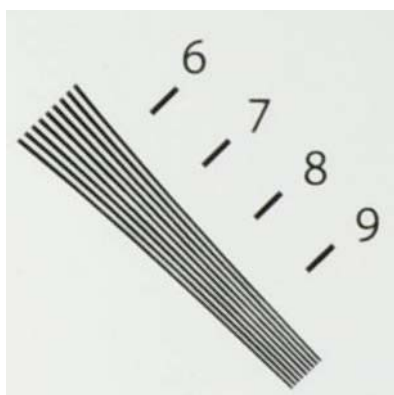
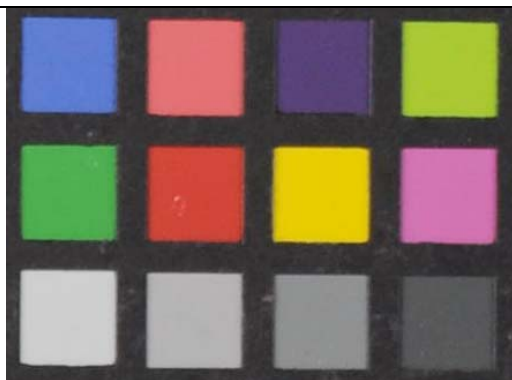
The D90 has a variety of noise reduction schemes, some of which work automatically and some of which are user controlled. **Long exp. NR** (on the SHOOTING menu) has nothing to do with ISO: it controls a type of noise that builds up when a sensor sits collecting light photons for long periods of time (8 seconds or longer on the D90).

High ISO NR (also on the SHOOTING menu) is a setting that *does* apply to noise caused by ISO settings. Because higher ISO values are typically caused by amplifying data, small inconsistencies in data are amplified as you increase the ISO setting. **High ISO NR** is a setting used to combat that; it begins working at ISO **800** or higher if specifically turned on

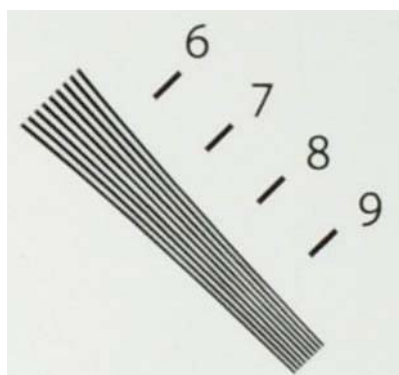
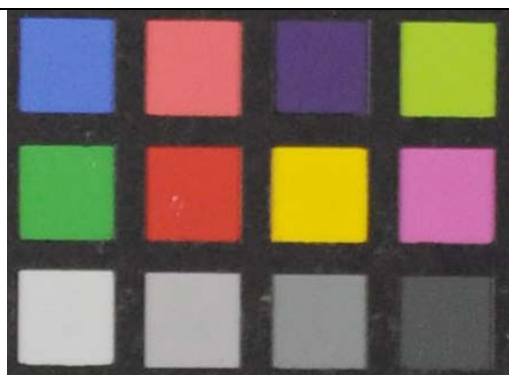
by you, but it is always active in some form at above ISO **Hi 0.3** (ISO 4000 equivalent and above).

But noise reduction routines aren't perfect, and they also have a tendency to reduce edge definition.

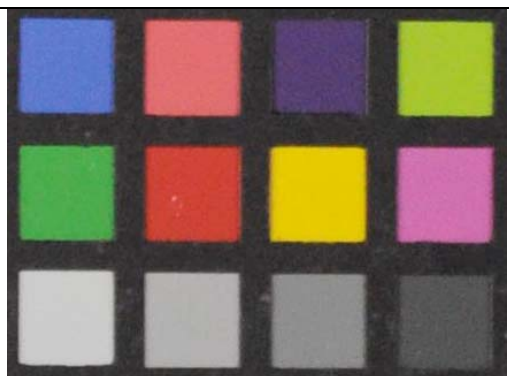
Note that the following samples (150% crops from the full test screen you saw earlier) are only a few of the ones I examined to make my comments. Go by what I write, not necessarily by what you see. These images are taken at the worst case scenario: noise reduction techniques off, and using **JPEG basic**. The color patches are at 180% view, the sharpness patches at 200% view.



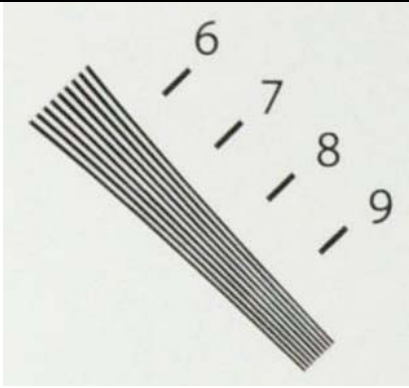
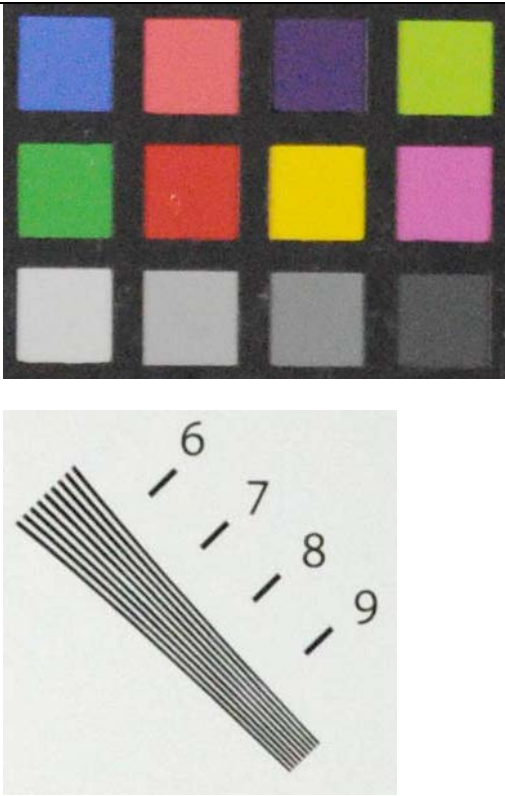
ISO 200. Look carefully at: (1) how well the resolution holds up; (2) whether broad color patches show any grain or unevenness; (3) whether hard edges are being “damaged”; and (4) are colors staying accurate and vibrant. (Yes, I know my Mini-ColorChecker needs to be replaced. It got dragged around Alaska a bit too much on the last trip.)

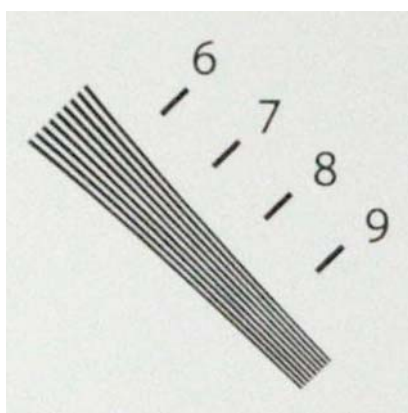
**ISO 400.**

Surprisingly, just a hint of noise has become visible, though nothing worth worrying about. There's just a bit of coarseness picked up in the sharpness sample.



ISO 800. A bit more noise has appeared (note the red and magenta color patches on the second row). The sharpness sample hasn't gotten any worse, however.

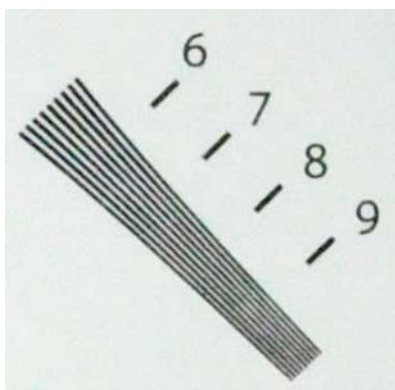
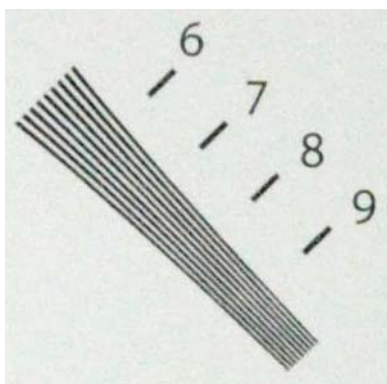
	
	ISO 1600. Noise is definitely visible now, and the colors have gotten a little off kilter due to that (note the red is going orange). The darkest gray patch shows that noise will be very visible in shadow areas. Still, for a worst case ISO 1600 performance, this isn't terrible. And sharpness is still okay.



ISO 3200 Here's where things fall down for me. The color patches are all drifting off color and polluted with noise. Shadow noise has crept up to the second darkest gray patch. There's a drab overall appearance. And in the sharpness image the black lines are now definitely hindered by noise.



ISO 6400 (Hi 1.0) Noise everywhere except the brightest gray patch. There's a pointalist feel to everything. Note how the blemish in the red patch is almost hidden



by the noise! Also note how turning noise reduction all the way up (second images in set) helps with the noise in broad color, but is hurting detail. Note the false colors starting to show in the sharpness details (the background is no longer a pure light gray), and see how setting noise reduction has increased contrast and managed to run together some of the fine detail.

Note: Underexposing is like setting a higher ISO. Some of the complaints I've heard from D90 users about "noisy, unsaturated images" can be attributed to this. For example, let's say you were shooting at ISO 200 but underexposed by two stops. Do your images look as if they were shot at ISO 800 when you run a correction on them in post processing? I'm betting that, yes, they do (and no in-camera noise reduction would have been run on the picture no matter what the camera's noise reduction setting!). Just as with other Nikon DSLRs, I see an almost direct one-to-one correlation between results from underexposure and higher ISO use on the D90.

Remember, as you increase ISO to the highest levels you'll find that colors tend to lose a bit of their punch (e.g. get "muddy" and drift from accurate colors), and overall contrast goes down. At the extreme, it can result in the equivalent of a 2-bit or higher reduction in individual color values, which is easily seen in images. **Hi 1.0** very obviously loses color saturation, but the visible effects begin as early as ISO 800 with the cruder JPEG compression settings.

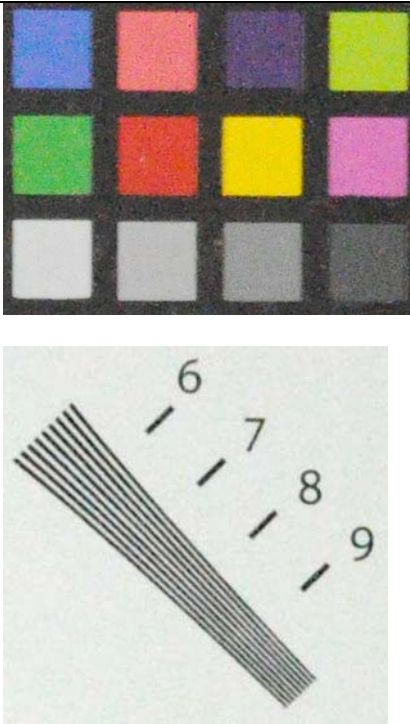
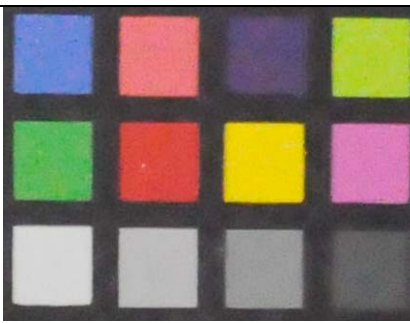
Noise Reduction Settings

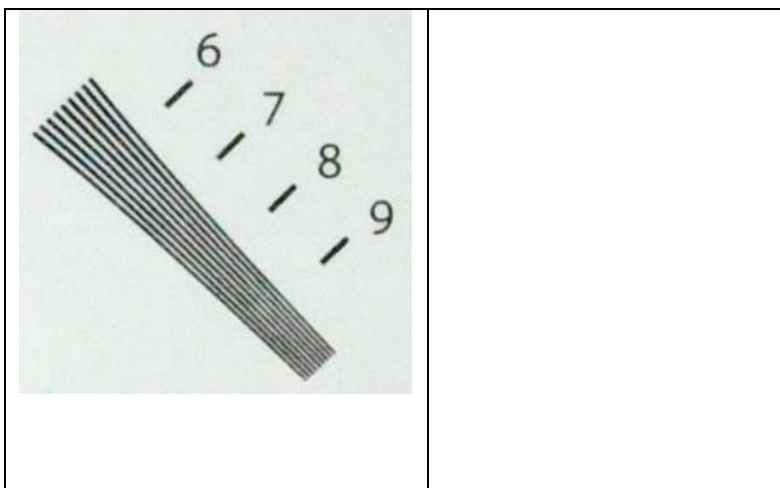
As mentioned, the D90 has two noise reduction abilities built in:

- **Long exp. NR**—performs a dark frame subtraction on long exposures to remove hot pixels (photosites where the data values get "stuck"). Surprisingly, this is a relatively necessary function on the D90, as it produces hot pixels easily. You should probably leave this option **On** (it only applies to exposures over 8 seconds).
- **High ISO NR**—performs in-camera noise reduction on images taken at or above ISO 800 *when set*. The manual and menu system seem a little out of sync with one another here. **Off** means no noise reduction is applied from ISO 200 through 3200, but a minimal amount is applied at Hi 0.3 through Hi 1.0. **On (Normal)** means no noise reduction is applied from ISO 200 to 640, a minimal amount is applied at ISO 800 through 1600, and

increasing amounts from ISO 2000 through Hi 1.0. **On (High)** means no noise reduction is applied from ISO 200 to 640, then large and increasing amounts are applied from ISO 800 through Hi 1.0.

Since this is apropos to a discussion of ISO, let's look again at how noise reduction fares at the highest ISO value, **Hi 1.0**.

	Here's High ISO NR set to Off at ISO Hi 1.0. (Remember, the camera always applies some noise reduction at this ISO value). You should see clear grain-like structures in most of the color patches. You'll see some destruction of edges in the sharpness chart.
	Here's High ISO NR set to On (High) at ISO Hi 1.0. The grain-like effect has disappeared from the color patches, but the detail in the sharpness chart now has all kinds of edge issues.



Nikon's Capture NX2 values⁸⁷ for various D90 **High ISO NR** settings shot in NEF give us a clue as to what the camera does internally:

ISO	Off	Low	Normal	High
Lo, plus 200 to 640	0 intensity 5 sharpness	0, 5	0, 5	0, 5
800	0, 5	4, 6	6, 6	14, 7
1000	0, 5	4, 6	7, 6	17, 7
1250	0, 5	4, 6	8, 6	20, 7
1600	0, 5	4, 6	9, 6	23, 7
2000	0, 5	5, 6	12, 7	26, 7
2500	0, 5	6, 6	15, 7	29, 6
3200	0, 5	7, 6	19, 7	31, 6
Hi 0.3	6, 6	9, 6	21, 7	33, 6
Hi 0.7	7, 6	10, 7	23, 7	36, 6
Hi 1.0	8, 6	12, 7	25, 7	40, 6

⁸⁷ Capture NX2 doesn't actually report the correct High ISO NR setting. Instead, it substitutes the implied setting in the metadata. For example, ISO Hi 0.3 is listed as NR (low) even when set to Off! Similar anomalies appear with other combinations of settings. I guess the metadata isn't really metadata in Nikon's mind, but "the data we think it should be."

In Nikon's noise reduction scheme, "intensity" (the first value for each entry in the chart) is a value between 0 (none) and 100 (maximum noise reduction) while "sharpness" (the second value for each entry in the chart) is a value between 1 (maximum!) and 10 (minimum!) permissible blur that the noise reduction routines will tolerate. A value of 0, 5 has no effect on the final pixels (intensity is off). Intensity values above about 10 start to produce visible impacts on pixels, in my opinion, and sharpness values of 6 or lower result in noticeable detail reduction.

Overall, my assessment is that the in-camera noise reduction works decently. Still, it should be a last resort: use it only if you really can't afford to have the grain-like noise effect in your images and can afford to lose a little bit of detail. The D90 is a camera where I don't mind using the in-camera noise reduction (normally I run post processing noise reduction on images from my other Nikon cameras at high ISO values).

Automatic ISO

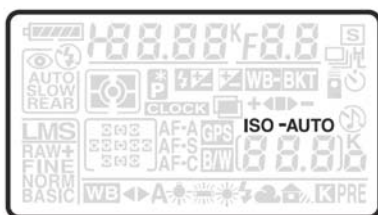
The **ISO sensitivity auto control** option (part of the **ISO sensitivity settings** item of the SHOOTING menu) tends to be misunderstood by virtually all users; it does not operate quite as you'd expect and has definite limitations. What happens when this Automatic ISO function is active (**ISO sensitivity auto control** set to **On**) depends upon what exposure mode you're using:

- In Manual exposure mode, the ISO is changed if the shutter speed and aperture combination you pick won't achieve a proper exposure (manual exposure bar centered at 0: ). For example, if you were at ISO 200 and set f/8 at 1/125 but the meter thought the exposure should be f/5.6 at 1/125, the camera will boost the ISO one stop to 400 (f/8 is one stop underexposed compared to f/5.6 in this example).
- In Shutter-priority exposure mode, the ISO is changed when the camera runs out of aperture range to use. For

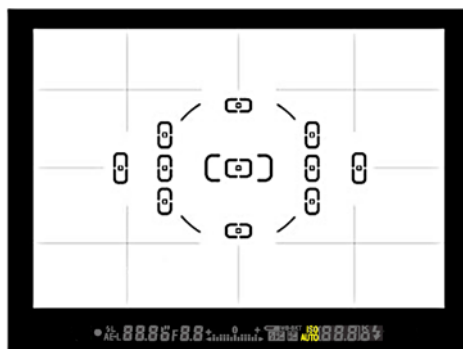
instance, assume that the initial ISO value is 200 and the aperture set by the camera to the lens' maximum of f/2.8. If the lighting changes such that f/2 is required, the ISO will be boosted one stop to 400 (f/2.8 is one stop underexposed compared to f/2 in this example).

- In Program (including the Scene exposure modes) and Aperture-priority exposure modes, ISO isn't changed until the exposure reaches the extreme at either end of the shutter speed range (1/30 second at the bottom end unless you set a different value for the **Minimum shutter speed** option); the upper limit is always 1/4000). As long as the camera will set a shutter speed between those two extremes, the ISO value won't change.
- In *all* exposure modes the ISO sensitivity will never be set higher than the value you set for the **Maximum sensitivity** option.

One nice touch is that last item: you can set the maximum ISO value (between 400 and Hi 1) for the camera to use when Automatic ISO is active. Plus the camera sets the ISO value in sixth stop increments when this feature is active. The Top LCD and viewfinder show the **ISO-AUTO** indicator:



Top LCD:



Viewfinder:

If the **ISO-AUTO** indicator is *not* flashing, the ISO has not been changed from your setting. If the indicator *is* flashing, then the camera has changed the ISO value (to find what it changed to, take a shot and examine the Data pages for that image, the altered ISO will be listed in red:



Note: *If you use flash and Automatic ISO your previously set ISO may be used! ISO won't be boosted unless the camera thinks the flash range will be exceeded. So normally with flash, the **ISO AUTO** indicators in the viewfinder and top panel stay lit (does not blink). This is Nikon's subtle reminder that "more light" is better than "higher ISO."*

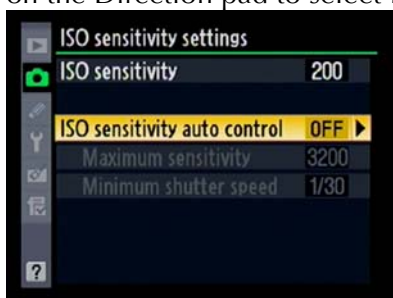
To activate the Automatic ISO option:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).

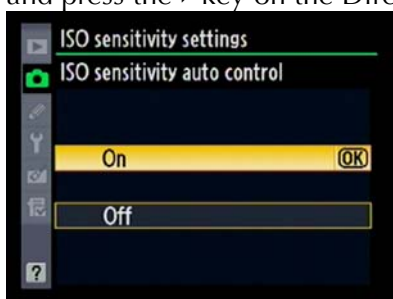
- Use the Direction pad to navigate to the **ISO sensitivity settings** option and press the ► key on the Direction pad to select it.



- Use the Direction pad to navigate to the **ISO sensitivity auto control** option and press the ► key on the Direction pad to select it.

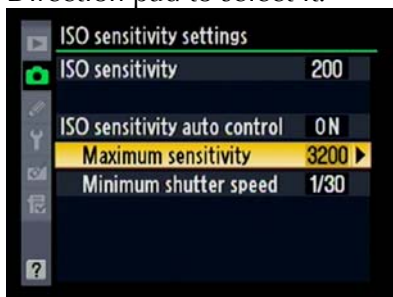


- Use the Direction pad to navigate to the **On** option and press the ► key on the Direction pad to select it.

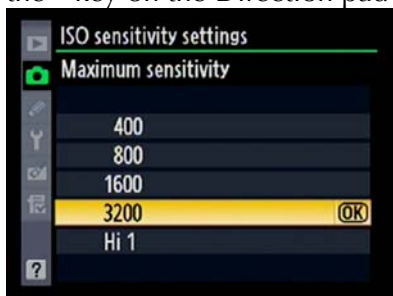


- Use the Direction pad to navigate to the **Maximum sensitivity** option and press the ► key on the

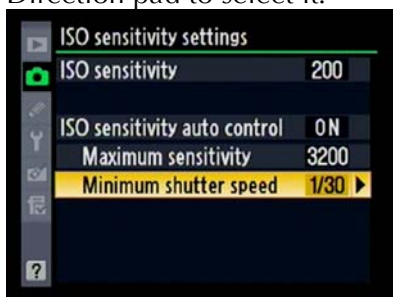
Direction pad to select it.



7. Use the Direction pad to select an ISO value to be used as the maximum the camera should set and press the ► key on the Direction pad to select it.

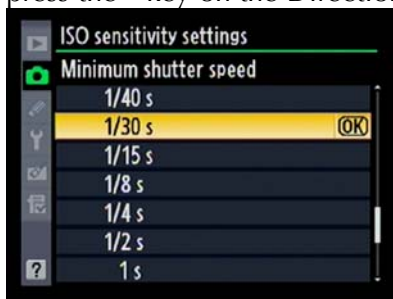


8. Use the Direction pad to navigate to the **Minimum shutter speed** option and press the ► key on the Direction pad to select it.



9. Use the Direction pad to select a shutter speed value to be used as the lowest the camera should set and

press the **▶** key on the Direction pad to select it.



My recommendation about automatic ISO is this: you can set it on your camera with a maximum automatic value of ISO 800 and probably never notice any real change of image quality for most types of shooting. You need to think more carefully about using it with higher maximum ISO values, and you should also consider what you have set your noise reduction settings to before cranking automatic ISO higher than ISO 800. You also need to learn when the camera will bump the ISO, so read about those exposure mode differences earlier in this section and make sure you fully understand them.

How ISO Values are Created

You might wonder how higher ISO values are generated by the camera. All ISO values above 100 are created by multiplying the data coming into the Analog-to-Digital converter. In other words, the sensor always works at the 200 sensitivity, but underexposed data values coming from the photosites are boosted by an amplifier to produce the higher ISO values.

As you might guess, this means minor differences between photosites get magnified and may become visible. Imagine a photosite that captures 150 light photons and an adjacent one that receives 155 photons. This difference is insignificant when these are black values and end up getting interpolated into, say, a pixel value of 10,10,10 versus 10,11,10. But if these values are being amplified several times and now

represent middle gray values, the difference may be significant and visible.

ISO Operating Suggestions

To optimize image quality, follow these guidelines for setting ISO values:

- *Use the lowest ISO setting (200) whenever possible.* If you suspect that the scene you're photographing might produce moiré, use only the lowest ISO value—once noise gets interlocked with moiré, both become very difficult to remove.
- *Expose to the right.* Underexposure can generate additional noise issues with the D90, especially with slow shutter speeds and ISO 1600 and above. Keep your exposure histograms pushed toward the highlights (but don't blow out highlights by going too far and pushing the histogram data off the right edge). Indeed, the minimum amount of noise for a low contrast, gray target would be generated by overexposing the gray target so that the histogram spike was well right of center, then using Capture NX2 or Photoshop to re-center the exposure (Curves, Gamma, Exposure Compensation, etc.). What you generally don't want to do on a D90 is to fail to use the full range of the histogram to the right of center (i.e. underexpose).
- *ISO 400 and even ISO 800 are actually quite close to 200 in quality, so don't be afraid to use them.* Normally you don't want to give up any image quality at all, but the very slight increase in noise at ISO 400 or ISO 800 isn't worth agonizing over: if it allows you to capture what you need to, use it! Indeed, using ISO 800 is a better choice than underexposing ISO 200.
- *Use ISO 1600 in a pinch,* but expect a minor loss of color saturation and some visible noise in large color blocks, such as skies. The latter may require a bit of touchup using a software noise reduction tool such as Noise Ninja, dFine, or Neat Image (or consider setting the camera's

noise reduction option). ISO 1600 properly exposed is an obviously better choice than ISO 400 underexposed, by the way—at this ISO level, underexposure will start showing significant noise in shadows that you don’t see at lower ISO values.

- *Use 3200 if you have to*, but you’ll almost always want to have noise reduction set and perform post processing sharpening (don’t set sharpening higher in the camera—you’ll be working at cross purposes by setting dueling in-camera settings). You may also need to perform some slight color correction and contrast adjustments on your ISO 3200 images, though these would still be minor adjustments.
- *ISO Lo 0.3 to Lo 1.0 are excellent, with an asterisk.* The low ISO values are as good (if not better) than ISO 200, but only if you avoid blowing out highlights. These settings have a tendency to blow out highlights more easily, and often require a bit of underexposure.
- *Avoid ISO Hi 0.3 to Hi 1.0 if you can.* There’s too much noise at these settings to make them useful for *general* shooting. These settings are usable in extreme lighting, but realize that edge definition and resolution is seriously compromised and you very well may need to run serious post processing on such images.
- *Use longer shutter speed before higher ISO.* Unlike the D80, the D90 doesn’t have as much tendency to produce hot pixels with long exposures, so my usual advice about using longer shutter speeds before higher ISO values stands.
- *Set the Automatic ISO option to **Max sensitivity of 800**.* The D90 is generally good enough at all ISO values up to 800 to leave Automatic ISO on, should you so desire (you certainly could leave it set to ISO 400 with no concern at all). Increase the value of this option only if you need the extra shutter speed (as in sports photography), and then only to the lowest possible level that achieves your objective (e.g., 1/500 shutter speeds for sports).

*Tip: For noisy NEF images taken at high ISO values, try using Nikon Capture NX2 to convert the image to 16-bit TIFF (make sure to turn off any noise reduction). Open the resulting file in Photoshop to make your color and image adjustments. Convert the image to Lab Color. Then use the **Median** filter (on the **Filter/Noise** menu) to remove noise on the A and B (color) channels. Don't sharpen the image until you're satisfied with the results.*

<i>ISO</i>	<i>General Recommendation</i>	<i>High ISO NR</i>	<i>Other Settings</i>
Lo values	Avoid if high contrast situation or highlights important	Not applicable	Any
200	Optimal ISO value to use; use freely	Not applicable	Any
400	Very close to ISO 200; use freely	Not applicable	Any
800	Very usable with slight loss of dynamic range and very mild noise; don't avoid using	Set it to Off	Any
1600	Some loss of dynamic range and very modest noise	Set it to Off	Any (though consider lower sharpening)
3200	Visible loss of dynamic range, some visible noise; use when needed	Low	No sharpening, if possible; avoid JPEG basic
Hi values	Use only if completely unavoidable; very visible impairments	Low or Normal	No sharpening; avoid JPEG norm and JPEG basic

Additional ISO-related suggestions:

- *Large prints require lower ISO.* If you're going to use an image for printing large prints (13x19 inches or bigger), try to use only ISO values through 800, if you can.
- *Conversely, small work allows higher ISO.* If your work is to be used at small print sizes (5x7 inches or smaller), you can probably work at up to ISO 1600 (and even 3200) with relative impunity. I routinely get good looking ISO

1600 prints off my 4x6" PictBridge printer without any noise reduction or other adjustments. Still, the higher the ISO value you use, the more likely you'll spend significant time performing image correction, especially as you go up in print size.

- *An image taken at one-quarter the largest size allows any ISO up to 3200 (hint: use **JPEG fine Small**).* If you're going to use the photo at smaller than captured sizes (e.g. for Web or computer display), you can probably use any of the ISO values. When you reduce the image from full resolution to a smaller image size, you'll often find that some of the noise pattern disappears (especially true if you get to 1/4 size or 1/8 size). Plus, you'll have far fewer pixels to correct if you do need to fix something. Color saturation is still a minor problem at the higher ISO values, though.
- *Noise from higher ISO values in NEF images will be higher than in JPEGs.* The in-camera noise reduction routines aren't applied to NEF image data. Capture NX2 uses the camera settings to apply a post-processing noise reduction similar to what the camera does (if you don't change the conversion defaults), but other converters don't recognize the camera settings; instead they make an attempt to reduce noise based upon ISO and sometimes proprietary profiles. I don't find that to be an issue, as I prefer post processing noise reduction under my control, anyway.

Exposure Bracketing

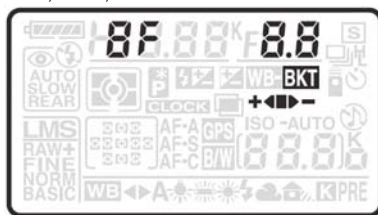
Obtaining correct exposures is important in digital work, as any overexposure kills highlight detail, while significant underexposure tends to mask (hide) shadow detail and produce noise. The D90's exposure meter, while quite good, isn't perfect, so some photographers like to bracket their exposures (i.e. take multiple exposures at slightly different settings).

The D90 has a flexible bracketing system, allowing between two or three exposures to be taken at 1/3 stop to 2 stop

intervals (1/2 stop to 2 stop if Custom Setting #B1 is set to **1/2 stop**). The D90 also allows you to set white balance bracketing and **Active D-Lighting** bracketing instead of exposure bracketing (only one option can be set at a time).

📷 To turn bracketing ON:

1. Hold down the **BKT** button while rotating the Rear Command dial until **BKT** appears in the top LCD. When this icon is actively displayed, exposure bracketing is active. The Rear Command dial controls how many images will be in the bracketing sequence (**2F** and **3F** are 2 and 3 images). Note that for two exposures you set either **-2F** or **+2F** (see chart, below).
2. Tell the camera what intervals to bracket by holding down the **BKT** button and rotating the Front Command dial until the top LCD displays your selection (0.3, 0.7, 1.0, 1.3, 1.7, and 2.0 at the camera defaults).



Top LCD:

Left indicator on top line is number of frames in bracket set; right indicator is the exposure step between bracketed frames

📷 Turning bracketing OFF is easy: simply repeat Step 1, above, but rotate the Rear Command dial until **BKT** no longer appears (a value of **0F**).

D90 Exposure Bracketing Values Table (Exposures)

Top LCD	# of Shots	Exposures*
- 2F 0.3	2	0, -0.3 EV
- 2F 0.5	2	0, -0.5 EV
- 2F 0.7	2	0, -0.7 EV
- 2F 1.0	2	0, -1 EV
- 2F 1.3	2	0, -1.3 EV

<i>Top LCD</i>	<i># of Shots</i>	<i>Exposures*</i>
- 2F 1.5	2	0, -1.5 EV
- 2F 1.7	2	0, -1.7 EV
- 2F 2.0	2	0, -2 EV
+ 2F 0.3	2	0, +0.3 EV
+ 2F 0.5	2	0, +0.5 EV
+ 2F 0.7	2	0, +0.7 EV
+ 2F 1.0	2	0, +1 EV
+ 2F 1.3	2	0, +1.3 EV
+ 2F 1.5	2	0, +1.5 EV
+ 2F 1.7	2	0, +1.7 EV
+ 2F 2.0	2	0, +2 EV
3F 0.3	3	0, -0.3, +0.3 EV
3F 0.5	3	0, -0.5, +0.5 EV
3F 0.7	3	0, -0.7, +0.7 EV
3F 1.0	3	0, -1, +1 EV
3F 1.3	3	0, -1.3, +1.3 EV
3F 1.5	3	0, -1.5, +1.5 EV
3F 1.7	3	0, -1.7, +1.7 EV
3F 2.0	3	0, -2, +2 EV
* Nikon rounds third stop settings to .3 and .7 (they should actually be .333... and .666...). Also, half stop settings (e.g. 0.5) are only available if the Custom Setting #B1 is set to ½ stop values.		

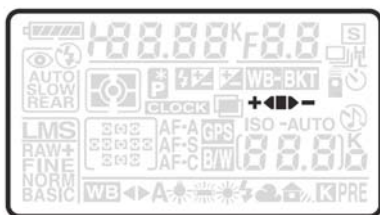
Note: The order in which the photographs are taken is normally as shown (e.g. correct value, followed by other values from negative to positive, in increasing order). You may change the order using Custom Setting #E6 (see page <527>).

Other Custom Settings make changes to bracketing, as well. Custom Setting #E4 (see page <523>) allows you to pick what is being bracketed (the default is that both ambient and flash exposures are varied during bracketing).

The D90 has more bracketing options than most photographers tend to use. Because the D90's meter is accurate, the most commonly used bracketing value is probably **3F 0.3** (or **3F 0.5** if you've set the camera for half stop values).

In very bright snow or sand conditions, I tend to set **3F 0.7** or **3F 1.0** and an exposure compensation value of +0.7 or +1.0 EV, as the Nikon metering system is often fooled into underexposing in those conditions. By setting exposure compensation, I move the bracketing midpoint from the metered value. (I end up with exposures of +0, +0.7 and +1.3 or +0, +1, and +2.)

When bracketing is active, a quick peek at the Bracketing Progress indicators on the top LCD tells you exactly which images you still have to take:



<u>Indicator</u>	<u>Images Remaining to be taken</u>
------------------	-------------------------------------

+■■■■-	Normal, under, and over
+■ ■■-	Under, over
+■	Over

Other options exist, but if you understand the above, you should be able to figure them out.

If you've set a three shot sequence and see +■■■■-, you know that you're at the start of a new bracketing series. Any other indicator would tell you that you're in the middle of a sequence. (This doesn't apply to white balance bracketing, which always takes a full sequence with each shutter press. See "White Balance" on page <305>.)

One very useful potential of the bracketing system is to increase the dynamic range of your finished shots. Landscape and nature photographers like me often have a difficult time balancing the exposure for distant objects and the sky against foreground objects that may be in shadow. With film, we used graduated neutral density filters in such situations, but since we're going to be working with our D90 images in an

image editing program such as Photoshop, anyway, why not go ahead and use different exposures for different parts of the scene? Here's the bare outline of the steps needed:

1. In the field, set your D90 to **3F 2.0** bracketing. In theory, this provides us another two stops of detail in the shadows and another two stops of detail in the highlights of our final shot when we combine the images later.
2. You need to make sure that neither the focus point nor the aperture changes between shots. The easiest way to do this is to use manual focus and Manual exposure mode, with a manual white balance. Also, be careful that zoom lenses don't shift focal length during the bracketing sequence. (You may also want to make sure **Contrast** and other **Set Picture Control** choices aren't set to **Auto**, as the camera may vary those settings between shots.)
3. With your camera on a tripod, take the bracketed sequence of pictures.
4. In Photoshop, open the three images and place them into three different layers of a new image (sometimes I take a shortcut and just use the two extreme exposures). Use Photoshop's layering tools to control which parts of each exposure are used in the final image.

Obviously, this technique works best if you have a sharp delineation between the shadow and lit areas of a scene, or have areas with little or no interesting detail in which to hide transitions between the exposures. How good your resulting image looks is in large part attributable to your Photoshop skills, but I've seen some remarkable images created this way, images that would be very difficult to duplicate with film.

Better still, with version CS2 or later of Photoshop, use the D90's bracketing sequence to create images for Photoshop's **Merge to HDR** function. This new ability *automatically*

merges multiple shots taken at different exposures into a single image with a potentially massive dynamic range. A few caveats apply:

- You need to bracket using shutter speed (changing aperture would cause focus differences). Thus, make sure your camera is set to Aperture-priority or Manual exposure mode before bracketing.
- You should normally take at least five photos for Photoshop's HDR function, but with the D90 you can only bracket three at a time. Try **3F 2.0** as your bracketing setting, but you may want to manually take five shots one stop apart instead.
- Focus should be set to a specific point (manual focus), Automatic ISO should not be used, avoid **Auto** white balance, the camera should be on a tripod, and all camera settings other than shutter speed should not vary between shots.

Assuming you pay attention to these details, you'll get astonishing tonal ramps and even any residual digital noise will tend to disappear (this is most noticeable in shadow detail, which tends to be impeccable using this method). Indeed, the combination is so good that I recommend that Fine Art photographers shooting for large prints use Photoshop's **Merge to HDR** and five or seven shot NEF bracket sequences⁸⁸.

When your camera is set to bracket, a few details sometimes catch new D90 users by surprise:

- In the Continuous frame shooting method, holding down the shutter release usually only takes the specified number of photos in the bracketing sequence (i.e. either 2 or 3).

⁸⁸ A number of other programs that perform the same function exist. I personally use Autopano Pro to do the same thing. I mention Photoshop's function because most digital SLR users end up with Photoshop and thus can experiment with high dynamic range shots without any further investment.

The camera automatically stops at the end of the bracketing sequence, regardless of whether you continue to hold the shutter release down.

- In the Single frame shooting method, you must press the shutter release once for each picture in the bracketing series. If you turn the camera **Off** in the middle of a series, it remembers that when you turn it back **On** (i.e. you're still in the middle of a bracketing sequence, no matter how long an interval has transpired). The same thing is true if your Secure Digital card fills up in the middle of a sequence: replace the card and the next picture picks up the bracketing sequence where it left off.
- Remember that exposure compensation interacts with bracketing values. If you set exposure compensation to -0.3 EV and a bracketing sequence of **3F 0.7**, you'd get shots of -0.3, -1, and +0.3 EV, not 0, -0.7, and +0.7 EV.
- When you set bracketing to **On** with the camera in manual (M) exposure mode, by default the D90 changes shutter speeds to accomplish the various exposures, despite your having set a particular shutter speed!

Nikon only mentions flash bracketing in passing in their manuals, and the way they describe the interaction with exposure bracketing confuses many new Nikon users. If you have a Speedlight attached and turned on when exposure bracketing is set, not only does the camera set different ambient exposure values for each shot, but it varies the output of the Speedlight, as well (remember, the default flash mode is a "balanced" mode, where flash doesn't assume that it is providing the main exposure). Normally, this is what you want the camera to do. You can tell the camera to use flash-only or camera-only bracketing by using Custom Setting #E4 (see "Exposure Bracketing Method" on page <523>).

Pay careful attention to the top LCD when setting bracketing. If there are decimals in the values (e.g. **0.3** or **1.0**), then you're setting exposure bracketing. If no decimals appear (e.g. you see only **1**, **2**, or **3**), then you're setting white balance bracketing!

Note: If you shoot in NEF format, Nikon Capture NX2 allows a range of after-the-fact “exposure” adjustment (as do most raw file converters). You can actually save space on your Secure Digital card by simply shooting in NEF format and adjusting the image’s “exposure” on your computer instead of bracketing a JPEG three-frame sequence. This is especially true if you make sure that your exposure doesn’t have any histogram that extends off the right side of the display (i.e. no blown highlights). However, remember this is not exactly the same as changing exposure; what you change with Capture NX2’s “exposure” adjustment is the linearity of the data. Still, for errors of less than a stop, this is a useful shortcut and a real butt-saver if you weren’t paying attention while shooting. Beyond -1EV compensation in Capture NX2, you’ll almost certainly get posterization of highlight data, while beyond +1EV you’ll begin pulling up visible noise. One final comment: Photoshop’s raw converter seems better at dealing with extreme highlight detail via exposure adjustment than does Capture NX2. If you’re having problems at the extremes of the exposure, try using Photoshop to convert the image. Still, my photography mentors said it perfectly: “everything you get right in the field saves you time and effort in the darkroom.” That’s true of even the digital darkroom.

Exposure Compensation

The D90’s exposure meter, like all modern meters, is set to assume that the subject it is looking at has a reflectivity of middle gray.

Camera meters are calibrated to luminance targets (lights), not reflective targets (walls or gray cards). Plus there’s an almost half stop tolerance allowed in the manufacturing standards. So your meter may be a bit off from what you expect it to register, though my experience with dozens of Nikon bodies has rarely indicated any deviation between bodies, let alone one big enough that I felt compelled to adjust exposure values to compensate for a meter inaccuracy.

Obviously, not everything you photograph is middle gray. Snow, for example, is obviously brighter (near 100%

reflectance), and coal in an unlit underground mine is dramatically darker (near 0% reflectance). Without exposure compensation, large expanses of white snow or black coal would both appear gray in your photos. That's because the meter thinks the world is middle gray and tries to match everything to that value.

Nikon's notes in some of their manuals can cause confusion. Nikon says that you normally use a positive correction value (e.g. +0.7 stops) when *your subject is darker than the background*, and you use a negative correction value (e.g. -0.7 stops) when *your subject is brighter than the background*. While true, Nikon's assumption is that the background exposure is correct. That's not always the case.

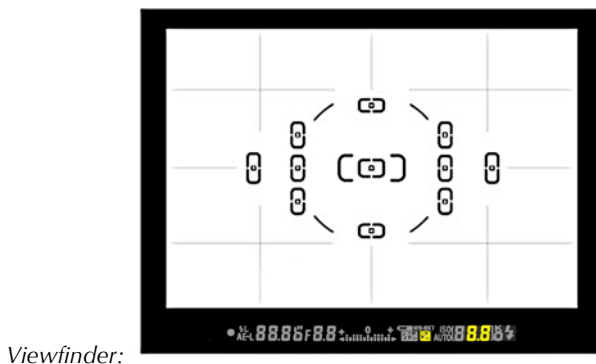
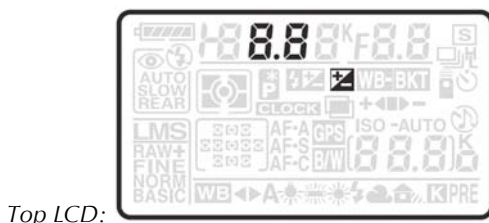
A better way to deal with placement of exposure is to use center-weighted or spot metering and measure a mid-tone item, or to measure something bright or dark and adjust the exposure so that it isn't rendered as a mid-tone.

Put another way: without exposure compensation, large expanses of white snow or black coal would both appear gray in your photos. That's because the meter thinks the world is middle gray and tries to match everything to that value.

<i>Object</i>	<i>Meter Sees it As</i>	<i>Result</i>	<i>Solution</i>
Bright white, such as snow	Brighter than middle gray	Camera underexposes	ADD exposure (+ exposure compensation)
Mid-tone values, such as grass or plants	Same as middle gray	Camera exposes correctly	--
Very dark object, such as black lava rock	Darker than middle gray	Camera overexposes	SUBTRACT exposure (- exposure compensation)

Virtually every professional I've met has his or her own method of deciding when to override the camera's meter, but every pro I know also does so with regularity⁸⁹. Fortunately, it's quite simple to do, and Nikon has been good about keeping the exposure compensation control in the same location on most of their recent camera bodies, whether they are film or digital.

📷 To set compensation hold the  button on the top right side of the camera and rotate the Rear Command dial until the value you want is shown in the top LCD. You can also see the value while looking through the viewfinder.



⁸⁹ As you might expect, I have my own method of dealing with exposure. Since this isn't a book on photography basics, I won't elaborate on it here other than to say that with digital cameras you have all the information you need to make excellent exposure decisions using the histograms. See "How to Interpret Histograms" on page <252> if you'd like more.

Note: Choose the exposure compensation increment (third or half stops⁹⁰) with Custom Setting #B1 (see page <494>).

Once set, exposure compensation remains set until you use the control again and set a value of **0.0**.

Note: In Manual exposure mode, exposure compensation is “invisible”: the zero point for metering is moved when exposure compensation is set. Try it. Set a correct exposure in Manual exposure mode and then dial in exposure compensation: you’ll see that the manual exposure indicator moves off of 0 in direct relationship to how much compensation you dialed in.

The D90 supports an alternate method of setting exposure compensation via Custom Setting #B2; see “Exposure Compensation Control” on page <495>. When you set this alternate method, called “Easy Exposure Compensation” by Nikon, one of the command dials on the camera is used to adjust compensation values, *even when the  button is not held down!* (Which dial is used depends upon your exposure mode and the value of Custom Setting #F5!) Frankly, I think this is a dangerous ability because if you forget that you have it set, you may not notice that you’re setting compensation instead of apertures or shutter speeds.

Some D90 users do find the Easy Exposure Compensation function useful, though, because they always shoot in one exposure mode (usually Aperture-preferred) and it gives them a convenient way to quickly take an exposure at a value different from the metered one (i.e. take a picture, twirl a Command dial (usually Rear, as the aperture is controlled by the Front), take another picture at the compensated setting).

⁹⁰ Half stops are shown in a series like this: 0.0, 0.5, 1.0, 1.5, 2.0, and so on. Third stops are always rounded and are shown as 0.0, 0.3, 0.7, 1.0, 1.3, 1.7, 2.0, and so on.

Active D-Lighting

Nikon's latest cameras have a control that intersects with exposure: **Active D-Lighting**. Before telling you how the exposure interaction works, I first need to describe "D-Lighting."

You may be surprised to find out that D-Lighting has its origins in Nikon's slide scanning software, where a feature originally called DEE (Dynamic Exposure Expansion) first appeared. What DEE and its progeny attempt to do is reposition highlight and shadow information.

Let's keep the discussion simple and hypothetical for a moment. Assume that you had an 8-bit data set that had three bit values in it: 0000 0001, 1000 0000, and 1111 1110 (those are equivalent to 1, 128, and 254, or "close to black," "middle gray", and "near white"). Now let's apply a shadow boost and highlight reduction scheme to our data. We might end up with values of 0000 0010, 1000 0000 and 1111 1100 (that's 3, 128, and 252). Note how the middle value remained unchanged, but the shadow value rose and the highlight value lowered. That's something akin to what DEE (and now D-Lighting) does, though the formula for moving the values is not linear and highly variable. Moreover, highlight changes are smaller and more subtle than shadow changes. Think of it as a method for moving shadow and highlight detail into the more visible middle-ranges of your exposure data.

Many recent Nikon DSLRs have had **D-Lighting** built in (as does the D90). This feature lives on the RETOUCH menu and is used to apply value changes *after the fact* on images you've already shot (see "D-Lighting" on page <685>). What's new on the D90 (plus D3, D300, and D700) is that the technique can be applied *as you shoot*. Nikon calls this **Active D-Lighting**.

Active D-Lighting also changes exposure (which is why I'm dealing with it in this section of the eBook). Specifically:

- **Low**—no exposure change is made. Flash, if active, is produced approximately 1/3 stop lower than normal.
- **Normal**—the exposure is lowered by as much as 1/3 stop. Flash, if active, is produced approximately 2/3 stop lower than normal.
- **High**—the exposure is lowered by as much as 2/3 stop. Flash, if active, is produced approximately 1 stop lower than normal.
- **Extra high**—the exposure is lowered by as much as a stop. Flash, if active, is produced approximately 1 stop lower than normal.
- **Auto**—the camera will apply any changes based upon its evaluation of the scene.

 To set **Active D-Lighting**:

1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).
3. Use the Direction pad to navigate to **Active D-Lighting** and press the **▶** key on the Direction pad to select it.



4. Use the Direction pad to navigate to **Auto**, **Low**, **Normal**, or **High** and press the **▶** key on the Direction

pad or the **OK** button to select it.



To turn **Active D-Lighting** off, repeat the above and select **Off** in Step 4.

Some important things to note when using **Active D-Lighting**:

- *It was designed to work with matrix metering.* If you switch to another metering type, you get variable results.
- *The camera never tells you when it is and isn't active.* Other than looking in the SHOOTING menu or the Info screen, you can't tell whether you've set **Active D-Lighting** or not, and you can't tell whether it's active or not.
- *It doesn't change the exposure in Manual exposure mode.* **Active D-Lighting** only changes the zero point in the metering bar in Manual exposure mode.
- *Some Picture Control settings are canceled.* Any **Brightness** or **Contrast** setting is overridden by **Active D-Lighting**.
- *It takes slightly longer to process an image with **Active D-Lighting** active.* This can lead to slower continuous shooting speeds than you may expect.
- *Automatic ISO and exposure compensation settings still apply, if set.* You can get really confused if you start setting multiple things that influence exposure simultaneously. If you don't believe me, set the camera to Manual exposure mode, then turn on **ISO sensitivity auto control**, dial in an exposure compensation, and set

- Active D-Lighting**; try to figure out what's changing the exposure and by how much in that situation.
- The **Active D-Lighting** function is designed to work on high contrast scenes. If you use it on a low contrast scene, the function will still tend to underexpose and reshuffle data values, which is probably less than useful. **Active D-Lighting** is really only useful for scenes that are near or slightly exceed the camera's dynamic range.
 - *NEF shooters beware!* Only Capture NX2 can apply the proper linearization curves automatically to get essentially the same effect as what the camera does for JPEGs. If you use another raw converter, though, consider not using **Active D-Lighting**. The reason for that is simple: you're going to end up with images that are underexposed, and you may have to manually apply corrections to the shadow area, mid-tones, and highlights *simultaneously*. Because of the decrease in exposure, noise presence tends to be increased when you do this (especially if you do it aggressively and don't use a post processing noise reduction after conversion). Personally, I'd say you're better off—even Capture NX2 users—to simply make sure that your exposure doesn't have channel blowout rather than using **Active D-Lighting**.

My advice is to use the **Active D-Lighting** function sparingly, if at all. While it can produce out-of-camera usable pictures in high contrast scenes that are better than with it turned off, it is not a leave-it-on-all-the-time type of feature. You need to be shooting in JPEG format and know that you've got highlight and shadow detail that might not show up visibly without the function. NEF shooters facing high contrast situations have better options for post processing (though note that you might want to dial down exposures slightly, just as **Active D-Lighting** does).

White Balance

All light is not created equal. The perceived color of an object depends upon the light source that illuminates it. Our brains, however, are pretty good at overriding what our eyes see. If someone wearing a white shirt walks from the sun into the shade (where the light is usually “bluer” due to reflections and light scatter), our brain knows that shirt itself isn’t getting bluer, even though the light being reflected by the shirt is now reflecting a bluer light. Essentially, our brain forces us to think of that shirt as a *constant* white value, regardless of how it is lit⁹¹.

Unfortunately, both film and digital cameras respond to light in a fixed fashion, so the resulting image taken with a camera *will* reveal the shirt to be a bluish white in shade and a bright, neutral white in the sun.

Color temperature is an objective measurement that defines the temperature at which a “black body” object would have to be heated to radiate light in the same wavelengths. Color temperature—the color of light—is expressed in units of Kelvin. Though it measures temperature, units of Kelvin do not get a degree mark, just a K (e.g. 5200K, not 5200°K). Lower numbers indicate a “redder” light (to our eyes), higher numbers indicate bluer light. The light itself isn’t “red,” it just has more red wavelength components than, say, a “bluer” light (which would have more blue wavelength components).

On digital cameras, you set a “white balance” to adjust the sensor to the wavelengths of light being captured. D90’s have nine basic white balance settings:

⁹¹ Okay, an *extreme* light might register, at least momentarily. For example, at Halloween I might place a bright green filter on my doorway lighting to make me “look ghoulish,” but it’s surprising how much our brain will still try to compensate. If you stand there looking at me long enough, your brain will start filtering out that extreme green light.

-
- AUTO** or **A** Automatic white balance. Nikon claims that this function works at any color temperature between 3500K and 8000K. Note that most indoor lighting falls *below* that range! Moreover, my experience tells me that the D90 gets less accurate towards the extremes, especially at the low Kelvin end (2000-4500K). I'd say the most accurate range is much narrower, perhaps 4500 to 6500K.
-  Indoor shots using incandescent light bulbs (3000K)
-  Indoor shots using fluorescent lighting (4200K)
-  Outdoor shots in direct sunlight (5200K)
-  Indoor or outdoor shots lit primarily by flash (5400K)
-  Outdoor shots in overcast skies (6000K)
-  Outdoor shots taken in shaded areas (8000K)
- PRE** Manually set white balance using a white or neutral object (Nikon doesn't specify a range, but we know that you can manually adjust a D90 from 2500K to 10,000K, so the range should be at least that wide)

K Individual Kelvin values can be set

*Note: Digital cameras fare less well using the Automatic white balance setting with light that falls under 4000K (note that Nikon doesn't recommend **Auto** below 3500K for the D90; yet I find that even at 4500K the camera tends to set a white balance that's a bit too high in Kelvin for the light). That's partially because the blue sensors receive very little information at these so-called "warm" color temperatures, so the minute amount of blue wavelengths being seen by the sensor becomes a factor.*

One novel way of coping with the problem of getting good automatic white balance with indoor light is to simply imitate what we used to do with film: use an 80B filter! The 80B shifts the 2900K color temperature of a 100-watt bulb

up to about 4300-4400K (an 80A would push it above 5000K), putting it within the range the camera handles well.

*Tip: Nikon's choice for normal outdoor lighting (5200K) should raise eyebrows, though I haven't seen anyone specifically comment on it. Daylight film is usually balanced to 5400K, and many digital photographers set their default daylight value even higher. (The origin of the 5400K number, by the way, is interesting—it's the average measurement of color temperature, taken at noon on summer and winter solstice on the Mall in Washington DC in 1926! Since altitude, time of day, time of year, cloud cover, and distance from the equator all alter daylight color temperature, one value does not apply to every situation.) Don't be afraid to experiment a bit to find the white balance you like best. In general, I find that **Flash -2** is the quickest way for me to set a sunny white balance I like, and I also tend to use much higher color temperature values than Nikon suggests for most indoor lighting (e.g. **Incandescent -1** or **-2**).*

The D90 detects white balance in two different ways: (1) via the 420-pixel sensor in the viewfinder; and (2) via the main imaging sensor itself. Nikon doesn't reveal how these two systems interact, but it's clear to me that the D90 has less accurate automatic white balance than the D2xs, which has a dedicated white balance sensor.

Let's look at color temperature in action. Since color temperature for daylight was originally determined on the Washington Mall, let's go there for our test. Below you'll find a photo taken late in the day (in late April) of the Lincoln Memorial. I've tweaked this photo a bit to saturate the colors and tone down the sky (which also has a graduated neutral density filter holding it back), but if you were standing next to me at the time, this would be pretty close to what you saw:



The left portion of the monument is the area we'll work with (though note the slight orange areas under the eaves in the front—we'll be coming back to those in a moment). Let's look at a number of options for white balance:



From left to right: 3400K, 3800K, 4400K, 4800K, and 5200K. I've added just a bit of color saturation to emphasize the cast. All photos taken at the same camera settings and processed through Nikon Capture NX the same.

You should notice in the above examples that as the color temperature on the camera is set lower than the actual value present in the lighting, a blue cast appears in the photo. (That again brings up Nikon's choice of 5200K for Daylight—most of the time you'll find that it generates results that are slightly on the blue side).

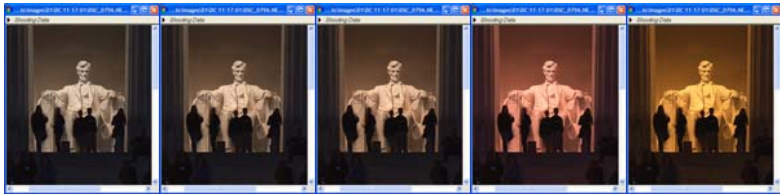
The further we get from the actual color temperature, the more distinct that cast is. Note, too, that the cast applies to everything: sky, building, and bushes. It isn't until you get 5200K that we begin to see some of the warmth that is in the limestone and sky, and it isn't until we get over 5500K that the greens actually become fully green (no hint of blueness; compare the larger photo with the rightmost small one and look at the greens).

Remember those orange spots on the walls of the Memorial? Those are areas lit by incandescent light, which has a lower color temperature than daylight. Inside the Monument, Lincoln's bust is mostly lit by incandescent lighting. Here's another full photo to consider:



Lincoln Memorial at night, when only the internal overhead lighting contributes to color temperature.

Now we're dealing with mostly incandescent lighting, which has a lower color temperature (most bulbs used on large buildings like this one are of the Photoflood variety, and about 3200K in output). There's a bit of overhead fluorescent in the Monument as well, but the incandescent pretty much overwhelms it where Lincoln sits.



From left to right: 3000K, 3200K, 3400K, 5000K, 6000K. All camera settings and Nikon Capture NX settings otherwise the same.

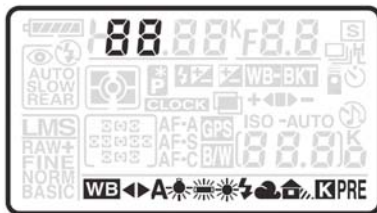
You should notice in the above examples that as the color temperature on the camera is set higher than the actual value of the lighting, a red/orange cast appears in the photo. The further we get from the actual color temperature, the more distinct that cast is.

So remember that orange cast on the outside of the building? That was caused by setting a color temperature higher than the actual color temperature. Most of the building was lit by the sun and sky, so the color temperature on those portions of the building was high (5500K to 6000K based upon my observation). The spots under the eaves that are orange were lit by incandescent light that was close to 3400K. Thus, if the rest of the building is rendered correctly, those spots turn orange.

This illustrates a common problem: in many scenes, there is no single color temperature of light that affects everything. An area in shade on an otherwise sunny day may be slightly higher color temperature than that in direct sun. Indoors you may find both incandescent and fluorescent bulbs lighting different areas. If the different lighting sources are equally mixed on your subject, you can use the Preset method of setting white balance and measure the value off a gray card (see below). But if the areas of different lighting are separate—incandescent lighting a foreground subject and fluorescent lighting a background, for example, you have to pick a color

temperature and live with the results, as I did in the photo outside the Lincoln Memorial⁹².

📷 To set the white balance: press and hold the **WB** button while rotating the Rear Command Dial until the icon for the desired method is shown on the top LCD. The Front Command Dial can be used to control the fine tuning of white balance (setting **A6** to **b6** increments on the basic value—more on that in a bit).



Top LCD:

Upper area and **◆** indicate Fine Tuning (value is at top); lower icons indicate the white balance setting

📷 Alternatively, you can use the menu system:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).
3. Use the Direction pad to select the **White balance** option and press the **▶** key on the Direction pad to see the submenu.

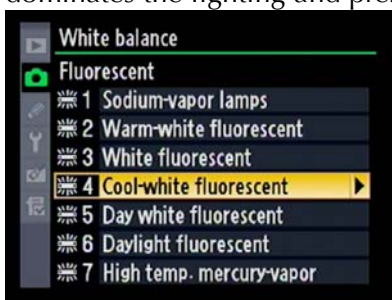


⁹² Other solutions exist. You could filter one or other of the light sources, add light of a different color (e.g. flash) to overwhelm the poor color, turn the troublesome light off, and more.

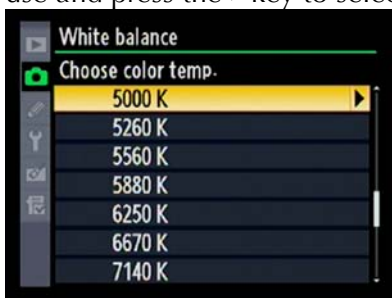
4. Use the Direction pad to highlight the white balance option you want and press the ► key to select it.



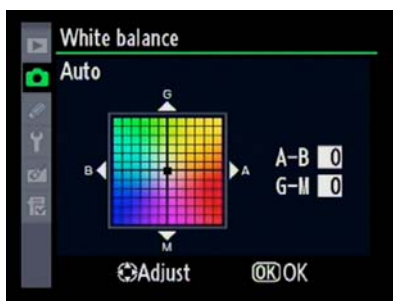
5. If you've selected a **Fluorescent** setting, use the Direction pad to highlight the type of bulb that dominates the lighting and press the ► key to select it.



If you've selected a **Choose color temp.** setting, use the Direction pad to highlight the value you wish to use and press the ► key to select it.



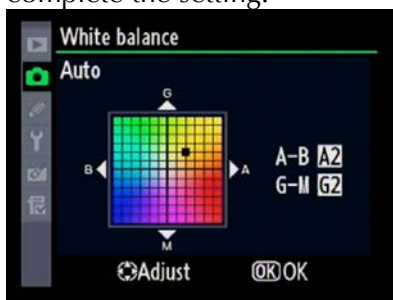
6. A new wrinkle (on the D90, D3, D300, and D700) is that you are next given the chance to fine tune the white balance using a two-dimensional plot.



The B (blue) and A (amber) axis is essentially equivalent to color temperature. By moving the position of the black dot along this axis you can cool (towards B) or warm (towards A) the overall color temperature setting used. Each increment you can move is about equivalent to a 5 MIREL change.

The G (green) and M (magenta) axis is similar to color compensation filtration adjustments you might have made with film.

Use the keys on the Direction pad to set the fine tuning you desire and press the **OK** button to complete the setting.



Here I've moved the balance point up two (G2) and to the right two (A2).

This last step is a tricky one. Remember that the adjustment you dial in as a fine tuning is applied to *all* colors. As long as you stick to the horizontal axis you're making color temperature-like adjustments. If you push the tuning up or down or towards a corner, that means that you're adding a

filtration-type effect to your colors (akin to the old color compensating filters, such as a 30M⁹³ CC filter).

*Tip: Use Live View to evaluate white balance settings in real time. That's right, you can change white balance using the **WB** button while looking at the view on the color LCD when Live View is active. Most people miss that this is possible because usually you can't use the **WB** button when something is displayed on the color LCD.*

Personally, I prefer to get dead-on neutral results out of my camera because it's always easy to add color in, but more difficult to later remove it. Thus, setting a proper white balance is very important to me. Unfortunately, "dead-on" might not be one of the labeled white balance settings and you'll *have* to adjust the fine tuning to get there. But knowing *what* to dial in takes experience in analyzing light. Even people shooting standard reference cards need some training to recognize color shifts.

For example, let's say that I walked into a room that was lit with Incandescent lights that were known to be 3000K. You might think that I'd just dial in **Incandescent** (which is balanced for 3000K) and be done with white balance. However, I long ago learned to look at the color of the walls, since they'll be reflecting that light. What if the walls were a slight yellow color? Well, I'd use the fine tuning attribute to move the black dot away from that color in the fine tuning grid. Why? Because the walls will add a yellow reinforcement to the colors and I need to add in color to balance that out.

If you use the camera's **WB** button with the Front Command dial to "fine tune" the white balance, you use only the color temperature adjustment from the white balance fine tuning system (blue/amber axis). Nikon only provides cryptic labels for indicating the fine tuning changes with this method (whole numbers from **A1** to **A5** and from **b1** to **b5**). According to

⁹³ That would be a moderate magenta filter.

Nikon, each increment represents a 5 MIREN shift in color temperature⁹⁴. These correspond (very) roughly to the old -3 to +3 white balance tuning options used in previous Nikon bodies.

Here's how these numbers influence each of the white balance settings:

	<i>Approximate Kelvin Value for Adjustments</i>						
	<i>a6</i>	<i>a4</i>	<i>a2</i>	<i>0</i>	<i>b2</i>	<i>b4</i>	<i>b6</i>
Incandescent	3300	3195	3096	3000	2915	2832	2755
Direct Sunlight	6173	5814	5495	5200	4950	4717	4505
Flash	6452	6061	5714	5400	5128	4878	4651
Cloudy	7299	6803	6369	6000	5650	5348	5076
Shade	10526	9524	8696	8000	7407	6897	6452

If you compare this to the tables Nikon supplied with older cameras, you'll note that either those old tables were wrong, Nikon's 5 MIREN per increment on the new camera is wrong, or the new camera's fine tuning option pushes color temperatures differently than do the older cameras: you have more ability to shift the white balance than you used to.

Nikon uses hue adjustments to shift the colors to better match the odd balances of fluorescent tubes, so I've not included them in the above table. Because fluorescent lighting uses colored phosphors that don't produce the entire light spectrum, and because those phosphors decay at different rates, most digital cameras have fluorescent settings that attempt to deal with the overabundance of green/blue values such light produces. The D90 does this, too. If you use the fluorescent white balance settings on light that was produced by a continuous spectrum light source (most other lighting), you're likely to see a cyan and/or green shift.)

⁹⁴ My *Nikon Field Guide*, published in 1998, was I believe the first non-academic work to use MIREN to calculate color shifts.

Let's put the D90 preset and settable Kelvin values in context of actual lighting sources:

						D90	Kelvin	Light Source
							1700	Match flame
							1900	Candle flame
							2000	Gaslight, max sunrise/set
						*	2500	
	1					*	2650	40W Incandescent bulb
B6						*	2700	
B4						*	2800	75W Incandescent bulb
B2						*	2900	100W Incandescent bulb
0	2					*	3000	Warm-white Fluorescent
A2						*	3100	
A4						*	3200	Tungsten lighting
A6						*	3300	Some studio lighting
						*	3400	Standard Photolamp
						**	3500	Typical sunrise/set
	3					**	3700	White Fluorescent
	4					**	4200	Cool-white Fluorescent
		B6				**	4500	Early Morning/Late Afternoon
		B4	B6			**	4700	
						***	4800	Daylight Blue Photoflood
			B4			***	4900	
	5	B2		B6		***	5000	Day white Fluorescent
		0	B2			***	5200	Carbon arc
				B4		***	5300	
			0			***	5400	Sunny daylight standard
		A2				***	5500	
			A2	B2		***	5700	
		A4				***	5800	Sunny daylight summer
			A4	0		***	6000	New Nikon flash
		A6				***	6200	
				A2		***	6400	Xenon arc
	6		A6		B6	***	6500	
				A4		**	6800	
					B4	**	6900	
						**	7100	Bright overcast sky, shade
	7					**	7200	Mercury vapor (some)
				A6		**	7300	
					B2	**	7400	
						**	7500	Overcast sky (typical)
					0	**	8000	Shade, hazy sky
						*	8400	Fog
					A2	*	8700	
					A4	*	9500	Deep shade
					A6	*	10000	

* Range D90 can set directly

** Range Nikon says Auto works well at

*** Range Thom says Auto works well at (Some values have been rounded.)

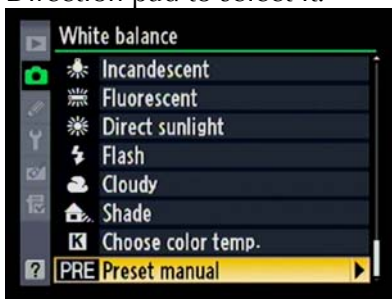
*Note: Nikon now has three different white balance fine tuning sets: the D1, D1H and D1X, form one group, which differs from the following cameras in the **Incandescent** values. The D2 series, D40, D40x, D50, D70, D70s, D80, D100, and D200 share the same Kelvin values and form the second group. The D90, D300, D700, and D3 are completely different, share the same Kelvin values, and form the third group.*

The D90 also allows you to measure the lighting in a particular location and manually select an appropriate white balance using the **White balance preset** selection. To select and set a white balance of **White balance preset**, there are additional steps you must take.

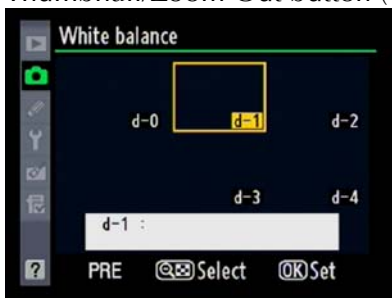
 To set white balance from a neutral reference source (if the white balance is already set to **Preset manual** and you wish to replace the currently selected preset balance you can skip Step 2):

1. If the camera is in Manual exposure mode, set a correct exposure for the gray or white card you'll use in Step 8, below, before proceeding.
2. Press the **WB** button on the top of the camera and rotate the Rear Command dial until **P-W** is displayed on the top LCD and in the viewfinder. Release the **WB** button.
3. Press and hold the **WB** button on the camera until **P-W** begins blinking on the top LCD and in the viewfinder (blinking continues until the camera's metering timeout expires or you complete the next step; if the blinking stops before you get to the next step, you'll have to go back to Step 2).
4. If you wish to measure off a neutral gray or white card, frame it fully in the viewfinder and press the shutter release.

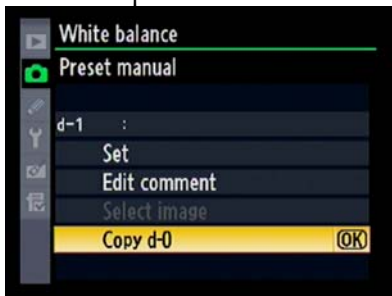
9. Navigate to **Preset manual** and press the **▶** key on the Direction pad to select it.



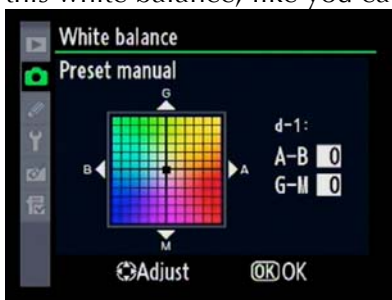
10. Navigate to the preset setting (**d-1** to **d-4**) you want to copy the white balance to and press the Thumbnail/Zoom Out button (**ⓧ**) to select it.



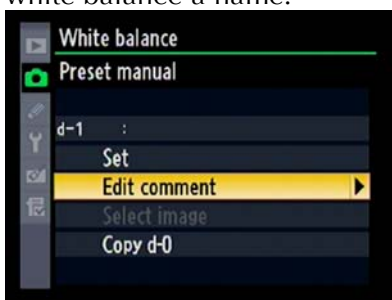
11. Navigate to **Copy d-0** and press the **▶** key on the Direction pad to select it.



12. Next, press the **OK** button and you'll be able to adjust this white balance, like you can with the others:



13. Finally, repeat steps 8 through 11, but select **Edit comment** instead of **Copy d-0** in Step 11 to give your white balance a name.



 If you want to use the white balance from an image already on the camera:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).
3. Use the Direction pad to navigate to the **White balance** option and press the **►** key on the Direction

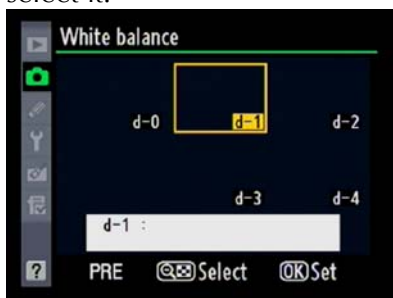
pad to select it.



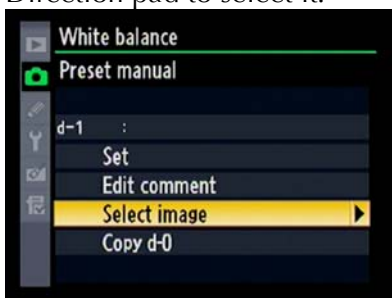
4. Navigate to **Preset manual** and press the **►** key on the Direction pad to select it.



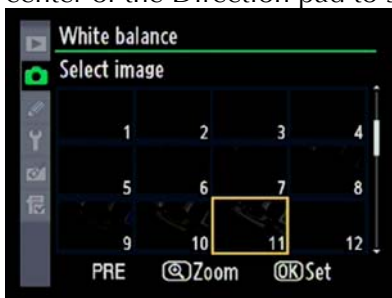
5. Navigate to the preset setting (**d-1** to **d-4**) you want to *assign* and press the center of the Direction pad to select it.



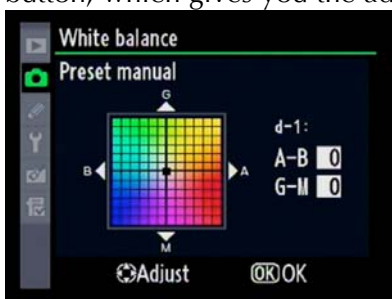
6. Navigate to **Select image** and press the **▶** key on the Direction pad to select it.



7. Navigate to the image you want to use and press the center of the Direction pad to select it.



8. At this point you can continue and name this white balance by repeating the steps but selecting **Edit comment** in Step 6, or you can just press the **OK** button, which gives you the adjustment screen:



Press the **OK** button one more time to complete the process.

Note: You can only copy white balance from an image taken with a D90. Curiously, the D90 will sometimes show you images

*from other cameras, but you'll get an error message (**Can only use photo taken with D90**) if you select one.*

You may wonder why you'd want to copy white balance from an existing picture on the card. Let me give you an example of when this is handy. Let's say you were assigned to shoot a wedding. During a relatively short period of time you need to take pictures in the wings of the church, at the altar during the ceremony, out on the steps of church, and in several different rooms at the reception. Let's assume further that all these locations have tricky lighting conditions (any wedding photographer can tell you that they usually do). You're also going to be moving back and forth amongst those locations and don't want to miss a photo opportunity because you were trying to figure out white balance. Worse still, there are more than five locations, so you can't simply store each one into one of the presets.

You can run around prior to the service and capture custom white balances for each of the locations, taking a picture with the correct white balance at each. Now, as you move from location to location during the wedding, you can quickly grab the white balance from an image you've already taken instead of having to go through the entire gray card reading method of setting white balance. Unfortunately, that doesn't really save an enormous number of steps on the D90 if you do it manually (but read next paragraph), but it is convenient enough to be effective in actual practice (moreover, you don't have to keep getting your gray card out).

Remember, once you've assigned preset values into **d-0** to **d-4**, either via measurement or reference image, you can quickly recall any of these by simply choosing a white balance of **PRE**, holding down the **WB** button and using the Front Command dial to navigate to the preset number. Thus, you should preassign your values during your setup prior to an event to make it easier to change white balances quickly. Unfortunately, you'll have to remember which scene you've assigned to each of the numbers, as the camera doesn't tell

you the preset's name (comment) when you use the Front Command dial to move between them.

*Note: Practical field tests show that **PRE** works more consistently using a neutral gray card than it does with a white card (the Nikon manual suggests either). A neutral gray card should, by definition, generate a correct exposure and has no color cast. A white card is often underexposed as compared to the eventual scene and sometimes contains a colored pigment to make it appear "white." Use Manual exposure mode and a gray card and follow my instructions, above. Use a white card only in a pinch.*

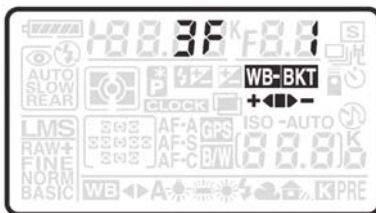
*Tip: You can use slightly colored cards to make the overall color balance warmer (redder) or cooler (bluer). Just pick a light version of the color you want to remove from the scene. For example, to make a warmer (redder) rendition, use **Pre** and measure on a light blue card. To remove green from fluorescent lights, try using a light green card. If you don't want to go to the trouble of making your own cards, do what the video pros do: buy a pre-made set from <http://www.warmcards.com>.*

Note: White Balance settings are maintained when the camera is turned off and turned back on.

 You can also bracket the white balance settings on the D90:

1. Make sure that **Image quality** isn't set to **NEF (RAW)** (white balance bracketing only functions for JPEG images, so if shooting raw files you need to make sure you have at least one of the **+JPEG** options selected).
2. Set Custom Setting #E4 to **WB bracketing**. (See "Exposure Bracketing Method" on page <523>).
3. Hold down the **BKT** button while rotating the Rear Command dial until **BKT** appears in the top LCD. When this icon is displayed, white balance bracketing is

active.



Top LCD:

4. Tell the camera how many pictures by holding down the **BKT** button and rotating the Rear Command dial, and at what white balance intervals by holding down the **BKT** button and rotating the Front Command dial until the top LCD displays your selection (see “D90 White Balance Bracketing Values Table,” below).

Turning white balance bracketing OFF is easy: simply repeat Step 3, above, but rotate the Rear Command dial until **WB-BKT** no longer appears.

D90 White Balance Bracketing Values Table

<i>Display</i>	<i># of Shots</i>	<i>Exposures</i>
3F 1	3	0, -5, +5 MIRE
3F 2	3	0, -10, +10 MIRE
3F 3	3	0, -15, +15 MIRE
A2F 1	2	0,-5 MIRE
b2F 1	2	0,+5 MIRE
A2F 2	2	0,-10 MIRE
b2F 2	2	0,+10 MIRE
A2F 3	2	0,-15 MIRE
b2F 3	2	0,+15 MIRE
<i>Remember, MIRE values represent a visually constant change in color. A +10 MIRE adjustment is twice the color change of a +5 adjustment. Nikon uses this instead of Kelvin because a doubling of Kelvin doesn't have a constant visual change. At low Kelvin values, doubling the value makes for a larger change than at higher values.</i>		

One final word about white balance: if you shoot NEF files, you can select your white balance after the fact (and try out different white balances to see which you like). Nikon Capture NX2 and other raw converters allow you to choose a white balance before the computer interpolates the final image data. Be careful of images with blown channels, however. When you blow out a single channel and then later try to adjust white balance using a NEF converter, you may see slight, uncontrollable shifts in the color of highlight detail.

Image Quality

I covered it earlier (in “Still Image Formats” on page <138>), but since image quality and size settings are something that you normally attribute to “setting up the camera,” this is a good place to summarize the choices and the method of setting them.

The D90 supports four basic levels of image quality (plus you can record NEF and JPEG qualities simultaneously):

- RAW** (NEF) Images are not demosaiced and do not have camera data applied to the pixel data; you're saving the 12-bit sensor data and a list of camera settings, not a finished image (though a finished **JPEG basic** thumbnail *is* saved in the file). The result is saved with a visually lossless compression. This is the highest quality image the D90 can create.
- Fine** (JPEG) Images are demosaiced by the camera, camera controls are applied, data is reduced to 8 bits, and compressed at a ratio of about 1:4 and stored as JPEG files. Compression artifacts are present, but generally not visible.
- Normal** (JPEG) Images are demosaiced by the camera, camera controls are applied, data is reduced to 8 bits, and compressed at a ratio of about 1:8 and stored as JPEG files. Compression artifacts are present, and may be visible on close examination (especially if high sharpening values are used or you're using a high ISO value).
- Basic** (JPEG) Images are demosaiced by the camera, camera controls are applied, data is reduced to 8 bits, and compressed at a ratio of about 1:16 and stored as JPEG files. Compression artifacts are present and often visible (especially if high sharpening values are set and you're using a high ISO value).

You also have a choice of **Large**, **Medium**, and **Small** sizes in the three JPEG formats.

Starting out, you probably should select **JPEG fine Large** to shoot in, as this will result in high quality, reasonable-sized files that can be used in virtually any digital photo software product. It also has the decided advantage—in my humble and slightly sadistic opinion—of showing you when you make other setting mistakes, which helps you learn faster. What do I

mean by that? Well, if you get the White Balance setting wrong while shooting JPEG images, the color in your photos will be wrong. If you get White Balance wrong when shooting NEF, you simply change the setting in editing.

Approximate Maximum Images Per Card

<i>Format</i>	<i>2GB</i>	<i>4GB</i>	<i>8GB</i>
12-bit RAW Compressed	146	292	584
JPEG Fine Large	298	596	1194
JPEG Fine Medium	528	1056	2112
JPEG Fine Small	1100	2200	4400
JPEG Normal Large	593	1186	2372
JPEG Normal Medium	1024	2048	4096
JPEG Normal Small	2200	4400	8800
JPEG Basic Large	1100	2200	4400
JPEG Basic Medium	1980	3960	7920
JPEG Basic Small	4180	8360	16720

*So why does the Nikon manual and your camera report and save different amounts than the ones above, you ask? For two reasons, typically. First, actual available space on cards is variable. Some 4GB cards have 4,194,304 bytes on them, some have 4,000,000 bytes, and bad sectors may reduce those numbers further. Second, for all formats the actual size of a file will depend upon how much detail is in the scene and the sharpening setting you've used. I've used "near average scene" numbers in the table with low sharpening values in the above table along with the highest storage capacity for a given size to create an approximate **maximum** of what you should expect. Like automobile mileage, what you get will vary (both from these tables and from the tables Nikon provides in its manuals, which tend to understate average storage capacity a bit). If you want to play it safe, reduce the table numbers by 10%. The numbers in Nikon's manual and that the camera reports both seem low to me.*

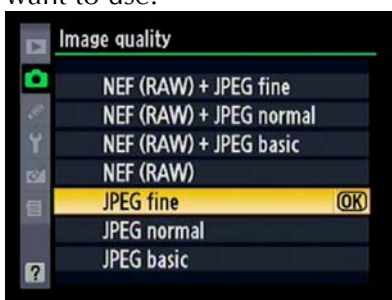
 To set **Image quality** (and **Image size**):

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).
3. Use the Direction pad to navigate to the **Image quality** option. Press the ► key on the Direction pad or

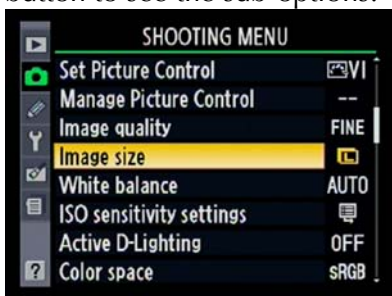
the **OK** button to see the sub-options.



4. Use the Direction pad to navigate to the quality you want to use.



5. Press the **▶** key on the Direction pad or the **OK** button to set the quality. If you've set **NEF (Raw)** (no JPEG file added), you're done and can skip the remaining steps.
6. Use the Direction pad to navigate to the **Image size** option. Press the **▶** key on the Direction pad or the **OK** button to see the sub-options.

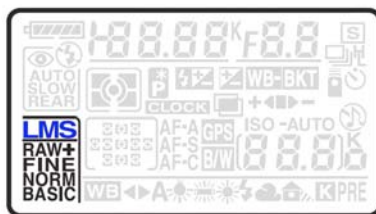


7. Use the Direction pad to navigate to the size you want to use.



8. Press the **►** key on the Direction pad or the **OK** button to select it.

Alternatively, **Image quality** can be set when nothing else appears on the color LCD by holding down the **QUAL** button and rotating the Rear Command dial; **Image size** can be set by holding down the **QUAL** button and rotating the Front Command dial. (Look at the Top LCD to see what you're setting.)



Top LCD:

Blue (Size) controlled by Front Command dial

Black (Quality) controlled by Rear Command dial

Picture Controls

If you're coming from a previous Nikon consumer DSLR you're going to have to learn about Picture Controls, Nikon's new way of dealing with image adjustments, such as contrast, color, and sharpness. These apply to JPEG images, and to NEF images that you convert using Capture NX2 with the default settings.

Most recent Nikon consumer DSLRs have had an **Optimize image** Menu Item, in which sub-controls such as **Tone**

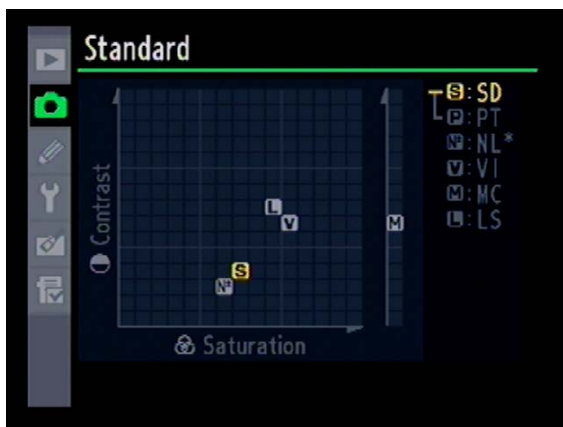
Compensation, Hue Adjustment, Saturation, Color Space, and **Color Mode** lived. Older Nikon DSLRs tended to have these things separated out into separate Menu Items.

The D90, D300, D700, and D3 have a new approach, which Nikon calls Picture Controls. A Picture Control is a set of parameters for telling the EXPEED imaging system (or Capture NX2) how to fine tune the image's appearance. Picture Controls can be saved, shared, and later loaded onto other cameras.

The D90 comes with six predefined Picture Controls: **Standard, Neutral, Vivid, Monochrome, Portrait,** and **Landscape**. The differences among these are in the base color and contrast definitions along with five parameters that can be controlled within each Picture Control: **Sharpening, Contrast, Brightness, Saturation,** and **Hue** (**Monochrome** substitutes **Filter effects** and **Toning** for **Saturation** and **Hue**). Here's how the predefined controls are set:

	Sharpening	Contrast	Brightness	Saturation	Hue
Standard	3	0	0	0	0
Neutral	2	0	0	0	0
Vivid	4	0	0	0	0
Monochrome	3	0	0	Filters Effects Off	Toning Off
Portrait	2	0	0	0	0
Landscape	4	0	0	0	0

Wait a second, you say, is **Sharpening** the only thing that changes? No. The individual parameters are set from a starting point for color definitions and overall contrast that is a bit different for each Picture Control. Pressing the Thumbnail/Zoom Out (⌂) button when you're looking at any Picture Control will show you how they really differ: **Standard** has a little more **Contrast** and **Saturation** than **Neutral**; **Vivid** has a starting position with a lot more **Contrast** and **Saturation** than **Neutral**.



N, S, V, L, and M represent the Nikon-supplied controls (**Portrait** starts out the same as **Standard**). An * by a control marker means the user has changed it. Numbered controls are user-defined controls. You should be able to see I've changed one Nikon-supplied control (**N** for **Neutral**). If you create your own Picture Controls, they'll be marked with numbers.

Any Picture Control that is set to **Auto Contrast** or **Auto Saturation** will appear in green instead of yellow, and have faint lines fanning out from the indicator to indicate how it may move from its indicated position (here's the same thing with **Auto Contrast** added to the **Standard** Picture Control):



Shortly after the D700 appeared (and before the D90 was launched), Nikon's Web site offered a download of **D2XMODE** Picture Controls, that mimic the D2x camera's settings in default settings at the three **Color Modes**. Curiously, Nikon has not decided to offer these additional

Picture Controls to D90 users. Nevertheless, it's worth visiting <http://nikonimglib.com/opc/> every once in a while and see if Nikon has updated the D90 Picture Control base set.

On the companion work that accompanied this *Complete Guide, Introduction to Nikon Software*, you'll also find Picture Controls described in the Capture NX2 section—this new facility obviously is something Nikon is promulgating across all of its digital products (I'm surprised they didn't call it EXPEED Picture Controls).

Obviously, we've got a lot to deal with. Let's start with some definitions:

- **Sharpening**—Sharpening refers to edge contrast techniques that are used to remove the visual impact of the anti-aliasing implicit in digital images (see “Sharpening” on page <396>). We use the **Sharpening** tool to add visual definition to edges in our images. Picture Controls allow you to set this to **A** (automatic), and levels from **0** (no sharpening) to **9** (a lot of sharpening). This is more control than was available with previous Nikon designs.
- **Contrast**—Contrast refers to the range of tonal values in an image and how they're compressed or expanded. A “low contrast” image would have a narrow range of tonal values (narrow histogram) while a “high contrast” image would have a wide range of tonal values (wide histogram, perhaps even exceeding the histogram's width in really high contrast situations). We use the **Contrast** control to try to balance the range of data captured with the available bit values (from 0,0,0 to 255,255,255). Picture Controls allow you to set this to **A** (automatic), and levels from **-3** (less contrast) to **+3** (more contrast).
- **Brightness**—Brightness is a bit of misnomer. You might expect that such a control would simply move all data values upward (to the right on the histogram). What you're actually controlling with this control is the image gamma

(mid-tone adjustment). Picture Controls allow you to set this to levels from **-1** (lower gamma) to **+1** (higher gamma). One thing to note: the D90 is already set to a slightly higher gamma than previous Nikon consumer DSLRs.

- **Saturation**—Saturation refers to what the camera does with individual colors, boosting or reducing the apparent color. We use the **Saturation** control to try to provide visually appealing colors. For instance, for a low contrast, low color scene, you might boost **Saturation** to provide more visual interest. Picture Controls allow you to set this to **A** (automatic), and levels from **-3** (reduced saturation) to **+3** (increased saturation).
- **Hue**—Hue refers to where colors are on the color wheel. Normally, red is red and blue is blue and green is green, but we can push these colors around the color wheel towards other colors (I'll describe that more in the individual section on Hue coming up). We use the **Hue** control to try to push colors towards a different rendering, often to deal with color tainting in the light or subject we're photographing. Picture Controls allow you to set this to levels from **-3** (red towards blue rotation) to **+3** (blue towards red rotation).

I'm going to come back to these individual items in detail with separate sub-sections in a bit, but first we need to deal with Picture Controls in a more general sense.

You can do three basic things with Picture Controls:

- *Choose a Picture Control.* The camera comes with four basic Picture Controls already defined. You can just select one of those and start shooting with it.
- *Modify a Picture Control.* You change one or more of the individual parameters that make up the Picture Control, and you can make "Quick Adjustments" to a Picture Control.
- *Manage your Picture Controls.* Nikon provides a system of naming, saving, loading, or even deleting Picture

Controls. You can define up to nine additional Picture Controls in addition to the four predefined and four (optionally) loaded ones, so managing is an important function. Managing your Picture Controls allows you to use as many as 8 base Picture Controls (by loading new ones from your card) and 8 additional ones (by modifying the base versions), it allows you to share Picture Controls between your D90 cameras (by saving on one and loading on another), and allows you to find the Picture Control of your choice by looking for its name (user assignable).

 To choose a Picture Control:

1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).
3. Use the Direction pad to navigate to **Set Picture Control** and press the **▶** key on the Direction pad to select it.



4. Use the Direction pad to navigate to the Picture Control you wish to use and press the **▶** key on the Direction pad or the **OK** button to select it.



You're now given the opportunity to adjust (modify) the Picture Control (press the **▶** key on the Direction pad *instead* of the **OK** button).

📷 To modify a Picture Control, continue:

5. Use the Direction pad to navigate or change an individual control:



- a. **Quick adjust** (if active) modifies the **Sharpening**, **Contrast**, and **Saturation** controls simultaneously and *resets all manual adjustments* you might have made previously. **Quick adjust** is not available for **Neutral** or **Monochrome** Picture Controls. If you leave the selection (yellow highlight) on **Quick adjust** and press the **◀** and **▶** keys on the Direction pad you'll modify these items simultaneously.
- b. Alternatively, use the Direction pad **▲** and **▼** keys to move the highlight to an individual parameter and then the **◀** and **▶** keys to make the adjustment for that parameter.

- c. If you want to start over on a modification, press the Delete (⌫) button to reset all settings for individual parameters to their 0 or default values.



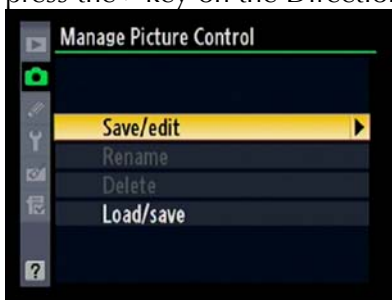
- d. When you've completed your modifications, press the **OK** button to complete your modification.

 To name a Picture Control:

1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).
3. Use the Direction pad to navigate to **Manage Picture Control** and press the **▶** key on the Direction pad to select it.



4. Use the Direction pad to navigate to **Save/edit** and press the ► key on the Direction pad to select it.



5. Use the Direction pad to navigate to the Picture Control you wish to use as the base for your newly named Picture Control and press the ► key on the Direction pad to select it.



6. Use the Direction pad to navigate to settings and change your new Picture Control:



- a. Use the Direction pad ▲ and ▼ keys to move the highlight to an individual parameter and then the ◀ and ▶ keys to make the adjustment for that parameter.

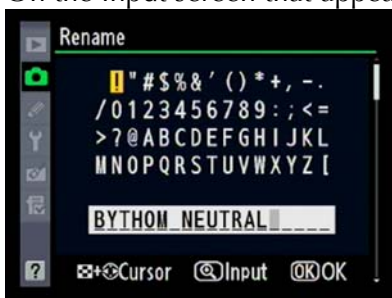
- b. If you want to start over on a modification, press the Delete (⌫) button to reset all settings for individual parameters to their 0 or default values.



- c. When you've completed your modifications, press the **OK** button to complete your modification and move to the next step.
7. Use the Direction pad to navigate to the "slot" you wish to use for your new Picture Control. The camera allows up to nine user-defined Picture Controls, labeled **C1** thru **C9**. Press the **▶** key on the Direction pad to select your chosen slot.



8. On the input screen that appears:



- a. Use the Direction pad to navigate to the next letter you want to *enter* (white letters on gray background).
 - b. Press the Zoom In button (Q) to enter the selected letter (highlighted in yellow at top) into the current position in the bottom box (highlighted slightly with a light gray background at bottom entry position).
 - c. If you need to move the cursor in the bottom box back to fix something, hold down the Thumbnail/Zoom Out button (Q ) and use the Direction pad keys to move it.
 - d. Use the Delete button () to remove the currently highlighted letter (gray highlight) in the bottom box.
 - e. If you have more letters to enter, return to Step 8a, otherwise press the **OK** button to return to the previous menu.
2. The new Picture Control will now appear in the selection list for **Set Picture Control**.

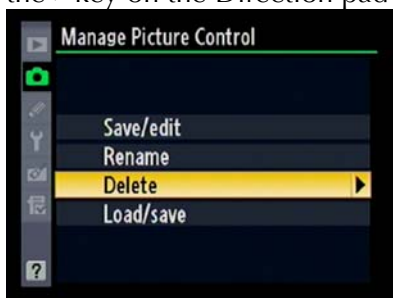
 To delete a Picture Control:

1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).
3. Use the Direction pad to navigate to **Manage Picture Control** and press the ► key on the Direction pad to

select it.



4. Use the Direction pad to navigate to **Delete** and press the ► key on the Direction pad to select it.



5. Use the Direction pad to navigate to the Picture Control you wish to delete and press the ► key on the Direction pad to select it.



6. Use the Direction pad to navigate to **Yes** and press the ► key on the Direction pad or the **OK** button to

select it.



📷 To load a Picture Control:

1. Make sure that the Picture Control (.NCP file depending upon its origin) is in a folder named **CUSTOMPC** in the **NIKON** that's at the root level of the card you put into the D90 or has been saved onto your card by the camera previously (it'll name it and put in the right spot).

NIKON

```
|___CUSTOMPC
    PICCON##.NCP
    PICCON##.NCP
```

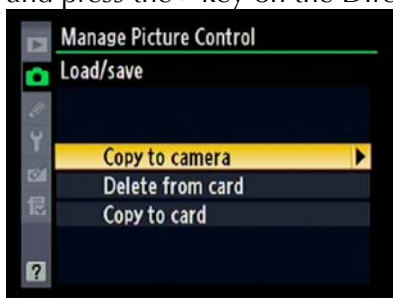
2. Press the **MENU** button to see the menu system.
3. Use the Direction pad to navigate to the **SHOOTING** menu (green camera icon).
4. Use the Direction pad to navigate to **Manage Picture Control** and press the **▶** key on the Direction pad to select it.



5. Use the Direction pad to navigate to **Load/save** and press the ► key on the Direction pad to select it.



6. Use the Direction pad to navigate to **Copy to camera** and press the ► key on the Direction pad to select it.

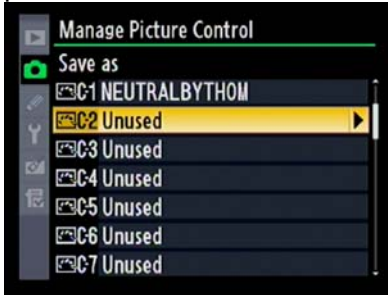


7. The camera looks in a folder at the root level named **NIKON** on the card and displays any **.NOP** files it finds there. Use the Direction pad to navigate to the one you wish to use and press the **OK** button to select it.

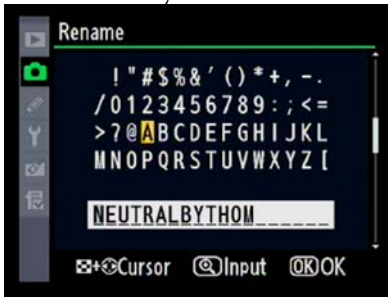


8. Use the Direction pad to navigate to slot you wish to store the Picture Control you specified in Step 7 and

press the **OK** button to continue.



9. You may be prompted to rename the Picture Control, which takes you to rename screen:



📷 To save the Picture Controls you've modified:

1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).
3. Use the Direction pad to navigate to **Manage Picture Control** and press the **▶** key on the Direction pad to select it.



4. Use the Direction pad to navigate to **Load/save** and press the ► key on the Direction pad to select it.



5. Use the Direction pad to navigate to **Copy to card** and press the ► key on the Direction pad to select it.



6. Use the Direction pad to navigate to the Picture Control you've defined that you wish to save and press the ► key on the Direction pad to select it.



7. Use the Direction pad to navigate to the slot you wish to save it in and press the ► key on the Direction pad or the **OK** button to complete the action.



The camera will give a confirmation message that the Picture Control has been saved.

8. Repeat Steps 3 through 7 for every Picture Control you wish to save (up to 99 Picture Controls can be saved on a card). When you're done, you'll find a file named **PICCON##.NCP** in the **CUSTOMPC** folder within the **NIKON** folder on your card, where **#** is the slot you chose in Step 7. To load saved Picture Controls, you use the same technique described above for the Nikon-supplied Picture Controls.



Okay, we've got the maintenance issues for Picture Controls taken care of, it's time to look a little more closely at what they are. Basically, a Picture Control includes information for **Sharpening, Contrast, Brightness, Saturation, and Hue** values to be used in creating JPEG images.

One thing to note about the **Sharpening, Contrast, and Saturation** parameters within a Picture Control: **A** (automatic) has different "personalities" that the camera uses but you can't set directly. The EXPEED image processor determines how to set these controls based upon its

examination of the underlying pixel data. An image low in contrast would be boosted while an image high in contrast would be pulled back. Personally, I find this setting problematic, just as I did in its previous incarnations on earlier Nikon DSLRs: **A** (automatic) settings in Picture Controls have a tendency to produce images without much punch.

Before we get to the individual parameters you can change, let's take a look at how the predefined settings look.

Standard:



Reds are a little orange, greens are a little yellow. Some colors are pushing out of gamut.

Neutral:



Reds are better, greens much better. Colors are not quite out of gamut.

Vivid:



Too much color push. We've lost detail in the brightest whites and reds. And look at the green, red, yellow, magenta, and cyan patches in the third row of the ColorChecker: wrong, a bit wrong, wrong, a bit exaggerated, and really wrong. While many people like saturated color in their final images, taking this color back down in post processing is difficult. It is easier to add saturation and vibrancy than it is to remove it from an image.

Monochrome:



Note how the blues are all going to black. Nikon's choices seem a bit on the contrasty side for me, and favor skin tones. You can generally do a better job using Channel Mixing in Photoshop.

PORTRAIT:



A pleasing rendering, and note the lower contrast and sharpness.

LANDSCAPE:



A punchy result that's a little better than Vivid. But note how it's pushed contrast upwards, forcing the whites to be near blown and taking the dark values downward.

*For people use **Portrait**, for vivid landscapes use **LANDSCAPE**, and for neutral color use **Neutral** as your starting point.*

Note: The latest versions of Adobe ACR and Lightroom support creation of Camera Profiles via the DNG Profile Editor. Adobe has been making Picture Control equivalents for Nikon cameras, though these were not available as I was finishing the eBook. Look for the latest Camera Files download on the Adobe Web site.

For a new D90 user, it's probably okay to select from the Nikon defined settings, though you'll want to make a few minor changes, I think:

	Sharpening	Contrast	Brightness	Saturation	Hue
Standard	5 or 6	Set based on scene	0	0	0
Neutral	5 or 6	Set based on scene	-1 or 0	0	0
Vivid	4	Set based on scene	0	-1	0
Monochrome	5 or 6	Set based on scene	0	Filter Effects set with scene	Toning Off
Landscape	6	-1 usually	-1 or 0	0	0
Portrait	2 or 3	0 or -1	-1 or 0	0	0

Contrast Parameter

By changing **Contrast** in a Picture Control you tell the camera what kind of exposure curve to apply to the sensor data. You may remember a footnote back in the sensor section where I pointed out that a digital sensor is more regular in capturing brightness values than film. The “normal” regularity is a curve that rapidly rises in the dark values but tapers a bit as it reaches the bright values⁹⁵. Tone compensation changes the slopes of that curve, which shows up to our eyes as image contrast.

Choosing a lower number (less contrast) tends to “flatten” and “narrow” the curve (and narrow the resulting histogram), resulting in considerably less overall scene contrast, often at the expense of rich blacks. Choosing a higher number (more contrast) tends to exaggerate the curve (and widen the resulting histogram), producing distinct blacks and whites (which may be blown out) with less subtle gradation in between. **0** is obviously between these two extremes. The **A** (automatic) setting uses the camera’s matrix meter to take a guess at how to set contrast. If it sees large differences in

⁹⁵ Okay, that’s a gross simplification. I wrote a long article in my *Nikon DSLR Report, Issue #5* that describes in gory detail the “normal” way in which brightness values becomes bit values, if you’re so inclined to get beyond the simplification.

brightness values, the camera may think it's dealing with a high contrast scene and *lower* the contrast (think about that statement; it's correct). Likewise, it might do the opposite if there are few or small differences in brightness values across the scene.

The final option, **USER**, appears if you've used Camera Control Pro 2 to create a Custom Curve. This parameter isn't selectable or changeable from the camera. See the *Introduction to Nikon Software* eBook that came with this *Complete Guide* for details on creating Custom Curves.

For JPEG images, you absolutely need to set something, with **0** being the default choice for the predefined Picture Controls.

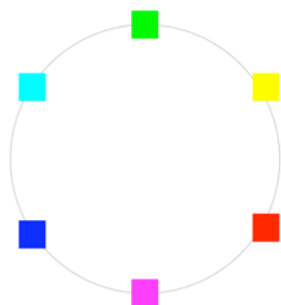
	+3 Contrast. Nikon's given you plenty of rope to hang yourself with. Note how cranking the contrast all the way up results in a vivid presentation.
	-3 Contrast. At the other extreme, you can wash out your image quite a bit, which better holds shadow and highlight detail within the usable bits.

As with anything in digital, adding contrast after the fact to an image is easier than taking it out. Indeed, Nikon provides such a high contrast capability that you might not be able to recover highlight and deep shadow detail in post processing. On the other hand, the low contrast choices provide plenty of

room to move contrast around in post processing. My advice: error on the low contrast side.

Hue Parameter

This control adjusts the relative intensity of the red, green, and blue values recorded for pixels. You can use this control to select increments of $\pm 3^\circ$ in color change, up to a total of $\pm 9^\circ$. (Nikon has now gotten away from using degrees, and simply uses a generic + and – scale. However the increments on that scale still represent about the same Hue adjustment range we’ve had before—each increment is about 3° .) Graphic artists will recognize this as being a deviation value on a standard color wheel (R, G, and B being 120° apart in the wheel). Just as a reminder, the basic orientation of the color wheel looks like this:



Red, green, and blue are each 120° away from each other, as are cyan, yellow, and magenta. Normally you’ll see color wheels drawn as continuous variations (there’s a range of oranges between yellow and red, for example), but I’m showing it this way for a reason I’ll get to in a minute. Grand total, we can move the hue about 18° around the circle using the controls on the D90; that’s about one-third of the way between any of the two colors I show in the wheel, above.

	Hue +3 (+9°). Look closely at the reds. They're redder. Also note the yellows have a bit of green to them.
	Hue -3 (-9°). Now the reds are headed magenta while the yellows are trending orange. The biggest issue is that the blues are going cyanish.

Here's the misnomer about **Hue** and the reason why I showed the color wheel the way I did: minus values don't "warm" while plus values "cool." Some colors may get "warmer" or "cooler," but the color spectrum is a continuous circle, so every color is affected in slightly different ways:

	<i>Hue Minus Values</i>	<i>Hue Plus Values</i>
Red	Adds magenta	Adds yellow
Magenta	Adds blue	Adds red
Blue	Adds cyan	Adds magenta
Cyan	Adds green	Adds blue
Green	Adds yellow	Adds cyan
Yellow	Adds red	Adds green

Thus, a skin tone, which has reds and yellows in it, gets both a red and a magenta boost with a minus **Hue** value, which may not be what you want. On the other hand, a plus **Hue** value might take the skin yellower and greener. Which is the better choice? Well, it depends upon whether reds (plus) or

yellows (minus) dominate the skin tone. And, of course, all the other colors are shifting, as well. In short, be very careful with hue adjustments.

Saturation Parameter

The Picture Controls allow you to control the saturation parameter from **-3** (remove saturation) to **+3** (add saturation)

Saturation is easy to understand if you think about it in terms of CIE Lab Color definitions, where luminance (brightness) is separated from chroma (color) information. If you boost saturation, you don't change the brightness of a pixel, you increase the amount of color in that pixel. Personally, I dislike added or subtracting saturation via Picture Control, as it is difficult to change your mind after the fact and remove your decision via post processing. The more you boost or reduce the saturation, the more difficult it is to correct.

	-3 Saturation Similar to low contrast, taking out color saturation tends to zap an image of its vibrancy. Note that lowering saturation and raising ISO are a bad combination: you'll get muddy, dark colors.
	+3 Saturation At the other extreme, cranking the saturation up results in a cartoonish-like look. Colors get an over exaggerated and false look to them.

Brightness Parameter

The Picture Controls allow you to control the “brightness” parameter from **-1** (darker) to **+1** (brighter).

Brightness is another term for gamma, or mid-tone value generation. A “brighter” image doesn’t mean that the pixel values are all shifted to the right. Instead, it means that the linearity curve is boosted, which has an impact on us perceiving the midtones as brighter. Think of it like applying a gentle Curve in Photoshop. Personally, I already find that the D90’s images have a slight boost to gamma compared to previous Nikons, so I don’t tend to make additional adjustments to this parameter.

	-1 Brightness Lowering the gamma tends to bring mid-tone values down. Look closely at the gray scale patches on the bottom of the ColorChecker chart.
	+1 Brightness Raising the gamma brings those same values up. Now that gray scale ramp is so low in value that the first two values look similar (though black still is black).

Lenses and Focusing

The D90 features the traditional Nikon F mount, and thus can use most lenses made for Nikon 35mm film cameras (see “Lens Compatibility” on page <365> for exceptions).



The white marker on the lens (right facing arrow in the photo) needs to be aligned with the white dot on the camera body (left facing arrow in illustration). Make sure the lens is perpendicular to the body, not at an angle.

📷 One of the first things you need to do is mount a lens on your D90:

1. Turn the D90's power switch to the **OFF** position.
2. Twist the included BF-1A body cap 45 degrees clockwise, and remove it from the camera.
3. Align the mounting mark on the lens⁹⁶ with the mounting mark on the D90 (see figure, above) and then twist the lens counter-clockwise (when facing the front of the body) until it locks in place.

Tip: The lens contacts and other aspects of the Nikon mount are actually quite impervious to damage caused by negligent lens mounting, but the Aperture Activation arm in the camera (black lever inside the left side of the mount as you look from the front) is. Make sure the lens is fully square to the mount and in the right position before twisting into the locked position. Damaging the Aperture Activation arm is usually done by trying to get the lens into the mount too fast and bumping the back of the lens against the arm.

⁹⁶ The “mounting mark” is usually the focus mark on the lens (or the aperture indicator dot on the aperture ring, if the lens has one). However, most recent Nikkor lenses have another handy shortcut: on the lens mount one of the screws is painted black (since you're usually holding the lens so you see the mount, this is useful information). Use the black screw as your alignment point!

4. If you're using an autofocus lens, set the aperture ring (if it has one) on the lens to the smallest aperture (usually f/22, but sometimes f/16 or f/32 or even f/45 on Nikkor lenses) and lock it at that aperture. *Failure to set the aperture ring to the smallest aperture will result in FEE being shown on the top LCD (see "Error Messages" on page <440>).*

If you're using an AI or AI-S lens, you should note that metering will *not* be available (it *is* available on the D200, D300, D700, D2 series, and D3 cameras).

Changing lenses follows the same steps, except that you're removing the mounted lens in Step 2 instead of a body cap (and you have to hold down the lens release button during that step).

*Note: When no lens is mounted, you should **always** protect the sensor from dust by using the BF-1A body cap (see "Keeping the Sensor Clean" on page <654>).*

Note: The body cap for the D90 (BF-1A) is different than the one for earlier, manual focus 35mm film cameras (BF-1) and much different than the cheap plastic cap that comes with the N80 and some other Nikon bodies. Nikon states that the older BF-1 body caps should not be used on the D90. The older body caps (and some generic, third party body caps) don't accommodate the electrical contacts built into the autofocus lens mounts.

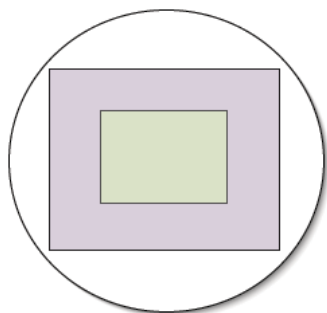
Focal Length Limitations

Because Nikon chose to retain its F mount on the D90, virtually every lens Nikon has made in the past 30 years can be mounted on a D90. But the field of view you see in the viewfinder is different on a D90 than on a 35mm film body.

The D90 crops the field of view by about 1.5x. This means that a 14mm lens mounted on a D90 has about the equivalent field of view as a 21mm lens mounted on a 35mm film or FX digital Nikon body (see the table later in this section).

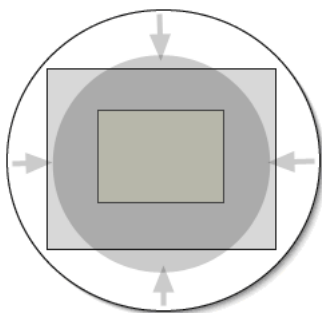
Field of view changes when a Nikon lens is mounted on a D90 because the camera's sensor is physically smaller than the 35mm frame for which it was originally intended. Note that I keep using the term "field of view." The focal length of a lens is absolutely unchanged when you mount a lens on a D90. Indeed, the resulting image on a D90 is no different than if you took a picture with a 35mm or FX body and then cropped it down to the smaller sensor area of the D90⁹⁷.

Note: I've read reports from professionals and editors who should know better that go something like this: "The D90's 1.5x magnification is like getting a 1.4x extender for free, with no aperture penalty." Sorry, but that's not really true. If you mount a 400mm f/2.8 lens on your 35mm body and then crop the resulting image to a ~28mm diagonal section in the middle, you'd get exactly the same image as you get from the D90.



The outer circle is the normal image circle of a 35mm lens. The purple frame is the boundaries of 35mm, the light green is the boundaries of the D90's sensor. The D90 is seeing only a portion of the area the lens covers. With lenses labeled as DX, the image circle is smaller (note the inner circle no longer covers the 35mm frame):

⁹⁷ In an earlier edition of one of my eBooks, someone challenged that assertion in regards to depth of field. But if you use the Zeiss method of depth of field calculations, as most people do, you'd have to change your Circle of Confusion value for the cropped 35mm image to match that of the APS-sized digital sensor. Thus, printed at the same size, they would look the same.



It is important to understand that, because of the small sensor size, the D90 only uses the innermost portion of the image resolved by most lenses. When you read lens tests in magazines or on the Internet, some criticisms of lenses may not apply when that lens is used on a D90⁹⁸.

For example, most wide angle lenses have light falloff in the corners when used wide open (at their widest aperture). Because the D90's sensor never sees those corners, light falloff may not be an issue for such lenses mounted on a D90. A good case in point is the Nikkor 18-35mm f/3.5-4.5D ED lens. On a 35mm body with the lens zoomed to 18mm and the aperture set to f/3.5, very visible falloff can be seen in the corners of the image, perhaps more than a half stop at the extremes. When that same lens is mounted on a D90, the falloff mostly disappears because the D90 doesn't see that image area! Still, there's perhaps a fifth of a stop falloff at the settings just cited—lower than you'd see on a 35mm body, but still present.

The 18-105mm f/3.5-5.6G DX lens included with the D90 "kit" uses a smaller image circle than earlier 35mm lenses (it barely covers the smaller digital sensor size), so at 18mm and the aperture set to f/3.5, it *does* show visible falloff when you

⁹⁸ Chromatic aberration and light falloff, for example, increase with distance from the center, and the D90 doesn't use the far edges of the image circle of regular 35mm lenses. However, note that DX lenses have an image circle smaller than the 35mm frame and may exhibit edge characteristics.

use it on the D90. Ditto for the 18-200mm f/3.5-5.6G DX lens and virtually all other Nikkor lenses marked DX.

However, the 12-24mm f/4G DX and 17-55mm f/2.8G DX are somewhere between a 35mm lens and the 18-105mm and other consumer DX lenses: these two lenses have an image circle that covers the 35mm frame at some (but not all) focal lengths. In general, the 12-24mm and 17-55mm lenses show slightly fewer edge problems on a D90 than the 17-35mm f/2.8D shows on a full frame 35mm or FX digital body.

Likewise, uncorrected chromatic aberration or lack of flat field focus capability may cause a lens to slightly soften the corners of images when mounted on a 35mm camera. But these issues are likely not as visible when using the D90. To my eye, there is no discernable difference in optical quality between the expensive Nikkor 17-35mm f/2.8D AF-S and the inexpensive Nikkor 18-35mm f/3.5-4.5D, at least when mounted on a D90. But there is when used on a 35mm body (though mostly in the corners).

Note: If you use your lenses on both a 35mm/FX body and the D90, you still must pay close attention to corner issues. While the Nikkor 18-35mm f/3.5-4.5D ED is all a D90 user needs in the way of quality, I find the Nikkor 17-35mm f/2.8D AF-S far better when used on my F6 or D3. When I shoot 35mm film—especially with wide angle lenses—I usually choose the more expensive lens.

Overall, here are the key differences between using a lens on a 35mm/FX film body and the D90 (which is DX):

Lens Differences When Using 35mm/FX versus DX

<i>Item</i>	<i>35mm or FX</i>	<i>DX</i>
Light Falloff	Can be significant in corners	Generally insignificant
Sharpness in corners	Often slightly soft	Almost as sharp as central area
Colors in corners	Often slightly muted, chromatic aberration can be an issue	Edge matches center, little if any chromatic aberration
Angle of view	As published	Altered (see chart, below)
Linear distortion*	Sometimes visibly significant	Reduced visibility
Vignetting w/ Filters	Sometimes significant	Not likely
<i>*E.g. barrel distortion (typical of wide angle lenses) or pincushion distortion (typical of telephoto lenses)</i>		

Items such as overall contrast, susceptibility to flare, center sharpness, and overall coloration are virtually identical for both 35mm and D90 use of a lens.

The following table illustrates the angle of view difference for each of the common Nikon focal lengths.

Note: The Lens Angle of View table (below) is slightly different from the ones in Nikon's manuals, as it is derived from precise calculations involving image size and not the generic and 1.5x DX factor Nikon uses (actually slightly more accurate than that, as I use the actual sizes for the calculations).

Lens Angle of View

<i>focal length</i>	<i>35mm & FX Horz Angle</i>	<i>35mm & FX Vert Angle</i>	<i>35mm & FX Diag Angle</i>	<i>DX Horz Angle</i>	<i>DX Vert Angle</i>	<i>DX Diag Angle</i>	<i>DX equiv focal length</i>
14mm	104°	81°	114°	80°	59°	91°	21mm
15mm	100	77	110	76	56	87	23mm
17mm	93	70	103	70	50	80	26mm
18mm	90	67	100	66	47	77	27mm
20mm	84	62	94	61	43	71	30mm
24mm	74	53	84	52	36	61	36mm
28mm	65	46	75	46	31	54	43mm
35mm	54	38	63	37	25	44	53mm
50mm	40	27	47	27	18	32	76mm
60mm	33	23	40	22	15	27	91mm
70mm	29	19	34	19	13	23	106mm
85mm	24	16	29	16	11	19	129mm
105mm	19	13	23	13	9	15	160mm
135mm	15	10	18	10	7	12	205mm
180mm	11	8	14	7.5	5	9	274mm
200mm	10	7	12	6.75	4.52	8.12	304mm
300mm	6.86	4.56	8.23	4.5	3.01	5.42	456mm
400mm	5.15	3.42	6.18	3.37	2.26	4.06	608mm
500mm	4.12	2.73	4.94	2.7	1.81	3.25	760mm
600mm	3.43	2.28	4.12	2.25	1.5	2.71	912mm
800mm	2.57	1.71	3.09	1.69	1.13	2.03	1218mm

All angles of view are expressed in degrees. Values for lenses shorter than 300 have been rounded to the nearest digit. Focal length equivalents have been rounded to the nearest digit.

35mm/FX Frame Size: width=24mm, length=36mm, diagonal=43.2mm

DX/D90 Frame Size: width=15.8mm, length=23.6mm, diagonal=28.4mm

This “field of view magnification” poses both positive and negative issues for the D90 user:

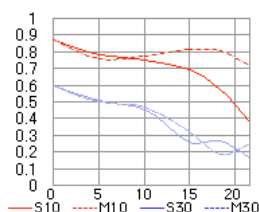
- *Lack of Wide Angle Ability*—physical constraints make it difficult to build 35mm film lenses wider than 14mm without introducing significant barrel distortion and other problems. Indeed, to do so even at 14mm is difficult, and involves costly aspherical lens elements to correct chromatic aberration (where colors focus at different points, a problem especially evident in corners of

uncorrected wide angle lenses). Thus, using a lens originally intended for 35mm on a D90 limits you to an angle of view of only about 80° across the frame, while 35mm film users can easily obtain lenses that go as wide as 104°.

Fortunately, Nikon started building DX lenses, restoring our wide angle abilities (at the cost of buying new lenses).

- *Longer reach*—Wildlife photographers in particular are well known for sticking one or more teleconverters on already long lenses to “pull in” the animal (I’ve watched several mount both a 1.4x and 2.0x converter on a 500mm lens, resulting in an unwieldy and slow [f/11] 1400mm lens). Using a teleconverter not only makes the effective aperture of a lens one or two stops smaller than normal, but it also tends to decrease overall image contrast and quality, especially in the corners. While the smaller imaging area isn’t the same as having a teleconverter, from a functional standpoint it’s a built-in crop that many 35mm photographers had to do any way.

■ Ai AF Nikkor 50mm F1.8D



Let's look at one of Nikon's published MTF⁹⁹ tables to see why the 1.5x change of view is important. First things first: the vertical axis is an indication of contrast on a high frequency test chart (red being a frequency of 10 lines per millimeter and blue being a more demanding 30 lines per mm). The solid and dotted lines indicate differences in the orientation of the line pairs being measured (sagittal and meridional orientations, thus the S and M in the legend). The higher a point is on the vertical axis, the better the “resolving power.”

The horizontal axis of the chart shows the distance from the center of the image area

⁹⁹Modulation Transfer Function. That's the name for a fancy test that measures the ability to resolve small alternations of black and white high-contrast lines (i.e. a test chart).

	<i>in millimeters. The charts show the full distance to the edges of a 35mm film or digital FX camera—for the D90 we need only go to about 12 or 13 on the horizontal axis, as the smaller sensor means we don't get as far from the center.</i> <i>Note that the lens being tested holds 30 lpm MTF values to about 0.5 up through 10mm from center. A value of 0.5 would certainly be considered "acceptable." But look what happens on the full 35mm frame at 20mm from the center (the 35mm frame edge): we're at 0.2, which would be considered a poor showing. In other words, the corners of the image using this lens on a D90 would look better than the corners using this lens on a film body.</i>
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Lens Compatibility

All D-type and G-type, AF-I, and AF-S lenses are fully compatible with the D90 and have unlimited use of any of the camera's features. Most third party autofocus lenses currently being made also tend to fall into this category¹⁰⁰.

Other lens types, and a few specific lenses, either limit the features that can be used on the camera or should not be used at all:

Non-D and Non-G type AF lenses

- 3D matrix metering is not performed (i.e. distance information isn't used in the meter's decision).
- Dust reference photos can't be taken.

¹⁰⁰ Most third party lens makers have to reverse engineer Nikon's communication between lens and camera. I've seen plenty of small anomalies occur because of this. For example, the very nice Tamron 18-50mm f/2.8 lens doesn't supply the correct distance information to the camera when flash is used, so flash exposures tend to be a bit off.

AI-P lenses

- Autofocus is unavailable and the focus confirmation in the viewfinder only works with lenses with maximum apertures of f/5.6 or larger.
- 3D matrix metering is not performed (i.e. distance information isn't used in the meter's decision).

AI and AI-S Nikkors, lenses converted to AI

- Autofocus is unavailable and the focus confirmation in the viewfinder only works with lenses with maximum apertures of f/5.6 or larger.
- Metering system is inactive.
- Some reflex (mirror) telephoto lenses may not show focus confirmation in the viewfinder; apertures must be set on the lens.

	<i>Auto-focus</i>	<i>Unavailable Exposure Modes</i>	<i>Metering Limitations</i>	<i>Other Limitations</i>
D-type	Yes	None	None	None
G-type	Yes	None	None	Apertures can't be set on lens
Autofocus Non-D, Non-G	Yes	None	Matrix metering isn't 3D	No 11-pt 3D autofocus
AI-P	No	None	Matrix metering isn't 3D	None
AI and AI-S, converted to AI	No	All except Manual	Metering isn't available	Some slow lenses may not show focus confirmation.
AI lens converted to CPU*	No	None	Matrix metering isn't 3D	Flash focal length may be off. No 11-pt 3D autofocus
Special case: PC Micro Nikkor 85mm f/2.8D	No	Program, Aperture-priority, and Shutter-priority	Metering may be off if lens is shifted or not at f/2.8	None

*See "Questions and Answers" on page <on page 761>

In addition, several broad caveats apply when using certain types of lenses or accessories:

- *PC Nikkor*—exposure reading must be taken and set (locked) with the lens in a non-shifted position.
- *Teleconverters*—the effective aperture must be f/5.6 or faster for autofocus and viewfinder focus confirmation to work. AF-I type converters otherwise have the same compatibility as AF-I type lenses (i.e. full), while older AI type converters have the same compatibility as AI type lenses (i.e. limited).
- *Bellows and extension tubes*—have the same compatibility as AI type lenses, and the effective aperture must be f/5.6 or faster for viewfinder focus confirmation to work.

Finally, some individual lenses have additional limitations:

- *TC-16S AF Teleconverter* is incompatible and shouldn't be used.
- *Non-AI lenses are incompatible*, may cause damage to the camera, and shouldn't be used (note that most non-AI lenses can be converted to AI).
- *Lenses that require the AU-1 focusing unit* (e.g. the Nikkor 400mm f/4.5, Nikkor 600mm f/5.6, Nikkor 800mm f/8, and the Nikkor 1200mm f/11) are incompatible and shouldn't be used.
- *Fisheye lenses whose rear element sticks into the mirror box and that require mirror lockup* (e.g. the Nikkor 6mm f/5.6, Nikkor 8mm f/8, and Nikkor 10mm f/5.6 OP) are incompatible and shouldn't be used.
- *Nikkor 21mm f/4 lenses* are incompatible and shouldn't be used. (Nikon's note in the manual implies that a later version of this lens might be compatible, but this lens has a rear element that sticks into the mirror box.)
- The K2 rings are incompatible and shouldn't be used.
- *Nikkor ED 180–600mm f/8* with serial numbers 174041 to 174180 are incompatible and shouldn't be used.

- *Nikkor ED 360–1200mm f/8* with serial numbers 174031 to 174127 are incompatible and shouldn't be used.
- *Nikkor 200–600mm f/9.5* with serial numbers 280001 to 300490 are incompatible and shouldn't be used.
- *Lenses for the F3AF* (e.g. the Nikkor 80mm f/2.8, Nikkor 200mm f/3.5, and TC-16 Teleconverter) are incompatible and shouldn't be used.
- *PC Nikkor 28mm f/4* with serial numbers of 180900 or earlier are incompatible and shouldn't be used.
- *PC Nikkor 35mm film f/2.8* with serial numbers 851001 to 906200 are incompatible and shouldn't be used.
- *PC Nikkor 35mm film f/3.5* is incompatible and shouldn't be used. (Note: Nikon's manual implies that a newer version of this lens can be used, but Nikon only made one version of this lens! Perhaps they were referring to the later f/2.8 version.)
- *Old style Nikkor 1000mm f/6.3 Reflex* is incompatible and shouldn't be used. (This apparently refers to the version that was intended for rangefinder cameras, which have a different lens mount.)
- *Nikkor 1000mm f/11 Reflex* with serial numbers 142361 to 143000 is incompatible and shouldn't be used.
- *Nikkor 2000mm f/11 Reflex* with serial numbers 200111 to 200310 is incompatible and shouldn't be used.

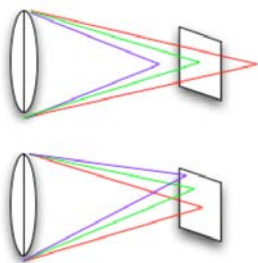
Finally, note that if you use the MB-D80, you may need to use a short extension tube to use bellows or other accessories that stick far down below where lenses normally do.

Chromatic Aberration Correction

When you shoot JPEG images with the D90 the EXPEED image processing system automatically removes lateral chromatic aberrations.

A chromatic aberration is the result of different wavelengths of light focusing at different points after going through a lens. These show up in images as color fringes, and are especially

noticeable at high contrast edges. Two types of chromatic aberrations exist: longitudinal and lateral (sometimes called transverse). Longitudinal aberrations are those where wavelengths focus at different depths relative to the focal plane, while lateral aberrations are those fringes that occur across the focal plane.



Top is longitudinal, bottom is lateral

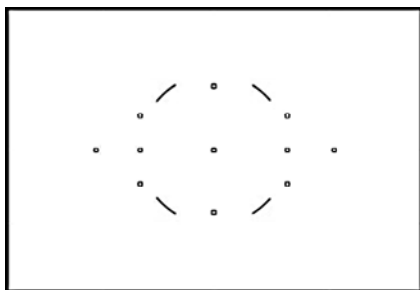
Specifically, lateral chromatic aberration usually shows up as a blue/purple fringing on one side of edges and a red/green on the other.

There's nothing you have to do to enable lateral chromatic aberration correction on the D90; it's done automatically when you shoot JPEG images. If you use Capture NX2 for NEF conversion, it, too, can do lateral chromatic aberration, though in that program you can turn that correction on and off. Longitudinal chromatic aberration is not corrected by the camera or Capture NX2.

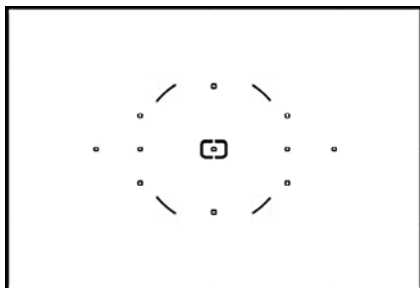
The Autofocus System

The D90 uses the same autofocus system as the D80 and D200, but with some new tricks. While arguably state-of-the-art, Nikon's documentation of the autofocus system is not up to the same standard.

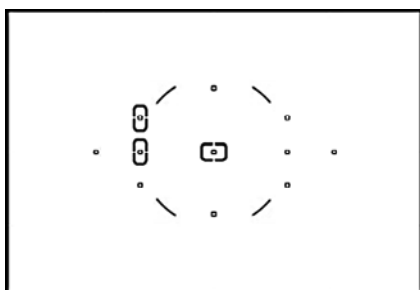
Autofocus is achieved using eleven small contrast sensors (actually, seven physical locations, of which a few are split into the ones you see in the viewfinder). The approximate positions of these sensors always appear in the viewfinder as small boxes:



With some autofocus settings—Single Point and Dynamic Area (see “Autofocus Area Modes” on page <380>)—the camera shows one autofocus sensor by putting a bold box around a sensor position; you control which sensor is boxed via the Direction pad on the back of the camera:

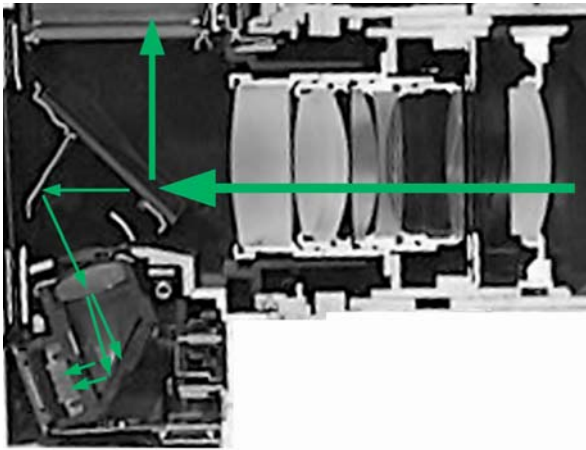


In some autofocus setting combinations, one or more sensors *automatically* get a bold boxes around the sensor positions, indicating the combination of sensors that were used to find focus:



If the “beep” function is set (Custom Setting #D1) a short beep is also sounded when focus is achieved.

The actual part that contains the autofocus sensors—called the CAM1000 is positioned at the bottom of the camera facing up towards the secondary mirror. The primary mirror is partially silvered in the middle, allowing a bit of light to get through to the secondary mirror, which then diverts that light downward into the autofocus sensors via yet another mirror (light is green arrows in cutaway view of camera, below).



How the autofocus sensors work is a bit difficult to describe, as both the physical implementation and the theoretical methodology used get quite intricate and complex. The simple explanation is that the light coming off the secondary mirror goes through what is known as a “separator” lens just above the actual autofocus sensors. This splits the light into two distinct “images” and the line sensors underneath measure the distance between the two images. Called *phase detection*, if the focus is in front of your subject, the image lines will be closer together than expected; while if the focus is behind the subject, the lines will be further apart than expected.

The camera’s electronics look at the two image locations reported by the autofocus sensor(s) being used and instruct

the lens to move depending upon whether the lines are too close together or too far apart. In AF-S lenses, there is a motor in the lens that does the focusing; in all other Nikkor autofocus lenses the camera drives the focusing cam of the lens with a small screwdriver-like extension that sticks out of the lens mount (and is slower and less predictable in terms of speed due to different inertial loads in the lens).

A phase detection autofocus system has the benefit of being fast and direct. Once a calculation of how much “off” the two split images is made, the camera has precise knowledge of how far to instruct the lens to move and in which direction. That’s why, when there’s enough underlying contrast in the subject to produce data that can be interpreted, the Nikon autofocus system almost never “hunts” for the actual focus point.

The drawback of all autofocus systems is that they have some level of focus tolerance and susceptibility to small differences in lenses.

Let’s discuss focus tolerance first. With subjects at midrange distances with decent contrast, focus tolerance errors tend to be insignificant—the difference between focusing at 12.10 and 12.12 feet is almost never perceptible in an image, even with moderate telephoto lenses.

Where the focus tolerance can become a factor is with very long telephoto lenses or with very close subjects (macro and near macro ranges), especially when using large maximum apertures. Even small misses in focus precision can result in slightly unsharp images at the extremes. But all the really long Nikkor lenses have focus override ability, and most macro shooters use focusing rails and manual focus for their work, so this shouldn’t be a big issue.

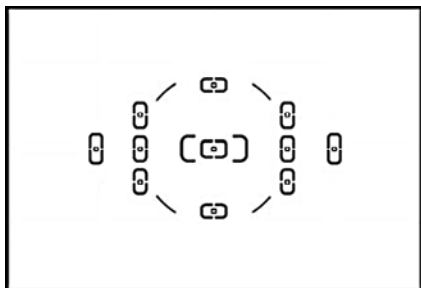
The other problem with getting precision in focusing is that even a small variation in the lens itself (and its internal motor, if it has one) can throw the system off. It’s not unusual to have

extremely small focus variations between two lenses of the same type when used on a single camera.

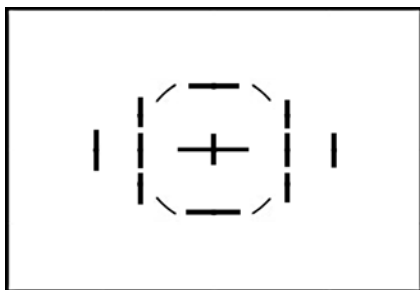
Unlike the professional Nikon DSLRs, the D90 doesn't have a method of being tuned for small focus variations. If you have lenses that consistently focus ahead of or behind the focus point you selected, they (or the camera) may need adjustment. Fortunately, such errors are rare.

We're still not quite done with the technical bits. One long-standing issue that many Nikon users don't understand or fully appreciate has to do with the size, shape, and detection axes of autofocus sensors.

First, despite the markings in the viewfinder, the actual position and shape of the autofocus sensors is different. The *shape* of the autofocus sensor markings in the viewfinder, for example, is a little deceptive. First, there are two types of autofocus detectors in the CAM1000: the center sensor is crossed, while all the other sensors are line sensors. Here's what the viewfinder shows for the shape and locations of the sensors:



And here's what the actual size and shape of the sensors is more like:



Notice that the outer sensors are lines, while the central one is a cross. This means that, when the camera is held in the normal horizontal orientation, objects off center generally need vertical detail in order for the autofocus sensors to function best.

One thing that intersects with sensor shape and size is subject size. One of the classic issues with wide angle lenses and autofocus systems is that very small objects you're trying to focus on—they're small because the wide angle lens has such a wide area of view—sometimes don't occupy enough of an individual autofocus sensor for the camera to make a determination of where focus should be.

Indeed, this is something you need to watch for in general: if what you're focusing on is visually smaller than the autofocus sensor that's going to be used, it probably needs to cover more than half of the sensor for the sensor to detect properly.

One final comment about the new system before we drop into the various modes and methods you have available: there can be a very brief lag before the autofocus system engages the first time. If you let go of the shutter release and again half-press it, you can re-encounter that lag. If you keep the shutter release part-way engaged and do something else that triggers a refocus (perhaps because you're in Continuous Servo AF), there will never be a lag.



*The Nintendo-like Direction pad on the back of the D90 is used to select autofocus sensors and to navigate the camera's menus. If the Direction pad doesn't seem to be functioning correctly, move the lever just below the pad to make sure that it isn't in the **L** (lock) position. In the illustration, it's in the unlocked position (dot).*

The autofocus sensor used in the D90 is called the CAM1000 by Nikon.

The D80 and the D200 were the first cameras to use the CAM1000 sensor, the D90 is only the third camera to use it. Here's the sensors used by Nikon so far:

<i>Sensor</i>	<i>Cameras</i>
CAM530	D40, D40x, D60
CAM 900	N65, N75, N80, D50, D70, D70s, D100
CAM 1000	D80, D90, D200
CAM 1300	F100, F5, D1 series
CAM 2000	D2 series
CAM 3500 (DX/FX)	D300, D700, D3
<i>The numbers in the AF part number indicate how much autofocusing sensor area there is overall. The D90, therefore, has about twice the overall focus sensing area than the D60, and half that of the D2 series.</i>	

Obviously, we've got a lot to understand; the D90's autofocus system is quite complex, and so far we've only touched on the technical side. Besides the physical part and its characteristics, you need to understand the software side of things—how the firmware interacts with the hardware to control where and how focus is achieved.

Focus Type: Autofocus and Manual Focus

You set the type of focusing you want the camera to use by moving the Focus Mode lever on the front of the camera to:



AF *Autofocus*—when you press or partially press the shutter release the camera will attempt to focus the lens (assuming it’s an autofocus lens, of course).

M *Manual focus*—the camera never attempts to focus the lens, even for autofocus lenses. You must use the focus ring on the lens to focus.

One confusing aspect is that many lenses also have a switch for these settings (labeled, even more confusingly: **A** and **M**, or **M/A**¹⁰¹ and **M**). Here’s what the switch looks like on the 18-105mm kit lens:



If **either** the camera or lens is set to **M**, you’ll be manual focusing. The good news is that the viewfinder always

¹⁰¹ This dual notation—M/A—is to remind you that with this type of lens (AF-S) you can manually override the focus at any time (with other lenses it’s an either/or situation).

indicates the focus status—even in manual focus mode—when you press the shutter release (or hold it halfway down):

- The subject is in focus

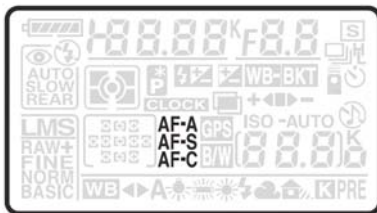
If this indicator does not appear, the subject under the selected autofocus sensor is not in focus. If this indicator is blinking, the camera cannot lock onto focus of the subject under the selected autofocus sensor.

Focus Mode: Single Servo, Continuous Servo, and Auto Select

On the top right side of the camera is another button, labeled **AF**. If the camera isn't set to manual focus, this button controls the Focus mode the camera uses. A Focus mode controls the manner in which the camera attempts to find and track a subject.

Each press of the **AF** button moves you to the next Focus mode option (with the last one returning you to the first). (You can also hold down the button and turn the Rear Command dial to change options.) You have three options:

- AF-A** Auto select (the default setting)
- AF-S** Single Servo AF
- AF-C** Continuous Servo AF



Top LCD:

Let's take a close look at the differences between these three Focus modes (I'm going to address them out of order for a reason that'll become more clear when we get to the last one):

- **AF-S** *Single Servo AF*

The camera finds focus once and locks on that as long as the shutter release is held partway. A picture is never taken unless focus is achieved. Put another way, when you fully press the shutter release the actual shutter opening is delayed until focus is achieved. The camera assumes that the subject is not moving. In low-light or low contrast conditions where the camera has a hard time detecting focus, there may be a lag between pressing the shutter release and the taking of the picture. In practice, the D90's autofocus sensors are so good that such lag rarely happens. About the only time I've seen it is in low light situations where there is also very little contrast.

- **AF-C** *Continuous Servo AF*

The camera looks for focus the moment the shutter release reaches the halfway point and continues to monitor focus as long as the shutter release is held partway. If a subject starts to *move after focus was established*, focus still follows the subject. However, a picture is always taken immediately when the shutter release is fully pressed, *even if focus hasn't yet been achieved*. That doesn't necessarily mean that the image will be out of focus, though. Remember, the camera has a calculation of where the focus point is and has instructed the lens to get there. Due to the brief delay in the time between pressing the shutter release and the opening of the shutter, the lens may have finally gotten to the right spot during that time. Indeed, for the fast focusing AF-S lenses, that's often the case.

- **AF-A** *Auto Select AF*

The camera chooses whether to use Single Servo or Continuous Servo. Basically, the camera starts in Single Servo Focus mode. But if it thinks the subject is moving, it *might* switch to a variant of Continuous Servo Focus mode.

It's very important to note the primary difference between the Single Servo and Continuous Servo Focus modes. Nikon calls the Single Servo Focus mode "focus priority" for a reason—an

image is not taken until the camera achieves focus. If the conditions are such that the camera can't manage to find focus—as sometimes happens with fast moving off-center subjects in low light—you won't be able to take a picture.

Continuous Servo Focus Mode is called “release priority” by Nikon, meaning that the picture is taken immediately after fully pressing the shutter release, regardless of whether or not focus has yet been achieved. That doesn't mean the resulting picture is out of focus, however. As I've already noted, usually the camera has enough time to move the focus point on the lens. Sometimes depth of field is enough to cover any focus error. And sometimes you just get lucky. But under release priority, there's no *guarantee* that you'll get an in-focus image if you didn't first press the shutter release partway and hold it there long enough for the camera to establish a focus point.

Auto Select Focus mode tries to bridge the differences between the two modes by automatically detecting whether a subject is moving or not. However, even if it is tracking motion like Continuous Servo focus always gets priority (i.e. no picture is taken unless focus is achieved).

I sometimes mockingly refer to Single Servo AF as the Shutter Frustration mode and Continuous Servo AF as the Focus Frustration mode. That's because until you learn how the Nikon AF system works and can anticipate and avoid the things that keep it from achieving focus, you'll be frustrated that the shutter release never quite works in a timely fashion if you're in one autofocus mode and you never quite get in-focus pictures when you're in the other. If you always shoot in bright light, you might never encounter those problems, but I strongly suggest to every Nikon newcomer that they actually practice focusing in a variety of conditions with the various camera settings.

Autofocus Area Modes

The D90 also has four Autofocus Area modes, which determine how the eleven individual autofocus sensors are used.

The Autofocus Area mode is set by with Custom Setting #A1 (see “Autofocus Area Modes” on page <486>). Your choices are:

- ☐ *Single Point AF*—the camera uses only the currently selected autofocus sensor for focusing. You control which sensor is used to focus by pressing the keys of the Direction pad on the back of the camera (when the meter is active). The active sensor is highlighted to indicate that you’ve chosen it. (The Macro Scene exposure mode sets this focus method.)
- ☐ *Dynamic Area AF*—the camera starts by focusing on the subject under the currently selected autofocus sensor, but may move to use another sensor if it detects that the subject is moving (for AF-A and AF-C Focus modes). You control which sensor the camera *starts* focusing with by pressing the keys of the Direction pad on the back of the camera (when the meter is active). Again, the active, starting sensor is highlighted to indicate that you’ve chosen it. (The Sports Scene exposure mode sets this focus method.)
- *Auto Area AF*—the camera focuses using the sensor that detects the “subject”; you get no choice in which autofocus sensor will be used for focusing. The D90 will show you which sensor (or sensors) is used for focus by highlighting it. If you’re using a G-type or D-type lens, the camera also uses the color information in the metering system and distance information to help it figure out human subjects in front of a background. (Auto, No Flash, Portrait, Landscape, and Night Portrait Scene exposure modes set this focus method.)
- [3D] *3D-tracking (11-point)*—similar to Dynamic Area AF. You select a starting point, and the camera uses all the

resources it has (both autofocus and metering sensors) to try to track the subject for AF-A and AF-C Focus modes. Nikon claims this method is particularly useful for focus-and-recompose, though they have some confusing language in their description of it. 3D-tracking really only works if the subject you initially focus on *stays* in the frame when you recompose or the subject moves. If you recompose with the focused subject out of view, or if the subject that was focused on moves out of view, focus won't be tracked correctly.

If you're using Program, Aperture-priority, Shutter-priority, or Manual exposure modes, the Autofocus Area mode is set using Custom Setting #A1 (see page <486>). If you use any of the Scene exposure modes, the Autofocus Area mode is set automatically by the camera (as indicated in the descriptions, above).

 The autofocus sensor that is used as the initial focus point (except for Auto Area AF) is set by:

1. Moving the Focus Area Selector Lock lever to the unlocked position (lever up to the dot position).
2. Making sure the camera is active (pressing the shutter release partway and releasing it if the camera isn't active).
3. Pressing the keys (edges) on the Autofocus Direction pad to change sensors (by default, the directions don't wrap around, so pressing left continuously just takes you to the left sensor and stops (see "Custom Setting #A5, Focus Area Selection Wrap" on page <491>).

Autofocus Summary

Yes, the autofocus system used in the D90 is quite complex and a bit difficult to understand at first. Here's a table that summarizes the key options:

Autofocus Settings Summary

<i>Focus Mode</i>	<i>AF Area Mode</i>	<i>Initial Area Selected by</i>	<i>Final Area Selected by</i>	<i>Final Area Shown?</i>
AF-S	Single Point	User	User	Yes
AF-S	Dynamic Area	User	Camera	No
AF-S	Auto Area	Camera	Camera	Yes
AF-C	Single Point	User	User	Yes
AF-C	Dynamic Area	User	Camera	No
AF-C	Auto Area	Camera	Camera	Yes
AF-C	3D-tracking	User	Camera	No
AF-A	Single Point	User	User	Yes
AF-A	Dynamic Area	User	Camera	No
AF-A	Auto Area	Camera	Camera	Yes
AF-A	3D-tracking	User	Camera	No

The big problem most first time D90 users have is that this is a very different system from previous and other current Nikon cameras, and it doesn't always give you feedback as to what it is doing. In particular, I see these aspects causing the most confusion:

- *Single Point AF no longer uses predictive focus.* A subject in motion when AF is first detected is not tracked on a D90, where it was on many previous Nikon models with the equivalent Single Area AF setting.
- *Closest Subject Priority (CSP) is gone.* As much as I've harped on negative aspects of CSP in previous bodies, there certainly were times when it was useful. The D90 has no method in which you can force it to focus on the nearest object or nearest object in a group of sensors. If you were using those facilities on your previous camera, you'll need to find a new method.
- *The camera doesn't always tell you which autofocus sensor was used.* See the summary chart, above. In most modes the camera does tell you which area was used for focus, but in Dynamic Area and 3D-tracking the camera may move the focus from the highlighted sensor. Over

time you'll learn to trust the camera. You can also use Nikon ViewNX to see where the camera chose to focus after the fact.

There's good news, too:

- *Focusing is integrated with metering.* The reason why Auto Area is so good at recognizing people in a frame has to do with the integration with the metering sensor, which provides the color information that tells the autofocus system where skin tones occur in the frame.

The big problem most first time D90 users have is that the Scene exposure modes also select autofocus settings. This news is sort of buried in the manual ("At default settings, the focus area is selected automatically in..."). You sometimes need to change the Autofocus Area mode after you've switched to one of the Scene exposure modes. Beyond that, there's the issue of confusing terminology: there's AF-A (auto) for Focus mode, and Auto-area for AF Area mode. Auto, auto, auto. There auto be a law against using the words "auto" and "mode" over and over again (let alone having "AF-S" stand for two different things).

Let's try to put this all in a simpler perspective. You really only have to set two things:

- You control whether a subject is followed and whether the camera releases the shutter before achieving focus by setting the Focus mode (with the button on the top right of the camera). If focus is your priority over shot timing, use Single Servo (**AF-S**) or consider Auto Servo (**AF-A**). If shot timing is your priority over precise focus, use Continuous Servo (**AF-C**) or consider Auto Servo (**AF-A**).
- You control which sensor is being used to focus by setting Custom Setting #A1. If you want full control, choose **Single point**. If you want the camera to follow subjects but start with your selected sensor, choose **Dynamic area**

or **3D-tracking**. If you want the camera to make all the sensor choices, select **Auto-area AF**.

- Just remember that choosing a Scene exposure mode can sometimes override your choices.

You'll note in the simplifications I just made, there still is a bit of overlap: as in use **AF-C** or **AF-A**. Or use **Dynamic area** or **3D-tracking**. In both these pairings, the first option puts you more in control, the second let's the camera make more of the decision. Thus, if I were to categorize focus settings from least control to most, the list would go something like this:

Least control	AF-A with 3D-tracking or Auto-area
^	AF-C or AF-S with 3D-tracking or Auto-area
	AF-A with Dynamic area
	AF-A with Single point
v	AF-C or AF-S with Dynamic area
Most control	AF-C or AF-S with Single point

That's not a perfect list, but in general if you find that your current setting combination doesn't give you enough control, find it on that list and try the next variant below it.

Autofocus Assist

The D90 has the dreaded built-in Autofocus Assist lamp that all the Nikon consumer cameras feature, which, in theory, is there to help the camera focus in low light situations. Unfortunately, it's generally more hassle than it's worth:

- *The location is poorly chosen.* If your hand doesn't block the light, the lens usually does the job. The D90 manual lists a number of lenses that block the sensor for distances shorter than 3' (1m), but in practice I've found that optimistic; more lenses block the sensor than Nikon claims, and if you use lens hoods the situation is worse.
- *Some lenses turn it off!* See the table below for lenses that turn this function off.

14-24mm f/2.8G ED AF-S
70-200mm f/2.8G ED AF-S VR
80-200mm f/2.8D ED AF-S

80-200mm f/2.8D ED
80-400mm f/4.5-5.6D ED VR
200mm f/2G ED AF-S VR
200-400mm f/4G ED AF-S VR

- *Some Scene exposure modes turn it off!* Landscape, Sports, and Night Landscape exposure modes turn the lamp off.
- *The range is minimal.* Beyond about 10' (3m), the light isn't strong enough to make a difference.
- *The light is annoying to subjects.* Do you like having a strong white light shined in your face just before being photographed?
- *Settings must be correct for it to work.* You must be in **Single point** or **Auto-area** Autofocus Area mode or you should be using the central autofocus sensor for **Dynamic area**. And Continuous Servo (**AF-C**) Focus mode turns the light off.
- *The lamp may turn itself off if it gets hot.* The lamp can't be used continuously. So if you're using the lamp constantly, it'll eventually shut down until it cools. I can usually get that to happen within five or six shutter release presses.
- *It uses more power.* When the lamp is lit the camera is using a minimum of another 20mA in power. While that figure is relatively low, multiple activations will certainly drain the battery faster, and in low light you may be activating the light repeatedly.

If you're getting the idea that I don't like the Autofocus Assist lamp on the D90, you're right. Fortunately, you can turn it off (see "Custom Setting #A3, Autofocus Assist Light" on page <489>).

If you have an SB-600, SB-800, or SB-900 mounted on the D90, the camera will use the Autofocus Assist lamp *on the flash* unless you turn that feature off at the flash. In very low light conditions, the wide red focus pattern thrown by the Speedlight SB-600, SB-800, and SB-900 makes the D90

almost eerily accurate in focus, but even without it the camera does just fine in virtually any situation you could handhold.

The Pro Approach to Autofocus

Many professionals gravitate to the same approach to autofocus (which I'll describe in a moment). The reason is that *changing* autofocus settings all the time can be a tedious process, as the autofocus controls are split between a switch on the front of the camera, a switch on the back of the camera, and the Custom Setting menus. Thus, most pros look for a single menu setting combination they can use that gets them 90% of their autofocus needs and helps them avoid menu-itis.

The solution is the **AE-L/AF-L** button on the back of the camera. Specifically, here's what you do:

- Use Custom Setting #F4 (and possibly #A6) to move autofocus activation to **AF-ON**. Note that this *removes* focus initiation from the shutter release.
- Set **AF-C** (Continuous Servo) via the **AF** button on the top of the camera.

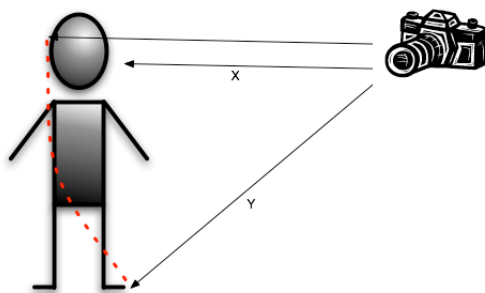
Now your camera is configured to autofocus *only* when you press the **AE-L/AF-L** button. This provides you with the following abilities:

- *Focus and reframe.* Focus on your subject using the **AE-L/AF-L** button, let go of the button, then reframe. Focus stays where it was when you let go of the **AE-L/AF-L** button.
- *Track focus.* Just hold the **AE-L/AF-L** button in while shooting. Focus will be performed as usual. This takes a bit of dexterity, as you have to hold the **AE-L/AF-L** button in at the same time as pressing the shutter release.
- *Manually focus.* With most AF-S lenses, just twist the focus ring. On other lenses, move the lens' focus switch to the **M** position first.

This means that the primary control you change—if you make any change—is the Area mode, via Custom Setting #A1, which you should probably assign to the **FUNC** button (Custom Setting #F3) for fast access.

Using this technique takes practice, so don't expect to make those settings and rush out and take perfect pictures a few minutes later. However, with practice it becomes second nature and relatively easy to control your focus in most situations without having to make multiple settings changes.

One comment about focus-and-reframe: be careful that you are doing what you think. For example, imagine a situation where you swing the camera after focusing:



Geometry can get you in trouble. In this instance, if we focused on the feet, that distance (Y) is longer than the distance to the person's face (X). Thus if we focus low and reframe upwards, we'll be pushing our focus backwards from where we probably want it (red arc and new line from camera).

If you're a focus-and-reframer, you should also check out **3D tracking** via Custom Setting #A1. This offers an alternative to using the AF-On function.

Manual Focus

You can focus lenses manually on a D90. With many older Nikkor lenses you'll need to move the Focus Mode lever on

the front of the D90 to the **M** (manual) position to do so. With recent AF-S lenses, you can usually focus manually at any time by simply turning the focus ring. Nikon's professional lenses typically have a Manual/Autofocus switch (or ring switch on older lenses) that can be used¹⁰².

When you focus manually, the D90 still provides a focus aid that's useful: the focus indicator at the far left of the viewfinder information display displays • if your focus is correct. Regardless of the autofocus sensor chosen and highlighted, the central autofocus sensor is what is used to confirm focus when set to manual focus.

Only a couple of caveats exist for this manual focus confirmation function:

- The lens must have a maximum aperture of about f/5.6 or faster. (In high contrast situations, sometimes you can get by with a lens that only opens up to f/8, but don't count on it.)
- If you use teleconverters or extension tubes, the effective aperture must be f/5.6 or faster. Again, sometimes an effective aperture of f/8 works, but don't count on it—at best, autofocus will be slow to lock on.

In both of the above cases, you must not be manually stopped down (e.g. have set an aperture of f/11 *on the lens aperture ring*).

Note that older AI and AI-S manual focus lenses do not meter with the D90, and that you have to put the Mode dial in the Manual exposure mode position (**M**).

¹⁰² This switch is (somewhat confusingly) labeled **M/A** for the autofocus position, **M** for the manual focus position on AF-S lenses. The “M/A” is trying to tell you that the lens will autofocus but you can override it with manual focus at any time by turning the focus ring.

Depth of Field Preview

The D90 features a Depth of Field Preview button that closes down the aperture to the one that will be used during exposure. This allows you to see the approximate depth of field of the final image.

Note: Immediately after you've taken a picture, the Depth of Field Preview button doesn't always work (you can hit it too soon after the previous exposure was taken). Press the shutter release partway to establish an exposure, and then retry the button.

Many D90 users question whether depth of field on a D90 is the same as on a 35mm film body (assuming the same lens, focus point, and aperture settings). After dealing with this issue for years with Nikon DSLRs, I can state conclusively that the answer is "no."

Depth of field in the 35mm film world is often calculated as follows:

$$NearFocus = \frac{Distance}{\left(1 + \left(Distance * \left(\frac{Aperture}{1000}\right) * FocalLength\right)\right)}$$

$$FarFocus = \frac{Distance}{\left(1 - \left(Distance * \left(\frac{Aperture}{1000}\right) * FocalLength\right)\right)}$$

But conservative photographers also take into account the amount of magnification that the final image undergoes. An 8 x 10" print from a D90 comes from a smaller imaging area than a print from a 35mm film negative, thus undergoes more magnification. Details that were small enough to pass as in focus to our eye at normal viewing distances may appear out of focus when magnified.

I could present a long theoretical discourse and accompanying math regarding the differences between 35mm film and the D90, but that's a bit beyond the scope of this book. Instead, I'll present my conclusion: depth of field appears to me to be a bit less than a one stop difference for a D90 than 35mm film, at least for the sized prints that you're likely to produce (11 x 14" or smaller).

So, if you're using depth of field or hyperfocal distance charts intended for 35mm film cameras with your D90, simply add a stop for a conservative approach. For example, if your 35mm film chart says that the hyperfocal distance is 50 feet for a 50mm lens at f/2 (which it should if it uses the conservative Zeiss circle of confusion value!), simply use f/2.8 on the D90.

Note: The depth of field markings on most Nikkor lenses appear to be calculated using a circle of confusion of 0.03¹⁰³, with a few older ones possibly using 0.033. The so-called Zeiss formula calculates that the circle of confusion should be 1/1730th of the diagonal measurement of the frame, which for 35mm would be 0.025. That's the value that I, and many other professionals, use for 35mm film and for FX-based DSLRs. For a D90, the Zeiss number would be 0.016 (technically 0.016416, but I round down). Since the penalty for goofing up depth of field is an unpublishable image, it pays to use conservative values.

The tables that follow are calculated for the D90 using the 0.016 circle of confusion value, and use distances in feet.

¹⁰³ The reason that .03 came to be used had to do with a standardization based upon film's resolving power prior to World War II! Films of that era could resolve about 30 line pairs per millimeter, so the 0.03 value actually worked reasonably well. But films eventually resolved upwards of 120 line pairs per millimeter, thus the rounded version was no longer precise enough to predict final results. Some would also point out that the Zeiss formula used values for average eyesight, average print size, and average viewing distance that are no longer true, thus even the 0.025 value may be too liberal.

18mm Lens

	Aperture									
Distance	2.8	3.5	4	5.6	8	11	16	22	32	
0.5	0.49	0.49	0.49	0.48	0.47	0.47	0.45	0.44	0.41	near
	0.51	0.51	0.51	0.52	0.53	0.54	0.56	0.59	0.63	far
1	0.96	0.95	0.95	0.93	0.90	0.87	0.82	0.76	0.69	near
	1.04	1.05	1.06	1.09	1.13	1.18	1.29	1.45	1.83	far
2	1.85	1.81	1.79	1.72	1.62	1.51	1.36	1.22	1.03	near
	2.18	2.23	2.26	2.39	2.61	2.95	3.76	5.60	30.83	far
3	2.67	2.60	2.55	2.40	2.22	2.02	1.76	1.52	1.24	near
	3.42	3.55	3.65	3.99	4.65	5.85	10.29	115.92	Infinity	far
5	4.14	3.97	3.85	3.53	3.13	2.75	2.28	1.90	1.48	near
	6.32	6.76	7.12	8.57	12.35	27.52	Infinity	Infinity	Infinity	far
10	7.05	6.56	6.26	5.44	4.55	3.78	2.95	2.33	1.73	near
	17.21	21.00	24.92	61.78	Infinity	Infinity	Infinity	Infinity	Infinity	far
20	10.87	9.75	9.09	7.46	5.88	4.65	3.45	2.63	1.89	near
	125.49	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	far
50	16.10	13.77	12.48	9.60	7.13	5.39	3.84	2.85	2.00	near
	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	far
hyperfocal	23.7	19.0	16.6	11.9	8.3	6.0	4.2	3.0	2.1	

20mm Lens

	Aperture									
Distance	2.8	3.5	4	5.6	8	11	16	22	32	
0.5	0.49	0.49	0.49	0.49	0.48	0.47	0.46	0.45	0.43	near
	0.51	0.51	0.51	0.52	0.52	0.53	0.55	0.57	0.60	far
1	0.97	0.96	0.96	0.94	0.92	0.89	0.85	0.80	0.73	near
	1.03	1.04	1.05	1.07	1.10	1.14	1.22	1.33	1.57	far
2	1.88	1.85	1.83	1.77	1.68	1.59	1.45	1.32	1.14	near
	2.14	2.18	2.21	2.30	2.47	2.70	3.21	4.16	8.16	far
3	2.73	2.67	2.62	2.50	2.33	2.15	1.91	1.68	1.40	near
	3.33	3.43	3.50	3.75	4.20	4.95	7.02	14.10	Infinity	far
5	4.28	4.13	4.03	3.74	3.38	3.01	2.55	2.15	1.71	near
	6.01	6.33	6.59	7.54	9.64	14.79	134.44	Infinity	Infinity	far
10	7.47	7.02	6.74	5.96	5.08	4.29	3.40	2.73	2.05	near
	15.13	17.36	19.40	31.10	324.78	Infinity	Infinity	Infinity	Infinity	far
20	11.90	10.81	10.14	8.47	6.79	5.44	4.09	3.15	2.28	near
	62.63	134.10	724.89	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	far
50	18.48	15.97	14.55	11.34	8.52	6.49	4.65	3.47	2.44	near
	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	far
hyperfocal	29.3	23.4	20.5	14.6	10.3	7.5	5.1	3.7	2.6	

24mm Lens

	Aperture									
Distance	2.8	3.5	4	5.6	8	11	16	22	32	
0.5	0.50	0.49	0.49	0.49	0.49	0.48	0.47	0.46	0.45	near
	0.51	0.51	0.51	0.51	0.51	0.52	0.53	0.54	0.56	far
1	0.98	0.97	0.97	0.96	0.94	0.92	0.89	0.85	0.80	near
	1.02	1.03	1.03	1.05	1.07	1.09	1.14	1.21	1.33	far
2	1.91	1.89	1.88	1.83	1.77	1.70	1.59	1.47	1.32	near
	2.10	2.12	2.14	2.20	2.30	2.44	2.70	3.12	4.17	far
3	2.81	2.76	2.73	2.63	2.50	2.36	2.15	1.94	1.67	near
	3.22	3.28	3.33	3.48	3.74	4.12	4.97	6.58	14.40	far
5	4.48	4.36	4.29	4.05	3.75	3.43	3.00	2.61	2.14	near
	5.66	5.85	6.00	6.52	7.50	9.23	15.01	60.17	Infinity	far
10	8.10	7.73	7.48	6.80	5.98	5.20	4.27	3.51	2.71	near
	13.08	14.17	15.06	18.89	30.50	131.99	Infinity	Infinity	Infinity	far
20	13.58	12.57	11.94	10.28	8.51	7.00	5.41	4.24	3.13	near
	37.91	48.84	61.51	362.16	Infinity	Infinity	Infinity	Infinity	Infinity	far
50	22.90	20.16	18.58	14.85	11.41	8.85	6.44	4.85	3.44	near
	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	far
hyperfocal	42.2	33.7	29.5	21.1	14.8	10.7	7.4	5.4	3.7	

28mm Lens

	Aperture									
Distance	2.8	3.5	4	5.6	8	11	16	22	32	
0.5	0.50	0.50	0.49	0.49	0.49	0.49	0.48	0.47	0.46	near
	0.50	0.50	0.51	0.51	0.51	0.51	0.52	0.53	0.54	far
1	0.98	0.98	0.98	0.97	0.96	0.94	0.92	0.89	0.85	near
	1.02	1.02	1.02	1.03	1.05	1.07	1.10	1.14	1.22	far
2	1.94	1.92	1.91	1.88	1.83	1.77	1.68	1.59	1.45	near
	2.07	2.09	2.10	2.14	2.21	2.30	2.47	2.71	3.23	far
3	2.86	2.82	2.80	2.72	2.62	2.50	2.33	2.15	1.90	near
	3.16	3.20	3.23	3.34	3.51	3.75	4.22	4.98	7.13	far
5	4.61	4.52	4.46	4.27	4.02	3.74	3.36	2.99	2.53	near
	5.47	5.60	5.70	6.03	6.62	7.53	9.78	15.24	219.63	far
10	8.53	8.23	8.02	7.43	6.70	5.96	5.03	4.24	3.36	near
	12.09	12.75	13.27	15.27	19.73	31.07	734.07	Infinity	Infinity	far
20	14.85	13.95	13.37	11.81	10.05	8.47	6.71	5.37	4.03	near
	30.62	35.31	39.64	65.29	2209.63	Infinity	Infinity	Infinity	Infinity	far
50	26.75	23.96	22.30	18.26	14.35	11.32	8.38	6.38	4.57	near
	383.08	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	far
hyperfocal	57.4	45.9	40.2	28.7	20.1	14.6	10.0	7.3	5.0	

35mm Lens

	Aperture									
Distance	2.8	3.5	4	5.6	8	11	16	22	32	
0.5	0.50	0.50	0.50	0.50	0.49	0.49	0.49	0.48	0.48	near far
	0.50	0.50	0.50	0.50	0.51	0.51	0.51	0.52	0.53	
1	0.99	0.99	0.99	0.98	0.97	0.96	0.95	0.93	0.90	near far
	1.01	1.01	1.01	1.02	1.03	1.04	1.06	1.08	1.13	
2	1.96	1.95	1.94	1.92	1.89	1.85	1.79	1.72	1.61	near far
	2.04	2.05	2.06	2.09	2.13	2.18	2.27	2.40	2.63	
3	2.91	2.88	2.87	2.82	2.75	2.66	2.53	2.39	2.19	near far
	3.10	3.13	3.14	3.21	3.30	3.43	3.68	4.01	4.74	
5	4.74	4.68	4.64	4.51	4.33	4.12	3.81	3.50	3.08	near far
	5.29	5.37	5.42	5.61	5.92	6.36	7.26	8.74	13.25	
10	9.01	8.79	8.64	8.19	7.61	6.98	6.14	5.36	4.43	near far
	11.24	11.60	11.87	12.83	14.60	17.64	27.01	74.63	Infinity	
20	16.37	15.66	15.19	13.86	12.24	10.69	8.82	7.29	5.66	near far
	25.70	27.67	29.27	35.93	54.57	155.07	Infinity	Infinity	Infinity	
50	32.13	29.49	27.86	23.67	19.31	15.70	11.97	9.31	6.80	near far
	112.67	164.08	243.41	Infinity	Infinity	Infinity	Infinity	Infinity	Infinity	
hyperfocal	89.7	71.8	62.8	44.8	31.4	22.8	15.7	11.4	7.8	

50mm Lens

	Aperture									
Distance	2.8	3.5	4	5.6	8	11	16	22	32	
0.5	0.50	0.50	0.50	0.50	0.50	0.50	0.49	0.49	0.49	near far
	0.50	0.50	0.50	0.50	0.50	0.50	0.51	0.51	0.51	
1	1.00	0.99	0.99	0.99	0.99	0.98	0.97	0.97	0.95	near far
	1.00	1.01	1.01	1.01	1.01	1.02	1.03	1.04	1.06	
2	1.98	1.98	1.97	1.96	1.94	1.92	1.89	1.85	1.79	near far
	2.02	2.03	2.03	2.04	2.06	2.08	2.12	2.17	2.26	
3	2.95	2.94	2.94	2.91	2.87	2.83	2.76	2.67	2.55	near far
	3.05	3.06	3.07	3.10	3.14	3.19	3.29	3.42	3.65	
5	4.87	4.84	4.82	4.75	4.65	4.53	4.34	4.14	3.84	near far
	5.14	5.17	5.20	5.28	5.41	5.58	5.89	6.31	7.16	
10	9.49	9.37	9.29	9.03	8.67	8.26	7.65	7.03	6.20	near far
	10.57	10.72	10.83	11.20	11.81	12.68	14.43	17.31	25.92	
20	18.04	17.61	17.32	16.44	15.27	14.03	12.36	10.80	8.93	near far
	22.43	23.13	23.66	25.53	28.97	34.83	52.53	134.68	Infinity	
50	39.30	37.30	36.00	32.37	28.12	24.16	19.56	15.93	12.16	near far
	68.71	75.80	81.83	109.78	225.15	Infinity	Infinity	Infinity	Infinity	
hyperfocal	183.0	146.4	128.1	91.5	64.1	46.6	32.0	23.3	16.0	

70mm Lens

	Aperture									
Distance	2.8	3.5	4	5.6	8	11	16	22	32	
0.5	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	near
	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	far
1	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.98	0.98	near
	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.02	1.03	far
2	1.99	1.99	1.99	1.98	1.97	1.96	1.95	1.93	1.89	near
	2.01	2.01	2.01	2.02	2.03	2.04	2.06	2.08	2.12	far
3	2.98	2.97	2.97	2.95	2.94	2.91	2.87	2.83	2.76	near
	3.02	3.03	3.03	3.05	3.07	3.09	3.14	3.19	3.29	far
5	4.93	4.92	4.91	4.87	4.82	4.75	4.65	4.53	4.34	near
	5.07	5.08	5.10	5.14	5.20	5.28	5.41	5.58	5.90	far
10	9.73	9.67	9.63	9.48	9.28	9.03	8.65	8.24	7.63	near
	10.28	10.35	10.40	10.58	10.84	11.20	11.84	12.72	14.52	far
20	18.96	18.71	18.54	18.01	17.28	16.44	15.21	13.96	12.27	near
	21.17	21.48	21.71	22.48	23.74	25.53	29.19	35.27	54.03	far
50	43.91	42.61	41.73	39.14	35.81	32.36	27.89	23.92	19.34	near
	58.05	60.49	62.36	69.20	82.83	109.90	241.26	Infinity	Infinity	far
hyperfocal	358.8	287.0	251.1	179.4	125.6	91.3	62.8	45.7	31.4	

Note: The Excel workbook used to calculate these tables is provided on the CD. All distances in the above charts are in feet, but the workbook also provides tables in meters, as well. The areas labeled in green are changeable by you, which mean that you can enter your own distances and apertures if the ones I provide aren't to your liking. The focal lengths in these tables, by the way, are the marked focal lengths on the lens, not the D90 angle-of-view equivalents.

Diffraction

Diffraction also needs to be mentioned as long as we're discussing things that impact the acuity of the final image.

Diffraction is what happens when parallel light rays pass through an opening (hit an edge). In cameras, that would be the aperture diaphragm of the lens. Some of the light passing through the aperture spreads slightly, forming slight "ripples" of light that extend outward instead of resolving completely at one point where the light hits the sensor (or film, or your retina, etc.). The primary area of diffusion is called the Airy Disk, and is named for the person who discovered it (George Airy). When the first diffracted ripple outside the Airy Disk starts resolving on the adjacent photosite (or film grain, or rod/cone, etc.) is when acuity problems arise, as now two adjacent receptors are seeing light from the same point.

Nikon hasn't spoken about diffraction on the D90, but says that diffraction begins to become clearly visible in images

when using apertures physically smaller than $f/11$ on the D2x (I concur with Nikon's assessment.)

Calculating actual diffraction impact on a DSLR is a little complicated, as the Bayer array sensor and the need to demosaic the data comes partially into play. Some people say that diffraction doesn't really become clearly visible on DSLRs until the Airy Disk diameter becomes twice the size of the photosite. That would put the aperture at which diffraction begins to be clearly recorded on a D90 at about $f/11$.

Personally, I do things experimentally and visually, taking pictures with progressively smaller apertures and noting where I begin to see the smearing of fine detail and loss of contrast that's clearly visible as diffraction becomes a major limiter. On a D90, this occurs at above $f/11$ on large prints off my Epson R2400. Thus, I say that the D90 clearly begins to resolve diffraction at about $f/11$ and try to avoid physically smaller apertures when I can.

I certainly wouldn't rule out using $f/22$ or $f/32$ to get an increased depth of field, but be aware that diffraction "steals back" some of the sharpness benefits of the very small apertures. If you're looking for absolute best possible acuity in your images, use apertures physically larger than $f/16$ and make sure that the things you want "in focus" are in the depth of field for that aperture and your focus point.

Other DOF Theories

You should be aware that depth of field is a very contentious subject among photographers. Not only are there variants of the circle of confusion formula and methods for using them, but there are also alternative calculation methods that have large followings.

The original Zeiss calculation, for example, was based upon prints smaller than an Epson R1800 or R2400 can produce and which are viewed from distances longer than many of us examine our photos from. I've seen hundreds of

interpretations of how to deal with all the variables that come up. When I questioned my mentor about it one day, he showed me that he basically was always using values for one stop faster than the calculations would indicate, “just to be safe.”

So instead of using the depth of field charts for $f/16$ (if that was the aperture he was shooting at), he always used $f/11$. On top of that, he tended to always put whatever depth of field he had at the near focus point in his shot. This was done on the premise that things that are slightly out of focus in the distance aren’t generally as obnoxious as things out of focus in the near frame¹⁰⁴.

Thus, taking two Zeiss-based calculations for his favorite lens where he needed 3’ (1m) to be in focus as his near point: instead of using one aperture that said 2.73’ to infinity would be in focus, he almost certainly would set his aperture one stop lower and use the value that said 2.55’ to 134.44’ would be in focus. The way he framed, infinity generally was a smaller portion of the frame than the near point, anyway, so a bit of softness at infinity actually drew your eyes forward to the near interest.

Harold Merklinger’s *The Ins and Outs of Focus* (self-published, ISBN 0-9695025-0-8) describes another depth of field method that is based upon the object field. Essentially, Merklinger’s thesis has you set the lens at infinity focus and then use an aperture that is the physical size of the smallest detail you want to render. For example, with a 50mm lens on the camera, if you wish to resolve details as small as 5mm (regardless of how close they are to you), you’d need to set the lens to approximately $f/11$. (Please be aware that the preceding is a gross oversimplification of something that takes

¹⁰⁴ It goes further than that, actually. The human brain is wired to interpret “less detail” as meaning “further away” (and vice versa). Having a slightly soft infinity plays upon those brain interpretations, while having a slightly soft near is in violation of them.

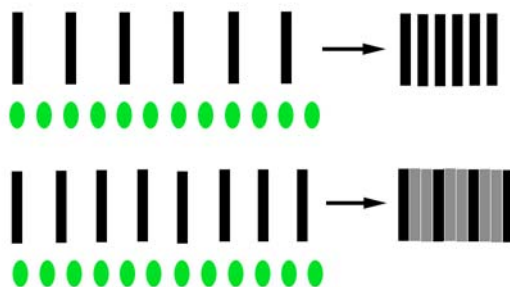
Merklinger an entire book to describe. A short summary of the thesis is at <http://www.trenholm.org/hmmerk/DOFR.html> if you want more info. To my knowledge Merklinger has never taken the consequences of anti-aliasing into account—his book predates digital.)

Sharpening

While technically not a “focusing” action, image sharpening algorithms can increase the apparent acuity of a photo taken with the D90.

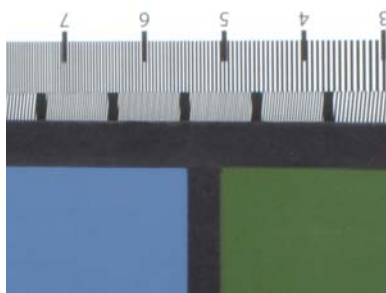
Why is it necessary to sharpen images if the camera is focusing correctly? The process of translating analog information (light) into digital data (pixels) involves a procedure called sampling. Edges of sampled objects tend to be rendered in a manner that looks slightly fuzzy to our eyes. (If you want to know more about why this is, get *The Manual of Photography, 9th Edition*. But be forewarned, analog-to-digital transformation is filled with mathematical concepts and some pretty intimidating formulas).

The short version: If the frequency of detail in a scene is higher than the sensor can sample, the detail is under-sampled and combined into a single pixel, and sharp edges tend to gather data from either side.) Sharpening uses contrast adjustments at edge boundaries to trick our eyes into seeing clearly defined edges.



If the green dots are photosites on the sensor and the black lines high contrast detail, when a line falls perfectly on a photosite (top), we get a perfect rendering. If some detail falls on multiple sensors (bottom) the detail is blurred.

While you might not have realized this, you've seen those "beat" patterns before in this book in some of the sample shots for various settings:



In the top row of resolution patches just to the left of the seven you can see some irregularity as the frequency of the detail starts to exceed the capture ability. You can see it even more clearly in the second row of diagonal line resolution samples below the 5, 6, and 7.

The usual technique for sharpening images is to apply a technique called "unsharp masking," and a variation of that technique is used by the D90. Unsharp masking finds edges by looking for adjacent pixels with value differences. On the brighter side of the edge, unsharp masking lightens the pixels; on the darker side, it darkens the pixels.



Unsharp masks work by exaggerating edges. I started with a medium gray block on the left and a dark gray block on the right, and then applied an Unsharp Mask. Note how on the lighter side of the image the edge was made even lighter, while on the dark side of the edge it was made almost black.

Most unsharp mask filters have settings for amount (controls how much lighter or darker the values are made), radius (controls how wide an area over which the value shifts are made), and threshold (controls how much of a difference there must be between adjacent pixels before adjustments are made). The D90 doesn't let you set the individual parameters of the sharpening control; instead, you set an overall "level."

The D90 has eleven possible sharpening levels (set via the Picture Control setting; see "Picture Controls" on page <330>):

- A**—(Automatic) The camera determines the appropriate amount of sharpening to apply.
- 0**—The camera applies *no* sharpening to the image data.
- 1 through 9**—The camera applies a level of sharpening you specify, ranging from a low amount (1) to a high amount (9).

*Note: If you're shooting JPEG or TIFF images, the above parameters are used to apply sharpening to the actual pixel data that is saved in your image file. If you shoot NEF, the "tag" for the sharpening value is stored in the EXIF data and the data is left untouched. However, note that a few programs, such as Nikon Capture NX2, use the camera tags as the default setting for conversion. So unless you override the sharpening value in Capture NX2, sharpening may be applied by the program! That's one reason why I sometimes suggest setting sharpening to **0** if you shoot NEF images.*

Sharpening is usually applied twice to images (only one of these potentially occurs in camera). The first sharpening is used to compensate for the anti-aliasing (fuzziness) that is inherent in digital image acquisition due to high frequency sampling. I'd argue that this sharpening should be minimized as much as possible.

A final sharpening should only be applied to an image when you know the reproduction size. For example, I often use a **Radius** value of **0.3** to **0.5** when sharpening small images destined for the Web or computer view. When printing on an Epson inkjet printer, such as the 1800 or 2400, I sometimes use **Radius** values as high as **0.8** to **1.2**, since I know that the ink tends to spread upon contact with the paper I use, masking the sharpening effect somewhat. (The dot gain on most consumer Epson printers with regular ink and papers is about 30%.) Another photographer I know applies Photoshop **Unsharp Mask** values of **4, 50, 4** for the D90 (Radius, Amount, Threshold). What you use depends on your output device and the way you balance visual impact with artifacts.

Many photographers also believe that it's incorrect to apply sharpening to color image data (amongst other problems, the colors can shift due to the methods used to lighten or darken edges). These folk tend to advocate switching the image mode to Color Lab (**Adjust/Mode/Color Lab** in Photoshop), applying sharpening only to the luminosity layer, then switching back to RGB or CMYK mode (**Adjust/Mode/RGB** or **Adjust/Mode/CMYK**). This method also tends to color shift images, though not by as much as the regular method, as Photoshop rounds pixel values during mode conversions. I've seen some colors drift by 2 or 3 values (out of 256) during this conversion. (For a fuller discussion of sharpening, see <http://www.bythom.com/sharpening.htm>.)

*Tip: In most recent versions of Photoshop, you can run your **Unsharp Mask** filter as usual, then select **Fade Unsharp Mask** from the **Edit** menu (select **Luminosity** in the **Mode** pop-up) to achieve the same effect as the Color Lab luminosity trick. This avoids the color shift.*

It makes sense to use in-camera sharpening when you're working under tight deadlines and know how the image is likely to be rendered. For example, photographers shooting on deadline for Web sites or newspapers often fall into this category, and should probably select something between **3** and **6** for the sharpening setting, depending upon whether the scene is normal contrast or low contrast, respectively). But be especially careful if you venture above ISO 1600, as sharpening interacts with noise *and* interacts with noise reduction techniques. Thus intense sharpening at high ISO values can create unusable images. Note also that high levels of sharpening also tend to increase the size of JPEG files, as sharpening increases detail that's difficult to compress.

My recommendation for most users who aren't shooting on deadline is that you set **Sharpening** to **0** or another low value when shooting with a D90 in the JPEG file format. This gives you slightly unsharp images for direct view that can be re-sharpened as necessary for other output formats. It also helps with masking noise in the image (yes, even after you apply sharpening later in post processing, the noise is better masked).

*Tip: On the other hand, setting sharpening to a high value allows you to use the camera's zoom review function to better assess focus, and the high sharpening values aren't bad on the D90 at the low ISO values. I'll often use a value of **7** or higher when I'm trying to assess focus in the field.*

NEF files don't get sharpened by the camera, but you should still probably set the camera to a value of **0** so that your conversion program doesn't pick up a sharpening value by default. Not only does Photoshop CS3 (and other image editing programs) do a better job sharpening images than the D90 does, but you can choose your sharpening methodology based upon how the image is used.

Note: If you've set a sharpening level on the D90, it is applied by default to NEF format files in Capture NX2 if you've left it at

the default settings. This is yet another reason to turn sharpening OFF on the camera (that way the camera's settings match what you get).



Sharpening set to **0**. Note the slight fuzziness (antialiasing) in the edges of the lettering.



Sharpening set to **9**. Is the lettering better, or worse? Obviously, quite better. But since this example is at ISO 1600 and has a bit of noise in it, let's run a simple post processing noise reduction followed by an aggressive sharpening (**Smart Sharpen**) on the unsharpened image and see what happens:



This is why I say “no sharpening” and “post processing noise reduction” is the best choice. If you look carefully at the in-camera sharpening on the words “Camera Shop” you can clearly see some edge effects that aren’t there (there is no dark edge between the yellow and red in the original scene; that edging is the result of the sharpening method used by the camera). Note also that the noise is clearly visible in the in-camera version, but in my post processed version it is gone. Yet visual acuity is about as good in my post processed version. Finally, look at the edge between the white chart and the gray building just above the “1” in both the in-camera sharpened version and my post processed version. Notice the artifact in the in-camera version?

Sharpening is set via the **Picture Control Set** option on the SHOOTING menu (see “Picture Controls” on page <330>). Just remember that you always have to use the **OK** button to complete a Picture Control change.

Shooting Controls

Many of the shooting controls of the D90 have already been covered in earlier sections, but a few important ones remain to be described.

Shutter Releases

The D90 sports the usual shutter release at the right-front top of the camera. If you're using an MB-D80 mounted to your camera, there is a second release for when you hold the camera for vertical shots. Both releases have Front and Rear Command dials. An **AE-L/AF-L** button is also available for both releases.

Note that the shutter release on the MB-D80 has a lock ring around it. When the dot on the ring is aligned with the white line on the body, the vertical release is active; otherwise it is inactive. Get used to flipping that Vertical Release Lock switch; if left unlocked, you're pretty much guaranteed of getting random pictures you didn't want as your hand and other things brush by the vertical release.

Personally, I rarely use the MB-D80 and its vertical release. I, like many outdoor professionals, use quick release mounts on my cameras (most of the time the camera is used on a tripod). I have an L-bracket mounted on my cameras most of the time. So when I grasp the camera to shoot vertically as Nikon intends me to, my palm then rests uncomfortably on the mount. It also doesn't help that it takes relatively large hands to also feel comfortable with the location of the Direction pad when shooting verticals. Long ago I learned how to shoot vertical with only one release, so that's all I tend to use.

The shutter releases control the activation of the camera's metering system and (usually) the start of autofocus (basically, all systems that need to be "active" during shooting). A partial press of the shutter release turns metering on and activates the autofocus system. Unlike consumer cameras, holding a shutter release partway doesn't lock exposure (unless you've set Custom Setting #C1). As long as you hold the shutter

release partway down, the camera stays active (and uses considerably more power, see “Battery Life” on page <113>).

If you let go of the shutter release after pushing it partway, the camera stays active based upon how Custom Setting #C2 is set (see “Meter/Camera Active Time” on page <501>). By default, this is six seconds.

Shutter Lag

One thing that catches D90 users unawares is the potential for “lag” in the time between pressing the shutter release and the picture being taken. Since many users purchase the D90 for its speed, this can be a frustrating aspect of the camera, at least until you understand that the settings you choose contribute to the problem.

In manual focus and manual exposure mode with no images in the internal memory buffer, the 65ms shutter lag on a D90 is actually quite fast for a consumer DSLR. The fastest pro camera only gets down to 37ms, and older consumer Nikon bodies had longer lags (the D70 series had a 106ms shutter lag, for example).

However, as you turn on automated features or put images into the buffer, the lag may actually become significant and difficult to predict.

Here’s a partial list of things that contribute to shutter lag:

- *The camera needs to clear the buffer.* In the Continuous shooting method (see “Shooting Method” on page <406>), when the internal memory buffer fills, the D90 must write that information to the Secure Digital card. As enough internal memory becomes available for another image, the D90 again releases the shutter. Fortunately, the D90’s buffer is adequate in size and its write speed to storage is fast, so it’s rare that you’ll encounter buffer delays for JPEG shooters. But it *is* possible to encounter buffer delays, especially if you shoot NEF format in rapid bursts

or use an older, slower Secure Digital card. *Suggestion:* make sure that you're using state-of-the-art cards that can write at 20MB/s, which clear images out of the buffer faster than slower cards. Also, make sure to turn off things that chew up buffer space (**Active D-Lighting**, noise reduction).

- *Autofocus is set to Single Servo.* In low contrast scenes and sometimes with moving objects, the autofocus mechanism may take longer than usual to lock into the focus point. If you've set Single Servo AF, the camera won't release the shutter until autofocus is achieved. With telephoto lenses that do not have a built-in motor (i.e. are not AF-I or AF-S), the number of turns the autofocus motor has to make to drive a lens from one extreme focus position to another can also be a factor (generally you don't see this with wide angle lenses). *Suggestion:* if you use Single Servo autofocus (**AF-S**), also select **Single point** autofocus and confine yourself to the center focus sensor, which has better low-light performance.
- *The shutter speed is long.* In continuous motor drive, it is possible for long shutter speeds to reduce the camera's frame rate. While this doesn't contribute lag to the initial frame in a burst, you may feel like subsequent frames have a built-in lag. Consider, for example, that you have the camera set to shoot continuously and are using a shutter speed of 1/2 second. Obviously, the absolute best you're going to get is something less than 2 frames per second, not the 4.5 frames per second maximum rate of the D90. *Suggestion:* use faster lenses or a higher ISO value so that you can get shorter shutter speeds.
- *You've told the camera to pause!* Custom Setting #D10 causes the camera to wait a second before opening the shutter.
- *The self timer is set.* See "Self Timer" on page <407>. This one is my favorites at workshops: the student comes to me and says their camera isn't working. About that point the shutter goes off and the student remembers that they set the self timer.

- *i-TTL flash is active.* Since the preflash is measured by the 420-pixel sensor in the viewfinder, the mirror has to be down while preflash signals and responses are made. Even the short pause necessary for this communication is enough to make the D90 feel sluggish. I measure the delay added by preflash to be about 60ms, which means that shutter lag is essentially doubled (that's still faster than some DSLRs, though!). *Suggestion:* learn how to use Manual flash mode (AA flash mode also uses preflashes, so Manual is the only mode that will give you less lag). Also, you can try using FV Lock to get rid of the lag. See "Using Flash" on page <540> for more on this subject.

Shooting Method (and Frame Rate)

One of the D90's key attributes is its ability to take multiple photos in rapid succession. Most digital cameras are quite limited in this respect, but the D90 operates much like the professional Nikon cameras, though with a few minor differences and slightly lower performance.

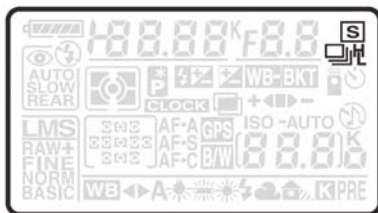
Three primary shooting method (frame rate) settings are possible:

- S** *Single-frame.* Each time the shutter release is pressed, a single image is recorded (i.e. holding the shutter release down past the shot doesn't take additional pictures). You can take additional pictures (until the buffer fills) without having to wait for the camera to write to the Secure Digital card—you just have to press the shutter release for each one.
- CL** *Continuous Low.* Images are recorded at 3 frames per second (fps) while you hold the shutter release down (unless you use Custom Setting #D6 to set another value from 1 to 4 fps). If the buffer fills and you continue to hold the shutter release down, the D90 shoots another picture each time one image has been completely saved to Secure Digital card.

CH Continuous High. Images are recorded at 4.5 fps while you hold the shutter release down. If the buffer fills and you continue to hold the shutter release down, the D90 shoots another picture each time one image has been completely saved to Secure Digital card.

Note: Nikon's frame rate specifications are made with the camera set to manual exposure, manual focus, and a shutter speed of 1/250 second or faster, and without VR being active. If you're using automatic exposure modes, slower shutter speeds, using VR, or light is too dim for optimal autofocus, you may experience frame rates lower than Nikon specifies.

📷 To change the shooting method setting: Hold down the Shooting Method button and turn the Rear Command dial until **S** (Single Frame),  (Continuous Frame High),  (Continuous Frame Low). (This control also provides access to the Self Timer and Remote Methods, which I'll deal with in separate sections that follow.)



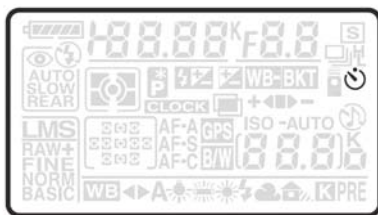
Top LCD:

Since the D90 is reasonably fast at emptying the buffer, you usually won't encounter any shooting limitations. However, be sure to read about the buffer capacity in "Buffer Sizes" on page <124>. If the buffer is full and you attempt to take another photo, the camera pauses until space for it is available.

Self Timer

The D90 features a variable self timer, which delays the opening of the shutter after the pressing of the shutter release.

📷 To turn the self timer ON: hold down the Shooting Method button and turn the Rear Command dial until  appears in the top LCD.



Top LCD:

When the self-timer is set, the camera blinks the white lamp on the front of the D90 from the time you press the shutter release until two seconds prior to the exposure, at which point the camera turns the light on continuously to warn you that the exposure is about to be taken. If you've turned Beep on (Custom Setting #D1), you'll also hear audible beeps along with the blinking of the white lamp.

📷 To set the delay value the self timer uses, see "Custom Setting #C3, Self Timer Delay Setting" on page <503>. Note that unlike Nikon film bodies, the D90 only allows settings of 2, 5, 10, or 20 seconds.

Using the self-timer has a few hidden "gotchas" you should be aware of:

- *Autofocus is attempted immediately upon shutter release.* If you stand in front of the camera and press the shutter release (as you might do before assuming your position away from the camera in a self-portrait), the camera focuses on you standing just in front of the camera; it doesn't wait until you have assumed your position and the delay has completed! I always trigger self-timer shots from alongside the camera, and then move to position in front of the camera; alternatively, I'll move the autofocus selector switch to manual focus. Note further that if you've selected Single Servo autofocus, the self timer countdown doesn't begin until focus is achieved. The

corollary is that if focus isn't achieved, the self timer isn't started.

- *Exposure may be wrong in automatic exposure modes.* Stray light can enter the viewfinder and influence exposure settings when using the self timer. Be sure to use the DK-5 Eyepiece cap Nikon supplies with the camera on the viewfinder if you won't be looking through the camera when the exposure is taken (or use manual exposure mode). And yes, this is a real problem—I've seen exposures vary by more than a full stop! Always use the DK-5 accessory to block light coming in from the viewfinder.
- *Bulb can't be used with the self timer.* The D90 automatically cancels bulb shutter speeds and uses 1/10 second instead. (**bulb** still appears as the shutter speed on the top LCD!)
- If you press the Depth of Field Preview button while the self timer is active and counting down, the self timer is cancelled¹⁰⁵.

Remote Control

The D90 has two remote shutter release options. The first is the optional MC-DC2 remote cable, which plugs into the bottom connector on the left side of the camera (as you face the back). This simple wired remote has a shutter release button with a lock (for long exposures using **bulb**). The shutter release on the MC-DC2 otherwise functions exactly as the main shutter release on the camera, and frame advance works as usual.

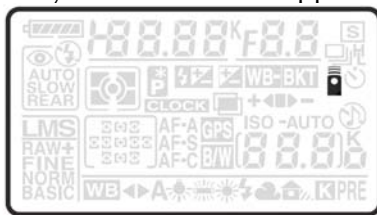
A second optional, *wireless* remote control is available for the D90. The ML-L3 remote is the same as used for the N75,

¹⁰⁵ Someone somewhere at Nikon seems to be reading my eBooks. On the D200 there's a bug that keeps the button from working when the self timer is active. The only place I've ever seen this mentioned is in my D200 eBook, and it's not a likely combination someone would try, yet here we are one camera down the line and the bug is fixed.

D40, D40x, D50, D60, D70 series, and D80, and is fairly simple in operation. Unlike the wired remote, you'll need to make Shooting Method settings specific to the remote use in order to use it.

You can do two things with the ML-L3 remote:

- Trigger the shutter release immediately (Nikon calls this the Quick Response mode). To set this, hold down the Shooting Method button and rotate the Rear Command dial until *only* the remote icon appears on the top LCD.



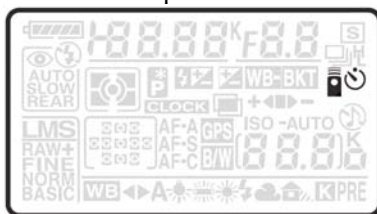
Top LCD:

Special note for long exposures: when the D90 is set in Quick Response mode, instead of the **bulb** shutter speed you'll get a **--** shutter speed (you also have to be in Manual exposure mode to set this). The **--** shutter speed is started with the first press of the button on the ML-L3 remote and ends with a second press (or after 30 minutes, whichever comes first)¹⁰⁶.

- Trigger the shutter release with a delay of two seconds (Nikon calls this the Delayed Remote mode). To set this, hold down the Shooting Method button and rotate the Rear Command dial until both the self timer and remote

¹⁰⁶ While you may be tempted to use this for cleaning the sensor, I don't recommend it.

icon appear on the top LCD.



Top LCD:

When the camera is set to either method of remote release, the camera automatically cancels that after a period of inactivity. By default this length of time is one minute, but you can change it with Custom Setting #C5 (see “Remote Active Setting” on page <506>). Also, as with the Self Timer, you should cover the eyepiece with the supplied DK-5 accessory if you’re not looking through the viewfinder.

Note: The internal flash must fully recharge before you can take another picture with the remote release, so if you used flash on a shot, it may take a few seconds before another press of the remote’s button triggers another picture.

Live View

Nikon added a significant new ability to the D90, something they call Live View. The D90 is the first Nikon consumer DSLR to have this facility.

Live View allows you to see an image on the color LCD on the back of the camera *prior* to taking a picture. The preview image is much like what you’d see from a video camera (i.e., it updates constantly). Live View may be used for up to an hour at a time, at least if the ambient temperatures are relatively low. The camera has an automatic heat detection mechanism that will shut down Live View if it senses the sensor is overheating.

Live View has a number of uses:

- *Evaluate focus.* Both the actual point of focus and the depth of field can be more carefully evaluated using Live

View, allowing you to optimize both. *Caveat*: this works best with either manual focus or with AF-S lenses where you can override the camera's focusing decisions. Also note that the aperture used by the camera temporarily when Live View goes active is the one you've set or something around f/8, whichever is larger. Changing aperture *while* Live View is active doesn't change the aperture being viewed¹⁰⁷. So if you want to see depth of field, make sure you've set your aperture prior to invoking Live View.

- *Set correct white balance.* Perhaps the most intriguing and useful of the possible uses of Live View is the ability to look at white balance settings in real time and pick the one that is most appropriate for the scene. *Caveat*: you're checking color on a display that is not finely calibrated, so you can still be off.
- *Frame when you can't look through the viewfinder.* The classic photojournalist position of camera-over-the-head while in crowds suddenly can still provide you some useful framing feedback. Likewise, the classic macro photographer down-on-the-ground position doesn't mean having to contort your body to look through the viewfinder. *Caveat*: the color LCD doesn't rotate or pivot, meaning that you're often at angles to it that make it hard to see; you may need to use an external monitor in some situations.
- *Contemplate still life framing.* With non-moving subjects, being able to see the composition in the flat two-dimensional representation that the final picture will take is often useful. Even with only one eye looking through the viewfinder our brain is trying to evaluate the scene three-dimensionally, which can trick you into seeing or

¹⁰⁷ In other words, the physical aperture on the lens is stopped down to the value that was set when Live View is invoked or f/8 if the aperture set is larger than f/8, and the aperture is not changed again until you take a picture, even if you use the Front Command dial to "change" the aperture.

not seeing subtle issues. *Caveat*: framing works best when hooked to a larger HDMI display.

The list of useful Live View possibilities is actually quite long. I'll leave it to you to decide when and how to use Live View. The key point is that you can get more detailed feedback on what the sensor will capture *before* you tell the camera to take a picture. So ask yourself this question: what do I need to know better before I snap my photo? Your answer to that question is likely the thing you'll use Live View for.

You'll note that I didn't put "Check exposure" in my list of primary advantages. That's because Nikon partially left out a key element that would help you do that: histograms. That's right; on the D90 you can't see a histogram while in Live View mode.

Also, remember that the color LCD isn't calibrated. It's very easy to have it set wrong (indeed, the default setting is too bright in my opinion), thus impairing your interpretation of "correct" color or exposure. So the one thing that I'd caution against doing is relying upon Live View to pre-evaluate exposure. You're better off just taking a sample shot, looking at the RGB histogram for it, then deleting that shot after tweaking your exposure for the final shot(s).

Unlike the professional Nikon bodies, to use Live View there's really nothing you have to set in advance. The one thing you might want to set is the Live View autofocus method, which is set using Custom Setting #A7 (see "Live View Autofocus" on page <493>).

In Live View the camera uses a contrast detection autofocus system similar to what Coolpix and other compact cameras use. While this doesn't require the mirror to drop to acquire focus, using the main imaging sensor for focus is slower than phase detection. Live View is a two-button process: press the **LV** button on the back of the camera to invoke the Live View mode, and press the shutter release to take a picture.

You'll note that the D90 "double-clutches" when you press the shutter release in Live View—the mirror sounds are doubled. That's because the camera flips the mirror down to get exposure information (especially necessary with flash). If you've got **Image review** set to **On**, after the picture is taken you'll also get a display of the image for the default image review time before the camera reverts back to Live View. Live View is not particularly suitable for fast picture taking due to all this extra mirror movement and delays.

Live View has implications on a number of other aspects of the camera:

- *Battery life.* Obviously, since the color LCD is on constantly during Live View, you get a hit on battery performance. As I noted in the sections on power earlier in the eBook, the color LCD is a large consumer of power; the more it is on, the higher the drain on the battery. Still, the D90 has enough power in a full battery that you'll exhaust the built-in limits (due to heat buildup) of the Live View mechanism long before you exhaust a battery. Still, if you're using Live View a lot, bring extra batteries with you—you'll go through them pretty quickly during a day's shooting that has lots of Live View usage.
- *Exposure.* You must cover the viewfinder if you're using any automatic exposure mode (Program, Aperture-priority, or Shutter-priority). That's because the metering sensor is just behind the eyepiece, and can detect light coming from behind the camera if nothing is blocking the eyepiece (usually your eye is there!). Remember to use the Viewfinder cap that Nikon supplies to block light from entering the rear of the camera if you use Live View.
- *Noise.* Running the sensor and associated electronics for long periods of time generates heat, and as I pointed out earlier, heat tends to increase electron migration. In general, Live View use of only a few minutes at a time at normal temperatures isn't likely to make any visual change to noise in your images. My simple tests at room temperatures showed it took somewhat long periods of

Live View use to invoke any additional regular image noise that I could see, though it does seem to increase the likelihood of my camera to produce hot pixels. But don't be too casual about this: give the camera some cool-down rests if you're using Live View for long periods of time. The camera actually monitors its internal temperature and will automatically shut down if it detects too much heat while using Live View; you get a 30-second countdown prior to this happening, displayed in the upper left corner of the Live View display.

- *Flash.* Speedlights work with Live View much as you'd expect, though they add a bit of a delay due to the mirror needing to be down longer to measure pre-flash. But it appears that flash via the PC Sync socket may not always trigger properly with Live View, so be sure to test your studio lighting before needed to rely upon it via Live View.
- *Shutter counts.* The internal shutter counter counts activations of the shutter, not pictures taken. Thus, each time you activate Live View you're activating the shutter, whether you take a picture or not. This isn't a big issue, but some people have been bothered by the fact that their file numbering doesn't align with the shutter count on their D90. This is probably the reason.

📷 When in Live View mode, here's a list of things you can do besides above and beyond what you can do in normal shooting:

- *Take a picture.* Press the shutter release, as usual. Remember, there's more delay between pressing the shutter release and the picture being taken due to the slower autofocus mechanism and the extra mirror flip.
- *Move the focus point.* Use the Direction pad to move the focus selection area (highlighted by the red box, which turns green when focus is achieved) to the location you wish to be used for focus (assumes **Wide area** or **Normal area** setting for Custom Setting #A7). Note that unlike the

normal autofocus system, you can move the focus selection area anywhere in the frame.

- *Change the focus method.* Hold the AF button and use the Rear Command dial to select between the focus methods (large box=**Wide area**, small box=**Normal area**, no box=**Face priority**).
- *Set the white balance.* Hold the **WB** button and use the Command dials to adjust the setting. The Live View updates immediately to the new balance.
- *Zoom in to check focus or detail.* Press the $\times$ button to zoom in and the $\times$  button to zoom back out.
- *Start recording a movie.* Press the **OK** button to start recording a movie at the current movie settings (see “Shooting Videos on the D90” on page <669>).
- *Change the display brightness.* Hold the  button down to get the brightness control on the screen, and use the $\updownarrow$ keys on the Direction pad to alter the brightness setting.
- *Cancel Live View.* Press the **LV** button again to leave the Live View shooting mode. Note that pressing the  button also cancels Live View.

Frame Advance Troubleshooting

Problem: In Continuous shooting method you can’t achieve the maximum 4.5 fps frame rate.

Solution: Turn off **Long Exp. NR**. Turn off Automatic ISO. Both can impact the maximum frame rate the camera can achieve. Make sure that you’re using a shutter speed that can achieve 4.5 fps. Also, note that some VR lenses seem to lower the maximum continuous frame rate speed of the camera (this isn’t true of the D200 or other high-end Nikons).

Problem: When set to either Continuous shooting method, the camera takes pictures at irregular intervals.

Solution: **AF-S** or **AF-A** autofocus is also set, and in these modes focus operations always have precedence over shutter release (e.g. the camera waits for the autofocus system to refocus the lens on a moving subject before releasing the

shutter). Even in **AF-C** autofocus the camera will sometimes “hiccup” while focusing. Set the camera to manual focus and the camera takes pictures at regular intervals.

Problem: Rapid shooting with a flash produces inconsistent exposures.

Solution: You probably need to use a Speedlight with faster recycling properties, or you need to set the flash to one of its lower-power manual modes (many Speedlights can fire at high frame advance speeds when set to manual flash mode at reduced power; see my *Nikon Digital Flash Guide* for more details). If you need to shoot with flash with rapid refresh, you should also look into getting the high voltage power option for your Speedlight. For example, you can run both a D90 and an external Speedlight from either a Digital Camera Battery or a Quantum Turbo battery, with the Speedlight being powered at 24v by the battery for faster cycling.

Problem: The D90 shoots at a slower frame rate when the background is dark (as compared to scenes with light backgrounds).

Solution: Most recent Nikon bodies exhibit this characteristic. Nikon has not released an explanation for the phenomenon. Switching to manual exposure mode does not change the behavior. Your only choice is to light the background.

Problem: The D90 shoots at a slower frame rate when noise reduction is turned on.

Solution: This is normal. Turn off the noise reduction.

Multiple Exposure

The D90 has two in-camera facilities for creating composite images. These differ in several ways:

	<i>Image Overlay</i>	<i>Multiple Exposure</i>
<i>Number of shots</i>	2 only	2 or 3
<i>Image Format</i>	Pre-shot NEFs create finished JPEG or NEF	Finished image is a JPEG or NEF
<i>Auto Gain</i>	No, though you can preview effect of gain	Yes
<i>Preview of Effect</i>	Yes	No
<i>Image Quality settings</i>	Are applied from first image to both	Are those in effect when each exposure is shot
<i>EXIF Data</i>	Is from first image	Is from first image in sequence

Image overlays are created on *existing* images via the RETOUCH menu (see “Image Overlays” on page <705>).

Multiple exposures are a little different. Here, instead of using two preexisting images you use the camera’s frame rate features to advantage to create overlapped images *during* shooting.

First, let’s go through the set-up necessary:

1. Press the **MENU** button to see the menus on the color LCD.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).
3. Use the Direction pad to navigate to **Multiple exposure** and press the **▶** key on the Direction pad to select it. If this option is grayed out, make sure that the

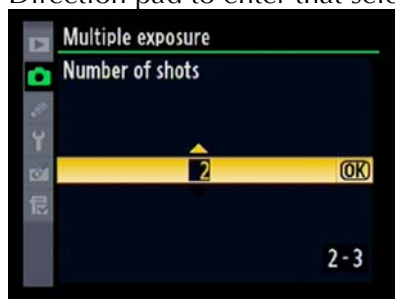
Shooting Method dial is not set to Live View.



4. Use the Direction pad to navigate to **Number of shots** and press the **►** key on the Direction pad to select it.

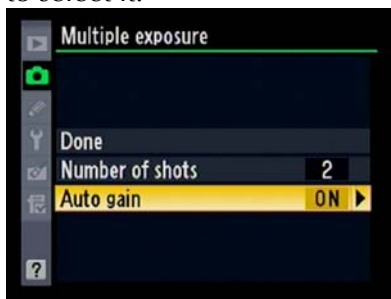


5. Use the **▲** and **▼** keys on the Direction pad to select the number of shots (2 or 3) and press the **►** key on the Direction pad to enter that selection.

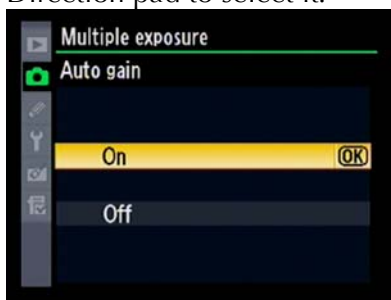


6. If you want the camera to adjust exposure for the multiple images automatically:
 - a. Use the Direction pad to navigate to **Auto gain** and press the **►** key on the Direction pad

to select it.



- b. Navigate to **On** and press the **►** key on the Direction pad to select it.



7. Navigate to **Done** and press the **►** key on the Direction pad or the **OK** button to select it.



The camera is now set to take a sequence of photos and combine them into one. But there are some twists involved, so let's look at them individually:

	<i>Shots Taken</i>	<i>Why Use It</i>
<i>Shooting method is set to single frame or self timer</i>	One with each shutter release press	To combine multiple, disparate elements into one shot
<i>Shooting method is set to Continuous</i>	With a single press of the shutter release	To track motion through a shot, or to make moving objects get soft edges
<i>Camera set to use interval timer via Camera Control Pro</i>	At the selected intervals selected	To track motion or an event over time, using an exact time sequence

A bunch of caveats apply, but they all amount to pretty much the same thing: long lapses of time or specific actions on your part will cancel the multiple exposure setting. Specifically, the option is canceled if you do nothing for 30 seconds, turn the camera off, exhaust or replace the battery, or cancel the multiple exposure operation specifically.

Connecting to a GPS

The D90 can be connected to the optional GP-1 device to record location data. When you do this, you'll have Coordinated Universal Time (UTC), longitude, latitude, and altitude data added to the EXIF information for every picture you take while the camera and GPS are connected. Specifically, you get the following data points in the EXIF (I've added some typical sample data):

GPS Version ID: 2.2.0.0

GPS Latitude Ref: North

GPS Latitude: 39 deg 0' 0"

GPS Longitude Ref: West

GPS Longitude: 70 deg 0' 0"

GPS Altitude Ref: Above Sea Level

GPS Altitude: 150 meters

GPS Time Stamp: 20:30:01

GPS Satellites: 08

GPS Map Datum: WGS 84

GPS Heading: 16°

To make the connection you need: the optional GP-1 GPS Accessory (from Nikon). In theory, other GPS devices could be supported with the correct cable. As usual, however, Nikon hasn't documented this connection, so third parties will have to reverse engineer the connector and do their own testing, which will delay third party support.

 To use GPS on the D90:

1. Turn the camera off.
2. Connect the cable from the GP-1 to the camera.
3. Turn the camera on.
4. You'll see the **GPS** icon on the top LCD blink until the GPS unit has obtained connection to enough satellites to have a reliable signal. GPS data is only stored for images when this icon has stopped blinking and appears steady in the D90's top LCD.

Any time the camera loses the signal from the GPS unit for more than two seconds, the **GPS** icon will go away and GPS information will no longer be recorded. However, you *can* take pictures when the GPS hasn't yet acquired or has lost the satellite signal; those pictures just won't have GPS data in the EXIF fields.

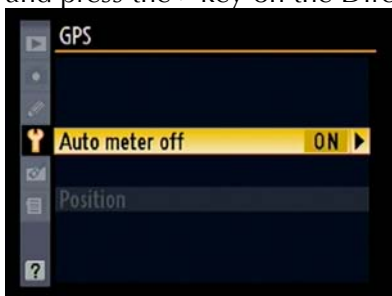
A word of warning: if you've got a GP-1 plugged into the connector on the D90, as long as power is being drawn off the connector the camera's batteries are being drained.

 The D90 has two menu options for GPS:

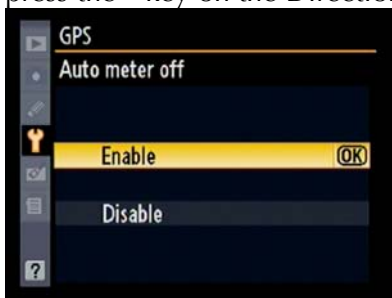
1. Press the **MENU** button to get to the menu system.
2. Use the Direction pad to navigate to the SETUP menu (yellow wrench icon).
3. Use the Direction pad to navigate to **GPS** and press the **▶** key on the Direction pad to select it.



4. Use the Direction pad to navigate to **Auto meter off** and press the **▶** key on the Direction pad to select it.



5. Use the Direction pad to navigate to your choice and press the **▶** key on the Direction pad to select it.



Enable means that the camera's usual meter off setting (Custom Setting #C2) will be honored. **Disable** means the camera metering will be left continuously

on. The reason you might want to set the latter value is that if the meter turns off, it takes a moment for the camera to re-establish communication with the GPS and pressing the shutter release suddenly to take a shot from the meter off state may cause the camera not to get the GPS information. With some GPS units that are powered from the camera, things can be worse, as they can take awhile to re-establish a GPS lock when powered up. My recommendation is that you either set a longer metering off value with Custom Setting #C2, get in the habit of pressing the shutter release partway to re-establish GPS communications before pressing the release completely, or both.

6. Use the Direction pad to navigate to **Position** and press the ► key on the Direction pad to select it.



The camera will now display the current information from the GPS unit.



Another GPS option that some consider is geotagging their images in post processing. In other words, they use a separate device to capture the GPS data and later integrate this into

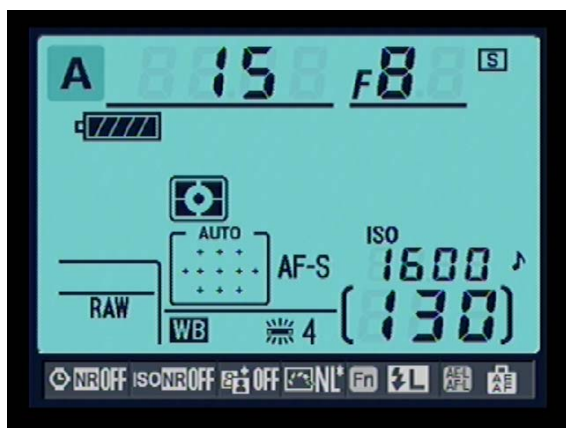
their image data. First, there's the issue of synchronizing the camera and GPS clocks. Without those being relatively close to synchronized, you're going to get incorrect data. But the big problem with post processing GPS data is that if you try to place it in the EXIF data for the original file, you can easily corrupt TIFF and especially NEF images. I don't recommend post processing geotagging.

Shooting Information Display (INFO Button)

One useful option the D90 provides allows you to display shooting information on the color LCD as well as the top LCD. The display includes some items that aren't found on the top LCD. This facility is similar to what the D40, D40x, and D60 use (those cameras don't have a top LCD), and based upon the revision that first appeared on the D700.

If you're coming from a D300 or D3, the D90's use of the shooting information display is actually much more useful, as the D90 allows you to set many of the items directly (the D300 and D3 only allow you to see the current setting). However, note that the shooting information display can only be seen when the shutter release is *not* pressed.

To activate the display, press the **info** button. You'll see something like the following on your color LCD:



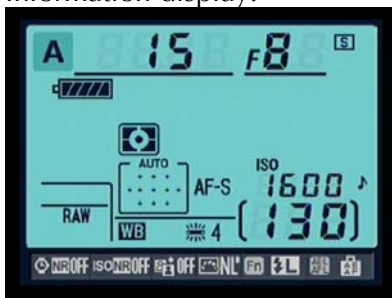
The main portion of this display mimics the top LCD though it does have a few additional pieces of information (the ISO value, for example). The default display is black characters on a light blue background in bright light, in dim light you get the light on dark display seen above at the default setting; you can control which appears via Custom Setting #D8. The length of time that the shooting information display stays active is controlled using Custom Setting #C4.

The bottom area is most interest to us (white characters on black background in both display options), as it displays other important information that isn't normally available short of looking at values in the menu system.

Short of dropping into the menu system, you won't find the values shown at the bottom of the shooting information display anywhere else, let alone all displayed together. Thus, I almost always do a quick inspection of this screen just before each shooting session, just to make sure that everything is set the way I want it to be.

But even better: all the items in the bottom portion of the shooting information display can be *set* directly from it:

1. Press the **info** button once to show the shooting information display.



2. Press the **info** button a second time while the shooting information display is visible and one of the items in the lower section is highlighted in yellow with a

balloon help message indicating which item that is.



3. Move your selection between the items by using the keys on the Direction pad.
4. Select the currently highlighted item by pressing either the **OK** button or the center button on the Direction pad and you'll be taken directly to the menu system option for that item.

The menu items that can be directly set from the shooting information display are (left-to-right):

Long Exp. NR

High ISO NR

Active D-Lighting

Set Picture Control

Custom Setting #F3, **Assign FUNC. button**

Custom Setting #F4, **Assign AE-L/AF-L button**

I find the shooting information display option especially useful when shooting at night or in dark places on a tripod. Indeed, I find it easier to read this display than the top LCD with the backlighting active.

D90 Menus

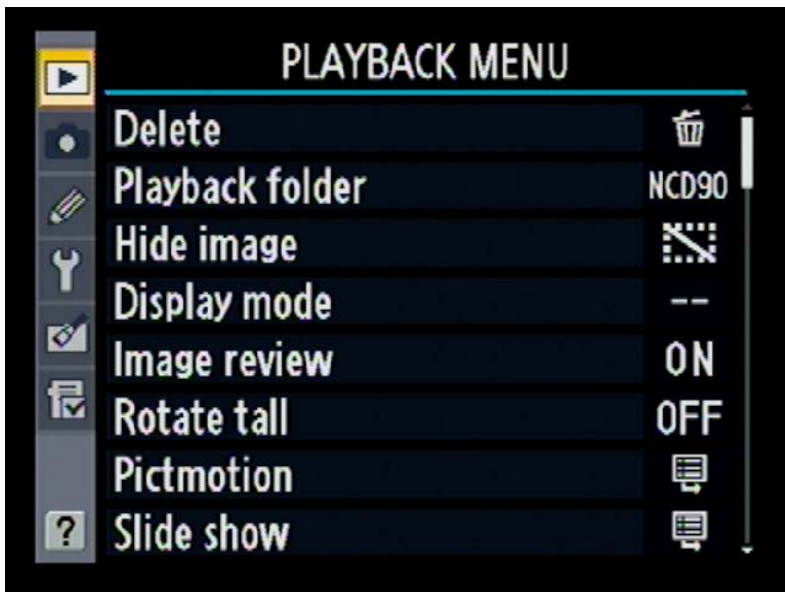
The D90 uses the color LCD extensively to give you clearer indication of your options and settings. Not only are the custom settings on this menu system, but many of the direct digital controls are duplicated with a menu system on the color LCD.

Note: While you use the Autofocus Direction pad to navigate these menus, some new users can't quite figure out how to move from tab to tab. If you want to move from the PLAY menu to the SHOOTING menu, for example, you may have to press the ◀ key on the Direction pad to select the tab area, then use the ▲ and ▼ keys to select the tab you desire. Use the ▶ key to then move back to the main portion of that menu, and then use the ▲ and ▼ keys again to move between menu items. That all sounds more complicated than it really is. Short course: if you find you can't get to something, try pressing the ◀ key first.

*Tip: Keep your eye open for sub-menus that have a **Done** option. They're going to trip you up some day, as any of the options for that sub-menu don't get set until you've also selected the **Done** option. It's kind of like the **Apply** button on some Windows dialogs: an annoying extra step that's easy to forget.*

Here's a handy summary of the menu hierarchy (my suggested settings, where appropriate and different from the default, are in **green**; settings I suggest you try to avoid are in **orange**):

PLAYBACK menu (▶ icon)



Note: The PLAYBACK menu and its Menu Items use blue for easy recognition of which menu system you're in (note the blue line).

Note: The PLAYBACK menu is a scrolling menu, meaning that there are more options available than can be seen at one time. Note the scroll bar on the right side of this menu; the white box shows you where you are in the scrolling Menu Item list. When you move past the bottom of the visible Menu Items, additional Menu Items are revealed.

Note: The PLAYBACK menu is disabled and inaccessible if no card is present in the camera.

Delete

Selected

Select date

All

Playback folder

Current

All

Hide image

- Select / Set
- Select date
- Deslect All?
- Display mode
 - Done
 - Highlights
 - RGB histogram
 - Data
- Image review
 - On
 - Off
- Rotate tall
 - On
 - Off¹⁰⁸
- Pictmotion
 - Start
 - Select pictures
 - Background music
 - High-speed
 - Emotional
 - Natural
 - Up-tempo
 - Relaxed
 - Effects
 - Zoom bounce
 - Zoom in/out
 - Blend
 - Wipe
 - Zoom out fade
- Slide show
 - Start
 - Frame interval
 - 2s
 - 3s
 - 5s
 - 10s
- Print set

¹⁰⁸ Showing images rotated on the LCD makes them too small to assess well, IMHO.

Select / Set Deselect all?

SHOOTING menu (📷 camera icon)



Note: The SHOOTING menu and its Menu Items use green for easy recognition of which menu system you're in (note the green line).

Note: The SHOOTING menu is a scrolling menu, meaning that there are more options available than can be seen at one time. Note the scroll bar on the right side of this menu; the white box shows you where you are in the scrolling Menu Item list. When you move past the bottom of the visible Menu Items, additional Menu Items are revealed.

Set Picture Control

Standard

Neutral

Vivid

Monochrome

Portrait

Manage Picture Control

Save/edit

Rename

Delete

Load/save

Image quality

NEF (Raw) + JPEG fine

NEF (Raw) + JPEG normal

NEF (Raw) + JPEG basic

NEF (Raw)

JPEG fine

JPEG normal

JPEG basic

Image size

Large (4288x2848; 12.2M)

Medium (3216x2136; 6.9M)

Small (2144x1424; 3.1M)

White balance

Auto

Incandescent

Fluorescent

Sodium-vapor lamps

Warm-white fluorescent

White fluorescent

Cool-white fluorescent

Day white fluorescent

Daylight fluorescent

High temp. mercury-vapor

Direct sunlight

Flash

Cloudy

Shade

Choose color temp

Preset

ISO sensitivity settings

200 to **3200** in third stop settings (half stop with custom setting), plus **Lo 0.3** (160), **Lo 0.7** (125), **Lo 1.0** (100), **Hi 0.3** (4000), **Hi 0.7** (5000), and **Hi 1.0** (6400)

ISO sensitivity auto control

On

Off

Maximum sensitivity (disabled unless auto control on)

400 to Hi 1

Minimum shutter speed (disabled unless auto control on)

1 second to 1/2000 second

Active D-Lighting

Auto

Extra high

High

Normal

Low

Off

Color space

sRGB

Adobe RGB

Long exp. NR

Off

On

High ISO NR

High

Normal

Low

Off

Active folder

Select folder

New

Rename

Delete

Multiple exposure

Done

Number of shots

Auto gain

On

Off

Movie settings

Quality

1280x720 (16:9)

640x424 (3:2)

320x216 (3:2)

Sound

On

Off

CUSTOM SETTING (custom settings) menu (✎ pencil icon)

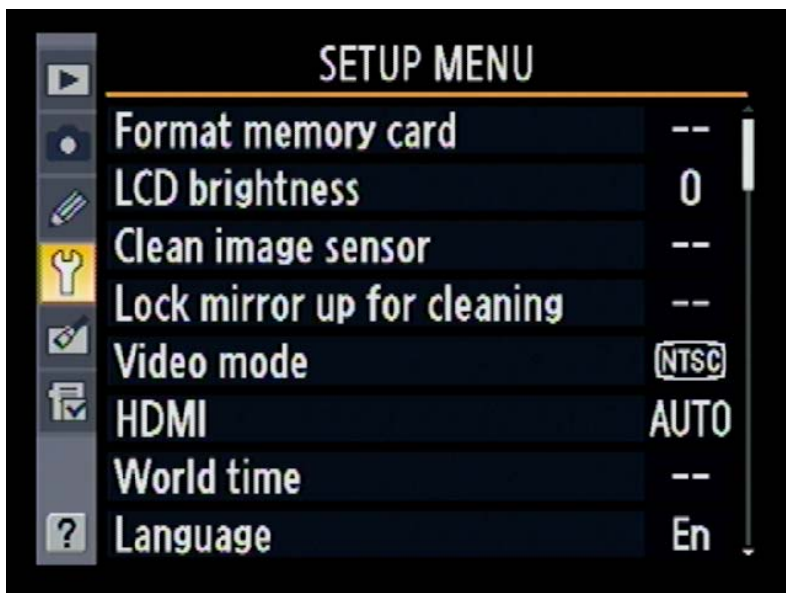


Note: The CUSTOM SETTING menu and its Menu Items use pink for easy recognition of where you are in the menu system (note the line).

Note: The CUSTOM SETTING menu is a master menu that leads to a long scrolling menu, meaning that there are more options available than can be seen at one time. Select one of the lettered areas to get into the scrolling menu at a particular section of it. When you move past the bottom of the visible options in a scrolling menu, additional options are revealed.

I'll deal with these individually a little later in the book (see the section starting on page <477>).

SETUP menu (⚙ wrench icon)



Note: The SETUP menu and its Menu Items use orange for easy recognition of where you are in the menu system (note the line).

Note: The SETUP menu is a scrolling menu, meaning that there are more Menu Items available than can be seen at one time. When you move past the bottom of the visible Menu Items, additional ones are revealed¹⁰⁹.

Format memory card

No

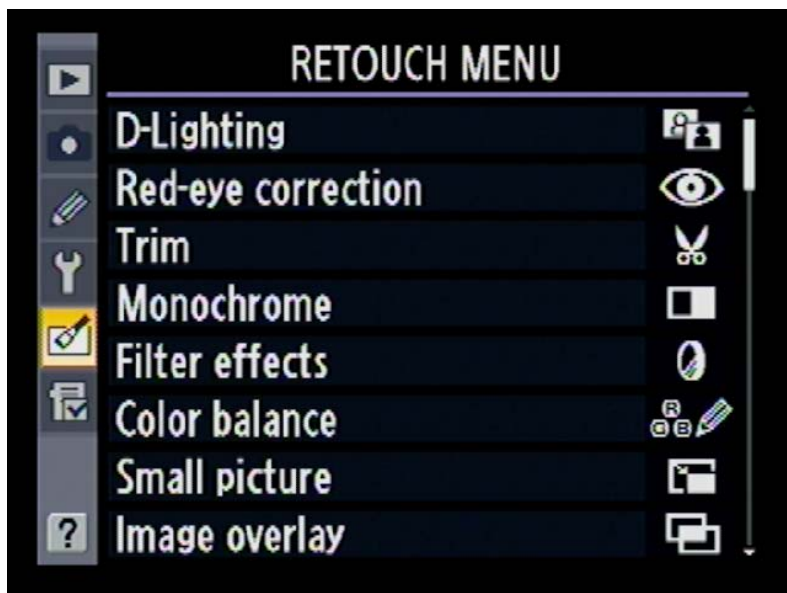
Yes

¹⁰⁹ If I have any gripe about Nikon's option ordering, it is on this menu. The things that you tend to change once (**World time** or **LCD brightness**, for example) really should be on the second page and the things you use more often (e.g. **Dust ref photo** or **Battery info**) should be on the first page. In general, Nikon still hasn't glommed on to the frequency with which certain settings are made or consulted, and thus you end up having to press more buttons than you should. The function on this menu you perform most often, for example, is **Format memory card**, which takes an additional two button presses to reach. Fortunately, we have an alternative, more direct method for that function.

LCD brightness**-2****-1****0****+1****+2****Clean image sensor****Clean now****Clean at startup/shutdown****Clean at startup****Clean at shutdown****Clean at startup & shutdown****Cleaning off****Lock mirror up for cleaning****Video mode****NTSC****PAL****HDMI****AUTO****480p (progressive)****576p (progressive)****720p (progressive)****1080i (interlaced)****World time****Time zone****Date and time****Date format****Daylight saving time****On****Off****Language****Dansk****Deutsch****English****Español****Suomi****Français****Italiano****Nederlands**

Norsk
Polski
Português
Русский
Svenska
Traditional Chinese
Simplified Chinese
Japanese
Korean
Image comment
Done
Input comment
Attach comment
Auto image rotation
On
Off
Image Dust Off ref photo
Start
Battery info
GPS
Auto meter off
On
Off
Position
Firmware version

Retouch menu (Brush icon)



D-lighting

Normal

Moderate

Enhanced

Red-eye correction

Trim

3424x2280 (3424x2568, 3216x2568)¹¹⁰

2560x1704 (2560x1920, 2400x1920)

1920x1280 (1920x1440, 1808x1440)

1280x856 (1280x960, 1200x960)

960x480 (960x720, 896x720)

640x424 (640x480, 608x480)

Monochrome

Black-and-white

Sepia

Cyanotype

Filter effects

Sky light

¹¹⁰ 3:2 aspect ratio, with 4:3 and 5:4 in parentheses.

- Warm filter**
- Red intensifier**
- Green intensifier**
- Blue intensifier**
- Cross screen**
- Color balance**
- Small picture**
 - Select picture**
 - Choose size**
 - 640x480**
 - 320x240**
 - 160x120**
- Image overlay**
- NEF (RAW) processing**
 - Image quality**
 - Image size**
 - White balance**
 - Exposure comp.**
 - Set Picture Control**
- Quick retouch**
 - High**
 - Normal**
 - Low**
- Straighten**
- Distortion control**
 - Auto**
 - Manual**
- Fisheye**

MY MENU (checked icon)



Note: The MY MENU and its Menu Items use gray for easy recognition of where you are in the menu system (note the line).

Note: Your MY MENU will look different. If you add more than five items, the menu will be a scrolling menu (note bar on right side).

Items always present on this menu are:

Add items

Remove items (grayed out if you have no items)

Rank items (grayed out if you have no items)

Choose tab

Nikon has taken a haphazard approach to ordering Menu Items across the many menus in the system, making many of the more useful ones sprawl into inconvenient locations that take many keystrokes to get to. Fortunately, they also gave us a partial solution in MY MENU (and a RECENT menu option, as well), which allows you to configure your own menu.

Here's my recommendation: look through the SHOOTING and SETUP menus and note Menu Items you use a lot that are buried down in these menus, especially ones that are on the second or third page of Menu Items. The PLAYBACK and RETOUCH menus are short enough that you don't usually get much faster access by moving Menu Items from them to the MY MENU. The Menu Items on the CUSTOM SETTINGS menu are another candidate for MY MENU, but I tend to suggest that you use the Custom Settings Banks to provide quick access to common camera changes.

Whatever items you choose, add no more than eight of your selected Menu Items to MY MENU. Adding more makes for yet another scrolling list, and starts to defeat the purpose of making controls more accessible. Also, note that shooting information display gives you access to 10 menu functions, so you probably don't want those 10 on your MY MENU.

Here are the things I sometimes put on my MY MENU:

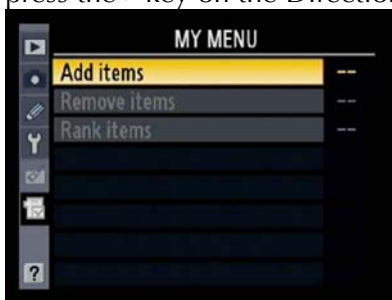
ISO sensitivity auto control
NEF (RAW) recording
Clean image sensor
Battery info
GPS

All these Menu Items take quite a few key presses to get to in the regular menus, yet are things I use more frequently than the Menu Items that are easier to get to.

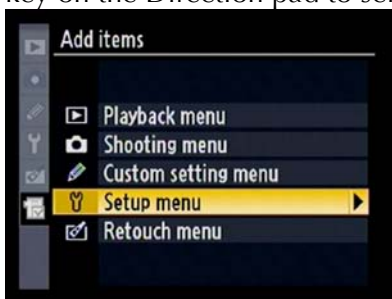
 To add an item to MY MENU:

1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the MY MENU menu (white checked menu icon).

- Use the Direction pad to navigate to **Add items** and press the **▶** key on the Direction pad to select it.



- Use the Direction pad to navigate to the Menu that has the Menu Item you want to select and press the **▶** key on the Direction pad to select it.

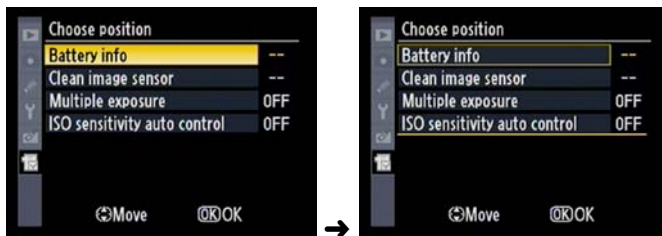


- Use the Direction pad to navigate to the Menu Item you want to select and press the **OK** button to select it. Items that have a  in front of them are not available for MY MENU. Items that have a  in front of them are ones that you've already placed on MY MENU.



- If the item is not in the position on MY MENU you want it at, use the **▲** and **▼** keys on the Direction pad

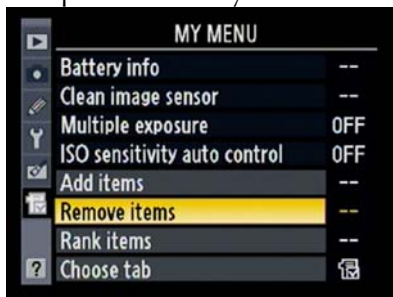
to move it to a new one (the yellow line shows where it will be inserted). Press the **OK** button again to move it.



Repeat Steps 3 to 6 for each of the Menu Items you want on MY MENU.

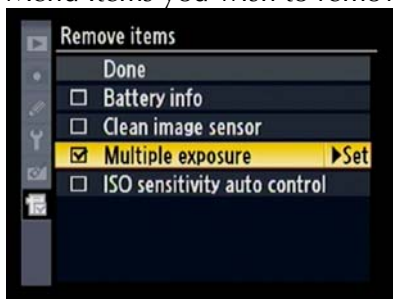
📷 Later, if you decide that an item doesn't belong on MY MENU and wish to remove it:

1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the MY MENU menu (white checked menu icon).
3. Use the Direction pad to navigate to **Remove items** and press the **►** key on the Direction pad to select it.



4. Use the Direction pad to navigate to the Menu Item you want to remove and press the **►** key on the Direction pad to select it. A check appears in the box in front of the Menu Item. Repeat this step for all the

Menu Items you wish to remove.



5. Use the Direction pad to navigate to **Done** and press the **Set** key on the Direction pad or the **OK** button. When the confirmation question appears, press the **OK** button again.

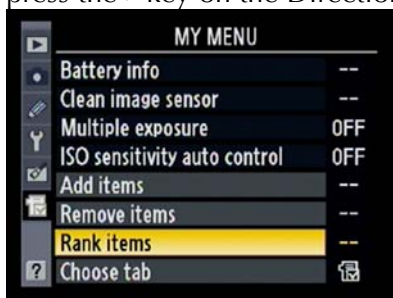


Tip: You can delete items faster by just navigating to an item on the MY MENU so that is highlighted, then press the Delete (M) button twice (once to initiate, once to confirm).

📷 If you decide that the order of the items you've placed on MY MENU needs to be changed:

1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the MY MENU menu (white checked menu icon).

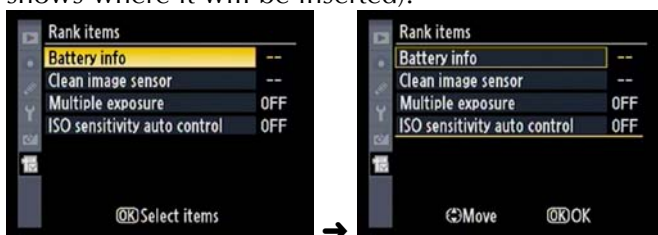
- Use the Direction pad to navigate to **Rank items** and press the **►** key on the Direction pad to select it.



- Use the Direction pad to navigate to the Menu Item you want to move and press the **OK** button to select it.



- Use the **▲** and **▼** keys on the Direction pad to move the Menu Item to a new location (the yellow line shows where it will be inserted).



- Press the **OK** button again to complete the move.

Repeat Steps 4 through 6 for all the Menu Items you wish to move. To leave the ranking option at any time, just press the **MENU** button.

When you select items from MY MENU during shooting, these apply to the currently active SHOOTING bank or CUSTOM SETTINGS bank. This is important to remember!

RECENT SETTINGS (file folder list icon)



Note: The RECENT SETTINGS menu and its Menu Items use gray for easy recognition of where you are in the menu system (note the line).

Note: Your RECENT SETTINGS menu will look different. This just happens to be the last two items I used when I set the menu to appear.

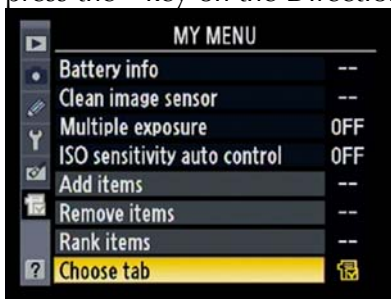
Items always present on this menu are:

Choose tab

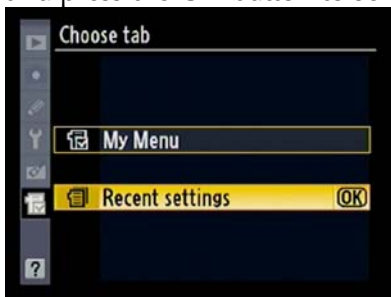
 To get RECENT SETTINGS to replace MY MENU:

1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the MY MENU menu (white checked menu icon).

- Use the Direction pad to navigate to **Choose tab** and press the **►** key on the Direction pad to select it.

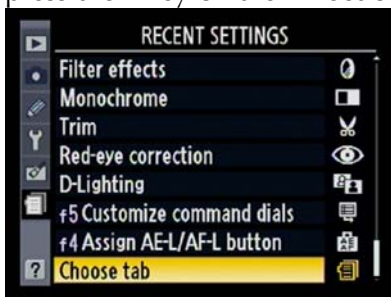


- Use the Direction pad to navigate to **Recent settings** and press the **OK** button to select it.

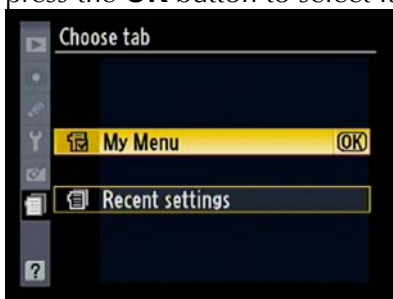


 To restore MY MENU in place of RECENT SETTINGS:

- Press the **MENU** button to see the menu system.
- Use the Direction pad to navigate to the RECENT SETTINGS menu (white file folder icon).
- Use the Direction pad to navigate to **Choose tab** and press the **►** key on the Direction pad to select it.



4. Use the Direction pad to navigate to **My Menu** and press the **OK** button to select it.



I personally prefer MY MENU over RECENT SETTINGS, mainly because I have more control over what's at my fingertips. But it's nice that we can now set the D90 to perform the same as some other Nikon bodies.

Error Messages

The D90 viewfinder and top LCD have a number of indicators that remind you how the camera is set while you're shooting. But more important is that these displays show error messages you need to be aware of:

<i>Message</i>	<i>Where Seen</i>	<i>What it Means</i>
FE (blinks)	Viewfinder, top LCD	The lens has not been set to the smallest aperture. Solution: Set the aperture ring on the lens to the smallest aperture (usually f/22).
• (blinks)	Viewfinder	Camera cannot obtain autofocus (normally only seen in dim light or low contrast situations, but also seen sometimes with lenses whose maximum aperture is near f/8). Solution: Focus the lens manually. Or use the Autofocus Assist lamp on your flash.
H!	Viewfinder, top LCD	Camera may not set proper exposure and the resulting ambient lighting will be overexposed. Solution: Choose a lower ISO value, if possible. In Program exposure mode, use a neutral density filter, a polarizer, or choose another exposure mode; in other exposure modes, choose smaller apertures or shorter shutter speeds.

<i>Message</i>	<i>Where Seen</i>	<i>What it Means</i>
	Viewfinder, top LCD	Camera may not set proper exposure and the resulting ambient lighting will be underexposed. Solution: Choose a higher ISO value, if possible. In Program exposure mode, use flash or choose another exposure mode; in other exposure modes, choose larger apertures or longer shutter speeds, or use flash.
 (blinks)	Viewfinder, top LCD	The camera is indicating that you've set the shutter speed to bulb and then switched to Shutter-priority mode. Solution: If you want to use a  shutter speed, switch to Manual exposure mode; otherwise set a valid shutter speed (the camera can't set an aperture when it doesn't know how long the shutter will be open).
 in Frames Remaning indicator (blinks) card icon may blink if overlays are active	Viewfinder, Top LCD ( blinks)	The card is full of images. Solution: Remove the current storage card and replace with a blank one, or transfer the images to computer via USB and format the storage card. If all you need is a couple more shots, try deleting images you don't need or setting an Image quality and Image size that uses less storage space.

Message	Where Seen	What it Means
 (blinks)	Viewfinder	The scene brightness exceeds that which the meter can handle. Solution: Use a neutral density filter in bright situations, flash in dim situations.
Shutter speed (blinks)	Top LCD	You're trying to use flash at a shutter speed higher than the sync speed; the camera will set 1/200. Solution: The camera automatically sets the shutter speed to 1/200 (which shows as the shutter speed in the viewfinder).
 (blinks)	Viewfinder	After exposure: flash fired at full power and the resulting image may be underexposed (it may also be correct). Solution: Review the image on the color LCD. If it is underexposed, use a larger aperture or reduce subject distance.
 (blinks)	Viewfinder and top LCD	A camera malfunction has occurred. Solution: Press the shutter release again. If the problem persists, take the camera in for servicing. (Also consider performing the steps mentioned in "The Last Resort Reset" on page <216>.
 (blinks)	Top LCD	Speedlight doesn't support red eye reduction. Solution: Cancel red-eye reduction Flash Option on the camera.

<i>Message</i>	<i>Where Seen</i>	<i>What it Means</i>
 (blinks)	Top LCD;  blinks in viewfinder	Speedlight doesn't support i-TTL. Solution: Either switch the flash to Automatic or Manual flash mode, or substitute an i-TTL capable flash.
• (stays on)	Back of camera Card Write indicator lamp	An image (or images) in the buffer has not yet been completely written to the card. Check to make sure you haven't taken a long exposure with Long exp. NR turned On —the Write indicator lamp will stay lit while the “dark frame” is being taken, which takes at least half the time of the actual exposure. Also happens when you've taken a large number of photos and a full buffer needs to be written to the card. Sometimes due to card write errors, this lamp stays lit. You may lose the most recently taken image(s) if you do this, but remove power from the camera and try another card.

Some error messages appear only on the top and color LCD:

<i>Message</i>	<i>Where Seen</i>	<i>What it Means</i>
-E- NO CARD PRESENT	Top LCD color LCD	The camera can't detect a Secure Digital card in the slot. Solution: Check to make sure that you've inserted a card and that it is properly engaged in the slot.
CH (blinks) THIS CARD CANNOT BE USED	Top LCD color LCD	The camera is having trouble accessing the Secure Digital card. This may indicate that the card is not formatted correctly or already contains the maximum number of files. Solution: Use a different card, or, if the card you inserted wasn't formatted properly, try to format it again.
For CARD IS NOT FORMATTED	Top LCD color LCD	The Secure Digital card you inserted hasn't been formatted for use in the camera. Solution: Format the card. <i>Note:</i> the For message also appears <i>during</i> formatting operation.
FOLDER CONTAINS NO IMAGES	color LCD	You're attempting to play back images from a folder on a card that contains none. Solution: It's possible that images are on the card, but in a different folder, so check to make sure that you've selected the proper folder. Otherwise, take a picture!

<i>Message</i>	<i>Where Seen</i>	<i>What it Means</i>
ALL IMAGES HIDDEN	color LCD	You're attempting to play back images from a folder on a card where all the images have been hidden. Solution: Unhide at least one image in the current playback folder; alternatively, select all folders for playback.
FILE DOES NOT CONTAIN IMAGE DATA	color LCD	Usually appears when you've overwritten a file using a computer. Solution: try looking at the image on a computer.
K	Top LCD	Not really an error. The camera is simply indicating that the Secure Digital card has space for more than 1000 exposures at the current settings.
∞00 to ∞09	Viewfinder	Not really an error, though many who don't read the manual carefully think it is. What the camera is trying to tell you is how many shots remain in the buffer ¹¹¹ .

¹¹¹ You'll note that the camera never displays a number higher than 9 for the buffer. But in Continuous frame advance mode at 3 fps, you'll also note that the indicator doesn't count down for each image. How fast the indicator counts down and the effective size of the buffer is determined by how fast your Secure Digital card is.

Image Review and Playback

The D90 allows images to be reviewed quickly and conveniently, and provides many options for viewing them. We'll deal with things that pertain to reviewing and marking images in this section.

Image Review

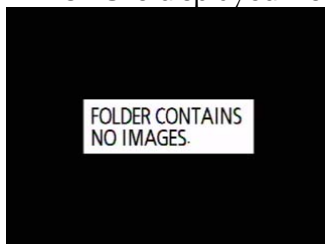
📷 Quick review is accomplished by pressing the  button on the back of the camera to turn the color LCD ON. After a brief delay, the most recently taken or displayed image is shown on the color LCD. The camera normally shows:

- The most recently *displayed* image if you have used the color LCD since taking a picture.
- The most recently *taken* picture if you've taken a picture since you last reviewed one.

(Yes, describing this difference is more difficult than it works out to be in practice.)

Note: The “normally shows” I just mentioned applies to the camera’s default behavior. It’s possible that you last left the camera showing multiple thumbnails, and if that is the case, you’ll be shown the thumbnail view again when the camera displays the most recently taken image in playback. Press the Zoom In button (⌂) until you see only one image again.

If no images have yet been stored on the Secure Digital card into the current folder, a message **FOLDER CONTAINS NO IMAGES** is displayed instead of an image:



If you see this message, try navigating to the **Playback folder** option on the PLAYBACK menu and make sure that you're

pointing to the correct folder (or select all folders for playback).

📷 When you're done with a quick review, press the  button again to turn the color LCD OFF, or press the shutter release partway as if you're taking a picture.

Note: The color LCD has a default power-off time (set via Custom Setting #C4, see "Color LCD Active Time" on page <504>). Press the  button to turn the color LCD back ON. If this is done after the camera's meter-off time has expired, the color LCD displays the same thing it did when it shut OFF; if the meter-off time has expired, the color LCD displays the most recent image in memory when it comes ON.

The image automatically appears for review on the color LCD after you take a picture if you set the **Image review** option (PLAYBACK menu) to **On**. Remember that you can also always press the  button to see the image.

Image Review Options

Whenever an image is shown on the color LCD, you have a number of options you can use:

- You can browse through any other pictures on the Secure Digital card by using the ◀ and ▶ keys on the direction pad (when you get to the last picture, the camera loops back to the first, and vice versa). You can also use the Rear Command dial to move through the pictures.
- You can browse through information pages for the current image by using the ▲ and ▼ keys on the direction pad (when you get to the last information page, the camera loops back to the first, and vice versa). You can also use the Front Command dial to move through the page options.

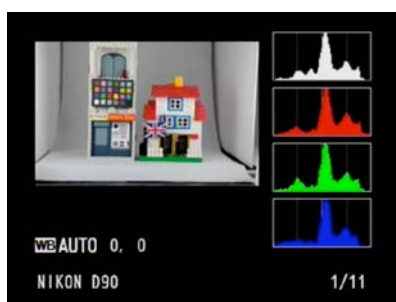
Some other Nikon bodies use the opposite orientation, but on those cameras you can usually use a Custom Setting to make the directions match those of the D90 (and the other low-end Nikon DSLR bodies). Thus, if you use a D90 as a backup

body to a D200, D300, D700, D2 series or D3, you might want to make sure that you've set the browsing directions the same on your other camera.

The pages, in order, are:



Page 1: folder and filename, size and image quality, frame count (#/# in upper right corner; first number is current frame number, second is the total number of frames in current folder), date and time.



Page 2: (Appears only if **Display mode** on PLAYBACK menu has **RGB histogram** selected) RGB Histogram—the frame count appears in the lower right corner, the camera and white balance setting below the picture. Luminance histogram (white) appears at top right next to the image and individual channel histograms (red, green, and blue) appear beneath that.



Page 3: (Appears only if **Display mode** on PLAYBACK menu has **Highlights** selected) Highlights—the overexposed highlights blink. The frame count appears in the lower right corner (**1/11** in this example).



Page 4: (Appears only if **Display mode** on PLAYBACK menu has **Data** selected). First Data Page—exposure information, exposure compensation, focal length, lens, focus and VR setting, and flash mode are overlaid on top of the image. The frame count appears in the lower right corner.

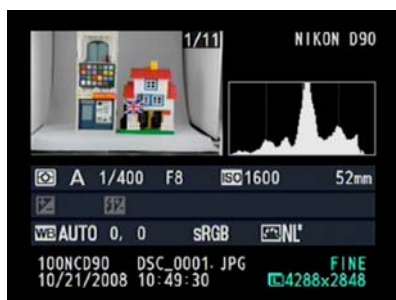


Page 5: (Appears only if **Display mode** on PLAYBACK

menu has **Data** selected). Second Data Page—White balance, Color Space, and Picture Control settings are overlaid on top of the image. The frame count appears in the lower right corner.



Page 6: (Appears only if **Display mode** on PLAYBACK menu has **Data** selected). Third Data Page—Noise reduction, Active D-Lighting, Retouch method, and Image Comment are overlaid on top of the image. The frame count appears in the lower right corner.



Page 7: Primary Summary Page—A basic luminance histogram is shown along with most of the critical camera settings in icon or abbreviated form. The frame count appears in the lower right corner.

You can protect the currently viewed image from deletion (but not from a card format) by pressing the **?/⏏** button while an image is displayed on the color LCD. A **⏏** icon appears at

the left top of the image:



Note that protected files are marked with a read-only marker that persists when you move them to a computer.

*Tip: In Windows, select the read-only file in a Windows Explorer window. Next select **PROPERTIES** from the **FILE** menu. Uncheck the box labeled **Read-only** to remove the read-only attribute.*

*On a Macintosh using OS 9.x or OS X, select the read-only file and press **Apple - I** (that's an i) to see the General Information box for the file. Uncheck the box labeled **Locked** to remove the read-only attribute.*

- You can delete the currently viewed image by pressing the  button. You'll be prompted to confirm the deletion: press the  button again to do so.



If the image was protected, you'll see **Cannot delete protected images** when you press the Delete button:

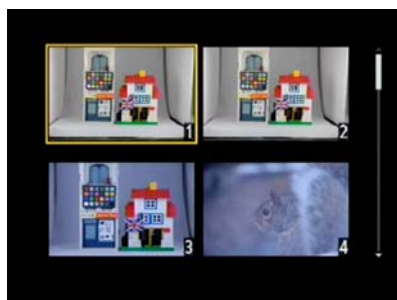


Unprotect the image before trying to delete it (press the **?/⏏** button).

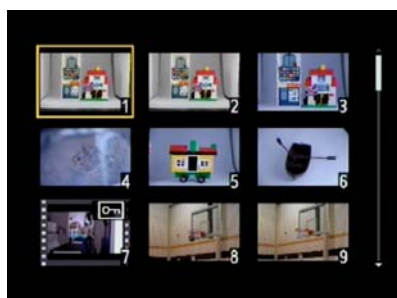
- You can display thumbnails of multiple pictures by pressing the Zoom Out (**⏏**) button. Each press of this button moves you one step further “away” from your images, which allows you to select 1 image per screen, 4 images per screen, 9 images per screen, or 72 images per screen when thumbnails are shown. There’s also a handy “calander view” that allows you to see images by when you took them.

Note that whatever choice you make is remembered, and that if more than one thumbnail is displayed, you can no longer reach other information pages about an image (the keys on the Direction pad control moving between thumbnails when multiple images are displayed).

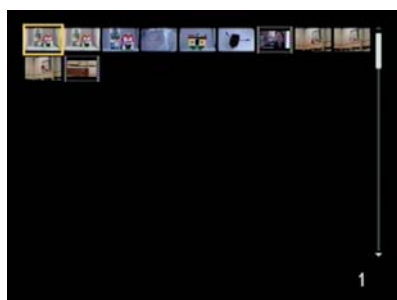
The currently selected image is outlined in yellow, and the delete and protect options I noted above work on this currently selected image. You can also press the **OK** button to get back to the full display mode for the currently selected image.



4 images per screen



9 images per screen



72 images per screen



Calendar view

- You can magnify the view by pressing the “Zoom In” button (⌕). Each press takes you “closer” to the image.



A box in the lower right corner appears briefly as a navigation box at each zoom level (the yellow box shows the zoomed area from the full image):



You can use the Direction pad keys to navigate to other areas of the image using the same zoom factor.

To move back away from the image, press the Zoom Out button (⌂). Each press takes you further away from the image until you return to the full image. You can also press the **OK** button to return directly to the full image.

Image reviewing has a different timeout setting than the shooting mode of the camera (the default is 10 seconds; see Custom Setting #C4, “Color LCD Active Time” on page <504>). If you have **Image review**

(PLAYBACK menu) set to **On**, images are automatically displayed after being taken, but only for four seconds at the default settings. This, too, can be changed via Custom Setting #C4.

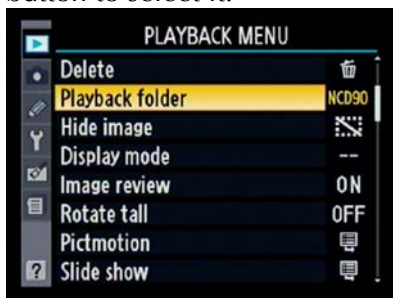
Videos appear slightly different on playback than stills. You see the first frame of the video with a video icon in the upper left corner. In the top middle there’s also a listing of how long the video is.



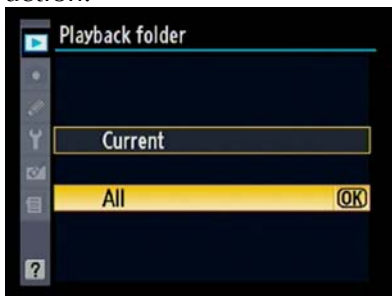
To play back the video, press the **OK** button. Other than zooming in, the other playback options (e.g. deletion and protection) apply to videos, too. During video playback, you can use the Zoom In (⌕) and Zoom Out (⌕❏) buttons to raise or lower the sound level, and the Direction pad to move around quickly within the video.

Don't panic if you see the **FOLDER CONTAINS NO IMAGES** message. The camera is trying to tell you that it can find no images in the *current folder* of the card; that doesn't mean that there aren't images on the card. Whenever you see the **NO IMAGES** message and you know that there are images on the card:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the **PLAYBACK** menu (blue play icon).
3. Use the Direction pad to navigate to **Playback folder** and press the **▶** key on the Direction pad or the **OK** button to select it.



4. Use the Direction pad to select **All** and press the **►** key or the **OK** button one more time to complete the action.



Rotating Images

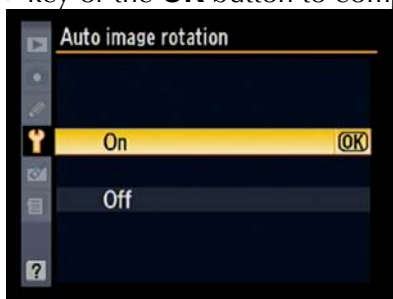
Images are usually displayed on the color LCD with the long axis across the long axis (i.e., vertical images aren't displayed rotated). The D90 has an automatic rotation detector, however. You can activate this so that images are correctly rotated to the proper orientation by Nikon's software, such as ViewNX or Capture NX2.

 To turn on automatic image rotation:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the **SETUP** menu (yellow wrench icon).
3. Use the Direction pad to navigate to **Auto image rotation** and press the **►** key on the Direction or the **OK** button to select it.



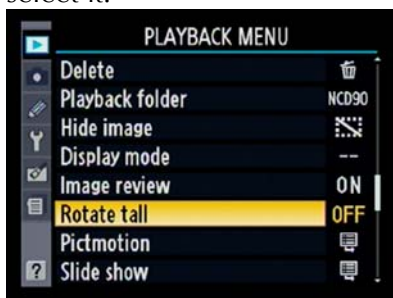
4. Use the Direction pad to navigate to **On** and press the **▶** key or the **OK** button to complete the setting.



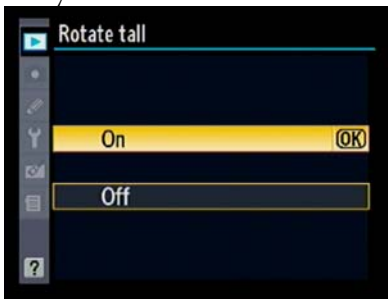
If you've set **Auto image rotation** to **On**, Nikon Transfer, Nikon ViewNX, and Nikon Capture NX2 also automatically rotate the images on your computer so that they'll show up in the correct orientation in whatever software you use. Other software may or may not recognize the rotation information in the file.

However, even if **Auto image rotation** is set to **On**, that doesn't mean the images show up rotated on the color LCD on the camera. For that you have to make a change in the **PLAYBACK** menu settings:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the **PLAYBACK** menu (blue playback button icon).
3. Use the Direction pad to navigate to **Rotate tall** and press the **▶** key on the Direction or the **OK** button to select it.



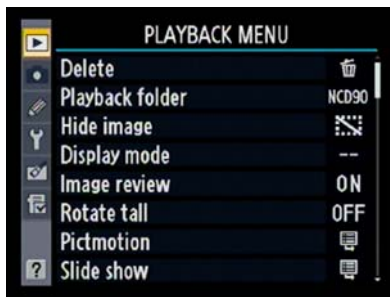
4. Use the Direction pad to navigate to **On** and press the **▶** key or the **OK** button to complete the setting.



Personally, I don't like the **Rotate tall** option, as it starts to make the review image too small to quickly evaluate. I leave this option **Off** on my D90 and just tilt the camera or my head.

The PLAYBACK Menu

Pressing the **MENU** button and selecting the first icon (▢) displays a selection of Menu Items on the color LCD:



The **▲** or **▼** keys on the Direction pad are used to navigate between the Menu Items (the currently selected item is highlighted in yellow; sometimes that's the icon, as in this case), and you press the **▶** key on the Direction pad or the **OK** button to select the highlighted Menu Item. Note that some of the Menu Items can be performed directly on the currently shown (or selected) image without using the menu system (e.g. **Delete** using the **🗑** button). The following sections detail most of the PLAYBACK menu options.

Deleting Images

📷 You can delete the image that is shown on the color LCD (or the currently selected thumbnails) by pressing the  button on the back of the camera. Before actual deletion begins, you'll be asked for confirmation, which you indicate by pressing the  button again (press any button on the back of the camera except for the  button to cancel deletion).



📷 Alternatively, you can use the **Delete** option on the **PLAYBACK** menu, which can delete either a few images or all of them:

1. **PLAYBACK -> Delete -> Selected**



2. Images are displayed twelve at a time:



3. Use the  and  keys on the Direction pad to select or deselect image(s) for deletion (you'll see the  icon

appear on it (see image 11, which is a movie, below).



4. Press the **OK** button to tell the camera you wish to delete the selected images.
5. Navigate to **Yes** and press the **▶** key on the Direction pad or the **OK** button to complete the action.



Here are the three **Delete** options via the menu system:

Selected



As just outlined in the screen shots, above, the D90 displays a thumbnail view of the images, twelve at a time (Step 2, above). You navigate through them similarly to the way you would in thumbnail view (◀ and ▶ key on the Direction pad), pressing the Zoom Out button (⌂) on the Direction pad on each image you want to erase (each press is a toggle, and a small trash can appears on any image scheduled for deletion—Step 3, above). You can

also press the Zoom In button (⌕) to temporarily see a larger version of the currently selected image (useful when you have a sequence of very similar images and are trying to figure out which one to erase). You confirm the deletion of all the selected images by pressing the **OK** button, navigating to **Yes**, and pressing the **OK** button again when prompted (Steps 4 and 5, above). Images marked with a protect symbol cannot be deleted; hidden images aren't displayed.

Select date



Similar to **Selected** but instead of selecting individual images, you select all images created on a particular date. The D90 displays a series of dates with the first image from each date:



You can press the Zoom Out button (⌕) to see the individual images for the highlighted date, or simply press the ► key on the Direction pad to “set” the images on the highlighted date for deletion. Continue this process until you’ve picked all the dates you wish to delete images for. You confirm the deletion of all the selected dates by pressing the **OK** button, navigating to **Yes**, and pressing the **OK** button again when prompted. Images marked with a protect symbol cannot be deleted; hidden images aren't displayed.

All



The D90 immediately displays a confirmation prompt. Navigating to **Yes** and confirming that by pressing the **OK** button immediately deletes all photographs on the card *except for ones that have been marked as **PROTECTED** or are **HIDDEN**.*

Nikon's manual says that deleted images cannot be recovered. They can, but not easily, and only if you take immediate action.

If you accidentally erase an image (or more) on a card, set that card aside until you can access it with your computer. Use an image recover utility program such as PhotoRescue (<http://www.datarescue.com/photorescue/>) to recover the deleted file before doing anything else with the card. This works because the act of deletion doesn't actually remove the data for an image, it simply marks the space used by the file as available. Thus, if you write additional images to a card after deleting a file, you often can't recover the deleted file, as the D90 has probably used the space for the new images.

Dealing with Folders

I've dealt with it earlier, but it's worth repeating here as we go through the PLAYBACK menu options: the D90 uses folders to organize images stored on the Secure Digital card. Because the D90 follows the DCF digital camera standard (Design Rule for Camera File Systems) agreed to by most manufacturers, there are limitations on folder names and locations.

If you do nothing (i.e. don't use any of the options on the **Playback folder** selection on the PLAYBACK menu), the D90 creates a root folder named **DCIM**, which in turn contains a

folder named **100NDC90**. The first 999 images stored on the card are stored in that folder, then a new folder named **101NDC90** is created and the next 999 images stored there¹¹². This process of creating new folders every 999 images continues until you fill the card. Thus, when you examine the structure of the Secure Digital card on your computer, you may see something like this:

```
DCIM
+----100NDC90
+----101NDC90
etc.
```

You can create new folders, but they always have a number as the first three characters and the D90 identifier as the last five (e.g. **102NDC90** or **102BYTHM**), which isn't particularly flexible.

Once again, here's the full extent of what you can do with folders on a D90:

- Create a new folder name
- Select which folder the camera writes to
- Select which folders to display in playback
- Delete *empty* folders

I deal with these things in “Folders” on page <173>.

Dealing with folder *numbers* is a different story. They can't be easily reset on the D90.

Folders are seriously confusing and restraining on the D90, at least if you start doing things that create new ones. I strongly advise against creating additional folders on the D90 (note

¹¹² If you reformat the card or otherwise erase the images in a folder before the image count gets to 999 for that folder, no new folder is created. In other words, it's not that a new folder is always created every time you take 999 images; it's that a new folder is created when the current folder *contains* 999 images.

that if you shoot more than 999 images on a card, you might have one created automatically by the camera). Not only will it create confusion when transferring images to your computer, but unless you're disciplined about erasing folders and restoring your "active folder" (**Active folder**→**Select folder**) setting, you'll start folder creep, which can be annoying.

Hiding Images

The D90 allows you to "hide" images, which prevents them from displaying in image review, in some of the PLAYBACK menu items, or in slide shows. When copied to a computer, hidden images are marked with both the hidden and read-only attributes, meaning that they don't normally display in directories.

📷 To hide images:

1. Press the **MENU** button to see the menus on the color LCD.
2. Use the Direction pad to navigate to the PLAYBACK menu (blue playback button icon).
3. Use the Direction pad to navigate to **Hide image** and use the ► key on the Direction pad or the **OK** button to select it.



4. Choose whether you want to hide/unhide individual images (**Select/set**), hide/unhide images for particular dates (**Select date**), or unhide all previously hidden ones (**Deselect all?**) by navigating to the appropriate

option with the Direction pad and pressing the **▶** key on the Direction pad or the **OK** button to select your option.



Each option works similar to the way Delete does:

5. For **Select/set** the D90 displays a thumbnail view of the images, twelve at a time. Navigate through them exactly as you would in thumbnail view (using the Direction pad keys), pressing the Zoom Out (⌂) button for each image you want to hide (or if it's already marked as hidden, unhide). If you need to see the full frame of the image to decide, press the Zoom In button (⌂) to get a temporary view of the full picture.



Confirm the hide action by pressing the **OK** button. Hidden images get a  icon on them (e.g. image 2 in

the following screen):



6. For **Select date** the D90 displays a list of dates on which images were shot with a preview of the first image taken on that date. Navigate through them (using the Direction pad keys), pressing **►** button for each date you want to hide (or if it's already marked as hidden, to unhide). If you need to see the full set of images for a date in order to decide, press the Zoom Out button (⌂) to get a temporary view of the pictures for that date.



Confirm the hide action by pressing the **OK** button. Hidden images get a  icon on them.

7. For **Deselect all?** the D90 displays simply asks you to confirm the action:



Tip: On a Macintosh using OS 9.x, you'll need a utility such as ResEdit in order to make a file visible again. In ResEdit, select **Get File/Folder Info...** from the **File** menu. Uncheck both the **File Locked** and **Invisible** boxes to remove the hidden attribute. In OS-X you get to the **Locked** file attribute by using **Get Info** (Apple-I) on the file (it's in the **General** section, which is usually opened by default; click on the ► next to it if it isn't).

Other PLAYBACK Menu Options

Are described elsewhere:

- **Display mode:** "Options for Evaluating Exposure" on page <248>
- **Rotate tall:** "Rotating Images" on page <465>
- **Pictmotion** and **Slide show:** "Slide shows" on page <742>
- **Print set (DPOF):** "Selecting Images to Print" on page <726>

Custom Settings

The good news is that many of the camera's defaults can be overridden or modified. The bad news is that Nikon's method of making these changes is slightly cumbersome.

Having to scroll through 42 Custom Settings choices can be time-consuming, especially for those of us who use multiple Nikon bodies. Why? Because Nikon keeps changing the Custom Settings number for functions that are identical across the bodies. For example, the self-timer function is #16 on the F100, F5 and D1s, but it is labeled #C4 on the D2 series and D200, and #C3 on the D90.

Yes, with 41 possible settings¹¹³, setting up your camera could take you a while to do. Another option is to use the optional Nikon Camera Control Pro 2 software to make the settings with your camera connected to your computer. This is the way I usually do it, as it goes a little faster than making lots of changes on the camera.

📷 All custom settings are made by:

1. Pressing the **MENU** button to see the menus on the color LCD.
2. Using the Direction pad to navigate to the CUSTOM SETTING menu (purple pencil icon).

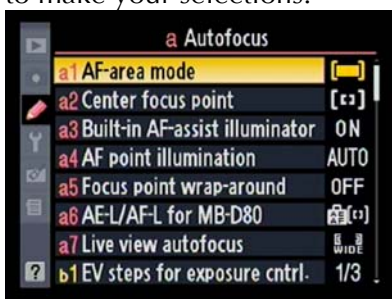


¹¹³ The 42nd choice is to reset the options.

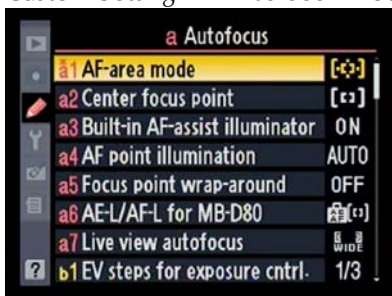
- Using the Direction pad to navigate to the group (**a**, **b**, **c**, **d**, **e**, or **f**) in which the custom setting you wish to change is located and press the **▶** key to select it.



- Using the Direction pad to navigate to an option and to make your selections.



Note: If an asterisk () appears just above the letter for a Custom Setting number, that function has been set to something other than the default value. In the following screen, Custom Setting #A1 has been modified:*

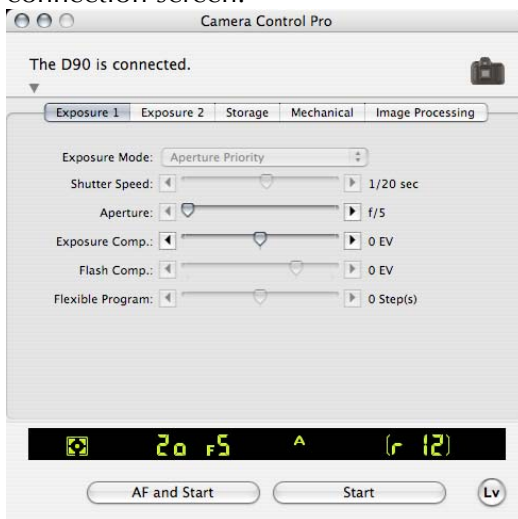


There are 41 individual Custom Settings (plus the **Reset custom settings** option), and the values and terminology used for each are sometimes obvious, sometimes cryptic, so

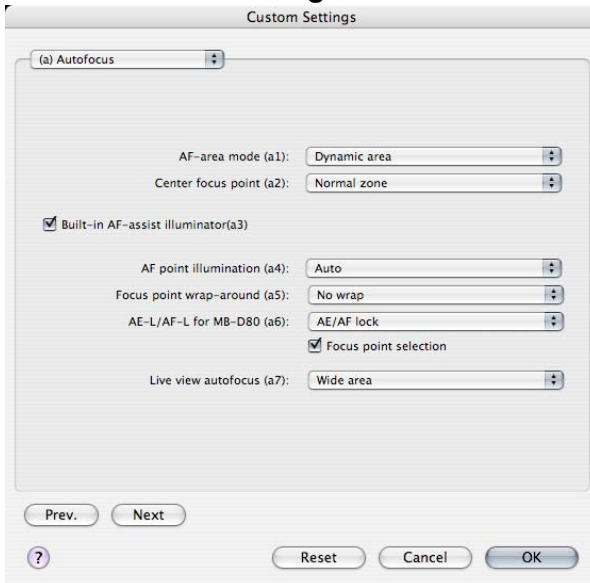
follow along closely. I'll provide a complete description of each option, along with my recommendations for each.

You may think that setting a lot of Custom Settings is going to be a big pain. Not really. As I noted earlier, I use my computer. With your D90 connected to the computer, here's how you use Nikon Camera Control Pro 2:

1. Connect your D90 to your computer via a USB cable.
2. Start Nikon Camera Control Pro 2. You'll see the basic connection screen:



3. Choose **Custom Settings** from the **Camera** menu.



4. For each option you wish to set:
- Navigate to a tab (pop-up in upper left corner) that contains options you wish to set. The tabs are grouped with the same **a** to **f** prefixes as the camera uses to organize the Custom Settings.
 - Select your settings for the options on the tab. Note that Camera Control Pro 2 often uses different controls for setting things than the camera does. An option that has an **On** and **Off** choice on the camera is usually presented as checkbox in Camera Control Pro 2 (checked is **On**, unchecked is **Off**).
 - Make sure you visit all six tabs (pop-up in upper left corner).
5. Click the **OK** button to complete your selections and begin transfer of your Custom Settings choices to the camera.

There are 41 individual Custom Settings (plus the **Reset** option), and the values and terminology used for each are sometimes obvious, sometimes cryptic, so follow along closely. I'll provide a complete description of each option, along with my recommendations for each.

Note: In the sections that follow, my name for the custom setting is given in the title. The name displayed underneath it is the one the D90 menu system shows.

#R Custom Settings Reset

(Reset Custom Setting Menu)

The D90 has a simple method of canceling all user-set Custom Settings and returning them to the defaults:

No No change to Custom Settings (no reset)

Yes Reset all Custom Settings to their default values



When you select **Yes**, the default values are restored for all custom settings. See the following table for the defaults (and my quick and dirty recommendations).

<i>Setting</i>	<i>Default</i>	<i>Recommendation</i>
A1: AF-area mode	Auto Area	(see Autofocus section)
A2: Center AF area	Normal zone	Wide zone for some types of photography
A3: AF-assist	On	Off ; use an external flash if you need this function
A4: AF point illum	Auto	Auto
A5: Focus Pt Wrap	Off	On if you can stand it
A6: Grip AE-L/AF-L	AE/AF Lock	Should usually match your #F4 setting
A7: Live View AF	Wide	You can override this during Live View with the AF button, so set this to your most used setting
B1: EV steps	1/3	1/3
B2: Easy Exp Comp	Off	Off This is a dangerous setting since it alters the behavior of the Rear Command dial; only use if you're always in Aperture-priority exposure mode

<i>Setting</i>	<i>Default</i>	<i>Recommendation</i>
<i>B3: Centerweight area</i>	8mm	8mm
<i>B4: Fine tune Exp</i>	Off	Tune exposure only if you've verified your meter is off. If it's off by more than half a stop, have Nikon recalibrate your camera.
<i>C1: Release AE-L</i>	Off	Off
<i>C2: Meter off delay</i>	6s	8s makes more sense to me; indeed, use an even longer setting if you're a slow shooter, and especially if you set #F4 to AE lock hold .
<i>C3: Self Timer</i>	10s, 1 shot	Tune as you see fit. I like to leave my camera set to a 2s setting, as I sometimes use the self timer in conjunction with #D10 when I don't have a remote in order to keep the camera as still as possible.
<i>C4: Monitor off delay</i>	Playback 10s Menus 20s Info 10s Review 4s	Playback 10s Menus 20s Info 20s Review 10s It makes more sense to have the timings line up with function.
<i>C5: Remote on duration</i>	1m	Consider a longer value so that you don't have to keep setting it, but be aware that this uses power.
<i>D1: Beep</i>	On	Off! Only have this on when you're learning the camera or absolutely need the focus feedback ¹¹⁴ .
<i>D2: Viewfinder grid</i>	Off	On There's no real penalty to having it on.
<i>D3: ISO display</i>	Off	If you really don't need the frame count, then consider setting Show ISO sensitivity ; but beware Show ISO/Easy ISO as it alters Command dial behavior.

¹¹⁴ If nothing else it will set you apart from all the Canon shooters, who seem to never change this function on their camera.

<i>Setting</i>	<i>Default</i>	<i>Recommendation</i>
<i>D4: Viewfinder warning</i>	On	There's no real penalty to leaving this set, but there's no big benefit to having it set, either. Basically, it just tells you when you've set B&W and makes the low battery warning bigger.
<i>D5: Screen tips</i>	On	On Leave it on.
<i>D6: CL shooting speed</i>	3 fps	I suggest 1 or 2 fps so that you don't get inadvertant bursts.
<i>D7: File Number Sequence</i>	Off	On! You absolutely must enable this function or you risk eventually losing images to duplicate file names. Why Nikon insists on their default for consumer cameras, I don't know, but it's just plain wrong.
<i>D8: Shooting Info</i>	Auto	Auto I've never found the setting to need overriding.
<i>D9: LCD Illum</i>	Off	If you're always shooting at night, you might switch this setting, but the INFO Shooting Display is more useful at night, anyway.
<i>D10 Exp Delay</i>	Off	Turn it to On if you're trying to get ultimate steady images on a tripod.
<i>D11: Flash warn</i>	On	On
<i>D12: Battery type</i>	LR6	You <i>must</i> set this to whatever type of AA battery you use in the grip.
<i>E1: Flash shutter</i>	1/60	Set it to the lowest value you can safely handhold.
<i>E2: Flash setting</i>	TTL	Set as necessary. <i>Tip:</i> you can set to Commander mode and leave the setting Built-in flash set to TTL and accomplish the same thing. Makes it quicker to go wireless.
<i>E3: Modeling flash</i>	Off	Off is probably the right choice. However, macro shooters may want it On in order to preview shadow effects.
<i>E4: Bracket Set</i>	AE flash	AE only as I generally want to control flash separately.

<i>Setting</i>	<i>Default</i>	<i>Recommendation</i>
<i>E5: Auto FP</i>	Off	If you've got a flash that supports it, no real harm in leaving it set to On .
<i>E6: Bracket Order</i>	Normal	I like the alternative setting better, as it orders my images from darkest to lightest.
<i>F1: Light Switch</i>	Switch only	Switch only as the alternative uses too much power and doesn't really gain you anything.
<i>F2: OK Button</i>	Center focus	Set to your preference.
<i>F3: FUNC button</i>	FV Lock	These two button assignments are where you need to give a lot of thought to how you use your camera. See the individual sections for some recommendations.
<i>F4: AE-L/AF-L Button</i>	AE/AF lock	
<i>F5: Customize Dials</i>	Rotation Off Change Off Menus On	This is a very dangerous control, as the Command dials are the very heart of the Nikon user interface. Change <i>only</i> if it works for you <i>and</i> you always make this change on every Nikon body you own.
<i>F6: No Card</i>	Lock	You really don't want to think you're saving images when you're not, so Lock is a good choice.
<i>F7: Reverse Indicators</i>	No	On cameras that support exposure with manual focus lenses I strongly suggest that you don't change this setting, but on a D90 change it to your preference.

Recommendation:

1. Use the reset option carefully. As I noted earlier, there's no quick and easy way to reload your Custom Settings except while connected to a computer using Nikon Camera Control Pro 2.

#A1 Autofocus Area Mode Setting

(AF-area mode)

This option is grayed out and unavailable if the camera or lens is set to manual focus or the lens used is not an autofocus lens.

This setting was discussed earlier in the autofocus section (the full description of the difference is in “Autofocus Area Modes” on page <380>):

Single area Only a single area is used

Dynamic area Area follows subject

Auto-area AF Closest area with focus is used [default]

3D-tracking Camera tracks focus if camera reframed

The last option is grayed out and not available except if AF-A or AF-C is chosen.



The top LCD shows an icon to tell you what you’ve set:



Single area



Dynamic area



Auto Area



3D-tracking

Recommendations:

1. Again, this is a conditional setting, though with more twists than Focus mode (see page <377>). If you've never used a sophisticated autofocus system before, it is probably safest to leave the camera set to the default, which will do its best to guess where your subject might be.
2. Consider **Single area** when you're dealing with non-moving subjects, especially ones that are off-center.
3. Consider **Dynamic area** when you're shooting fast moving action, especially if that action may be moving across the frame. If you do use this setting, pay careful attention to the starting sensor used (e.g., if action is going from top to bottom of the frame, you probably should start autofocus from the top sensor). Avoid spot metering with this setting unless you've paid particular attention to what I wrote in the metering section. You may not be metering where you think you are.
4. Photographers either love or hate **Auto-area AF**. On the positive side, it tends to work like magic when it works. I remember one photo I took of my two-year old god-daughter and her parents walking where she had run just a bit ahead of them, and the camera correctly focused on her despite the fact I had my autofocus sensor trained on her dad (the Nikon body I was using allowed me to pick a sensor but overrode my selection). Magic. But this setting has a host of caveats and interactions (spot metering only in the central sensor, for example), and it sometimes does the absolutely wrong thing. For example, at crowded parties, a typical bad response is to focus either on the central subject or the closest subject.
5. **3D-tracking** is useful for focus-and-reframers: the camera uses the color information from the exposure meter to

figure out which sensor the subject you originally focused on is now at. This works like magic with modest reframing, but fails completely if the subject focused on leaves the frame.

#A2 Focus Area Size

(Center focus point)

The D90 has the ability to set the framing area (size of the detection area) of the central autofocus sensor. As I noted several times earlier in this work, the underlying part that contains the autofocus sensors actually has seven physical sensing areas to it. The central area can be set to look at a wider area or a narrower area.

Normal zone Narrow sensing area used [default]

Wide zone Wider sensing area used



Recommendations:

1. One important thing to notice is how the camera displays the AF sensing area. In **Wide zone**, the central AF sensor is shown as distinctly wider, and it is. But what does that mean? Well, in **Wide zone** there's a bit of Closest Subject Priority going on. The wider sensor area is big enough so that it is often on both a near and far subject simultaneously. In that instance, the closest subject under the widest version of the sensor appears to be used. For example, if the left-hand portion of the center sensor is on something at 10 feet and the right-hand portion of the center sensor is on something at 20 feet, the camera focuses at 10 feet. In **Normal zone**, the central sensing

area is small enough that it normally only obtains focus on one thing (you'd need a really wide lens and lots of tight detail at different distances for it to react the same way as **Wide zone**, something that just doesn't occur in nature).

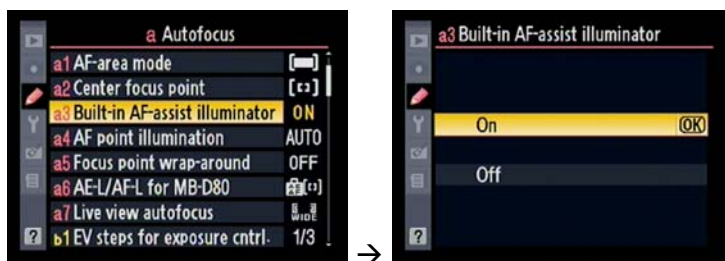
2. This is a subject-motivated setting. For example, while shooting flying birds, I actually preferred **Wide zone**, because the wider sensing area almost always got enough of the bird to get the right focus, while **Normal zone** sometimes was small enough to sometimes miss part of the centered bird. Ditto for many sports. In general, I tend to use the **Wide zone** option when I have rapidly moving objects that intersect the central area of the frame.

#A3 Autofocus Assist Illumination

(Built-in AF-assist illuminator)

The D90's Autofocus Assist lamp is controlled by this function:

- On** In poor lighting, the Autofocus Assist light on the camera illuminates [default]
- Off** The camera's Autofocus Assist light never illuminates



Recommendation:

1. Turn it **Off**, if possible. The light on the camera is annoying to subjects and poorly located (lens hoods and fingers tend to block it, rendering it ineffective). Instead, if you need autofocus assist, mount an external i-TTL flash and activate *its* Autofocus Assist lighting. The SB-600, SB-

800, and SB-900 have much wider patterns of lighting, and because these are a dim red, are not as intrusive to your subjects. Moreover, because the external flash assists are high up off the camera, they tend to clear large lenses.

#A4 Focus Area Illumination

(AF point illumination)

The focus area indicators in the viewfinder normally light up briefly to indicate which ones are being used to initiate focus. The D90 allows some control over how the sensors appear.

- Auto** Sensors only use brief red highlight *when necessary* to distinguish them due to lack of scene brightness [default]
- On** Sensors *always* light briefly in red to show which one will be used for focus information
- Off** Sensors *never* light in red, only in black



Recommendations:

1. Personally, I like the default. In dim light I get the brief red boost to help find the selected sensor, in bright light the black outline is good enough.
2. You're probably wondering why you might want to turn this off. One word: power. If you set **On**, you'll be using a tiny bit more power every time you move autofocus around. The default is a good balance between power consumption and visibility, but if you're a power miser, select **Off**.

#A5 Focus Point Selection Wrap

(Focus point wrap-around)

The Direction pad on the back of the camera is used to select which autofocus area to use. You can change the behavior of repeatedly pressing the Direction pad:

No Wrap Repeated presses stop sensor selection at edge of display [default]

Wrap Repeated presses wrap selection around to the opposite side of the display (but continue in the same direction).



Recommendation:

1. I like the wrap-around effect, but you'll need to try both options to figure out which you like better. I will note that you're more likely to like the wrap option with 11 points than you did with only 5 points to choose from, so if you're coming from one of the earliest Nikon DSLRs, consider setting this option to **Wrap**.

#A6 MB-D80 AE-L/AF-L Button Options

(AE-L/AF-L for MB-D80)

The optional MB-D80 vertical grip hand position replicates the **AE-L/AF-L** button. Nikon has wisely chosen to allow you to specify what this button does.

AE/AF lock Focus *and* exposure lock when the button is pressed [default]

AE lock only	Exposure locks when the button is pressed; focus continues to be active
AF lock only	Focus locks when the button is pressed; exposure continues to be active
AE lock (Hold)	Exposure locks when the button is pressed and stays locked until it is pressed again <i>or</i> the camera's metering system turns off; focus continues to be active
AF-ON	Pressing the button activates the autofocus system (much like a half press of the shutter release). The shutter release no longer activates focus.
FV lock	Pressing the button fires the flash and sets a TTL exposure that is held until the next time you press the button. This also cancels preflash for subsequent flashes when the internal flash is set to TTL .
Focus point selection	Holding the button and rotating the Front Command dial allows you to scroll through the autofocus selection points. When you release the button the last highlighted point is used as the new focus selection point.



AE/AF lock, **AE lock only**, **AF lock only**, and **AF-On** also have a sub-option of activating **Focus point selection** *in addition* to your chosen option. This is reached by pressing the ► key on the option and choosing **On**.

Recommendations:

1. Unfortunately, the D90 skimps on the button assignment functions. **AF-On** is not very useful without being able to decouple focus from the shutter release (the higher-specified bodies allow this). You're given the option of the most logical coupling (exposure and focus lock), plus the ability to have the button control only one thing. Thus, the first thing you should think about is whether you want the button to do one or two things.
2. Note that when you have the MB-D10 mounted on the camera you can usually reach the **FUNC** button on the camera (albeit a little awkwardly), so you probably want to consider how that's set at the same time you consider how you set the **AF-ON** button.
3. I leave my camera set at the default. Why? Because I don't necessarily like having two buttons labeled **AF-ON** that do different things (this function only changes the button on the vertical release).

#A7 Autofocus Setting for Live View

(Live view autofocus)

This setting allows you to change the focus method used by the Live View function:

- Face priority** The camera looks for faces to focus on
- Wide area** The camera focuses using a wide boxed area [default]
- Normal area** The camera focuses using a small boxed area



Recommendations:

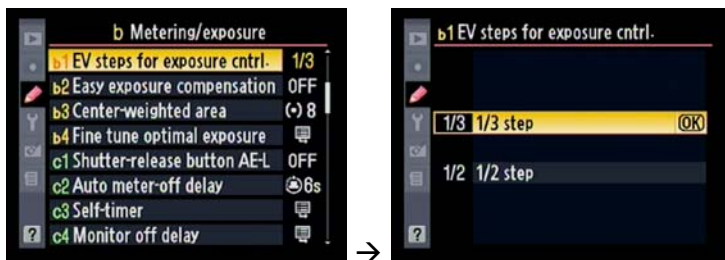
1. Note that while you're in Live View you can set this Custom Setting *directly* using the **AF** button and the Rear Command dial. Whatever you set during Live View will become the new Custom Setting value (and vice versa).
2. You can move the location of the box used for focusing with **Wide area** and **Normal area** using the Direction pad. Personally, I find that **Normal area** gives me more control over the focusing.

#B1 Exposure Control Increment

(EV steps for exposure cntrl.)

Exposure settings (apertures, shutter speeds, and bracketing, *but not exposure compensation*) that the D90 uses can be set in two different increments. The increment chosen with this setting is used for all exposure settings in the camera:

- 1/3 step** 1/3 stop increments [default]
- 1/2 step** 1/2 stop increments



Recommendations:

1. It really doesn't make much sense to set the alternative value *unless* you are simultaneously shooting with another camera body that doesn't support 1/3-stop increments (i.e. you want exposure settings to match between both cameras). If you set 1/2-stop increments you could find yourself in situations where you're underexposing more than necessary to preserve highlight detail. Generally you want to set your brightest point as close to the top end of the D90's range as possible, and 1/3-stop increments allow you to get closer to the top end than 1/2 stop increments¹¹⁵.
2. Note that this controls the apertures, shutter speeds, bracketing steps, exposure compensation and flash exposure compensation values that can be set.

#B2 Exposure Compensation Control

(Easy exposure compensation)

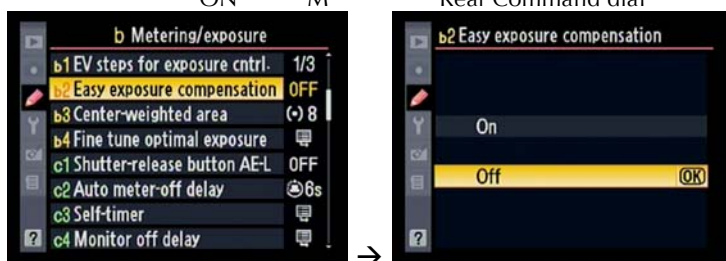
Some users think that pressing a button and turning a dial to set exposure compensation is less convenient than other possibilities. Again, Nikon allows you to change the behavior of the D90:

Off Exposure compensation requires holding in the  button [default]

¹¹⁵Technically, we're talking about a 1/6 stop difference. But every little bit helps.

On Exposure compensation is set by rotating a Command dial without pressing the  button. Which Command dial is used depends upon the exposure mode and whether you've switched the Command dials using the **Change main/sub** function of Custom Setting #F5:

<u>CSM #F5</u>	<u>Exp Mode</u>	<u>Exposure Compensation set by</u>
OFF	A	Rear Command dial
OFF	S, P	Front Command dial
OFF	M	Rear Command dial
ON	A	Front Command dial
ON	S, P	Rear Command dial
ON	M	Rear Command dial



Recommendations:

- Any Custom Setting that requires a table (see above) to understand the nuances of what each control does is, by my definition, confusing and to be avoided. Especially when the behavior changed is a default one on every Nikon body built to date (which makes changing between bodies problematic, especially if the other body doesn't have a custom setting to make this setting! Fortunately, most do). However, some D90 users only have one camera and always use their camera in one exposure mode (usually aperture-preferred), and thus find this custom setting useful. Your choice. But know what you're doing.
- If you've used Nikon 35mm film bodies for any amount of time, the  button is right where you expect it and works just as you'd expect. I never fiddle with this setting, as not all Nikons allow this Custom Setting. I prefer to have all

my bodies work identically. Moreover, hold-button-and-twirl-dial is the basic tenet of Nikon's user interface. Violate it at your own risk.

3. Note that this function *only* applies when using the Program, Aperture-priority, Shutter-priority, and Manual exposure modes. In the Scene exposure modes this Custom Setting is ignored.

#B3 Center-weight Circle Size

(Center-weighted area)

The center-weighted metering can be adjusted: you can choose the size of the inner circle that produces 75% of the meter weighting. The default is 8mm, which is the size of the circle shown in the viewfinder. Your choices are:

6mm	6mm circle for 75%
8mm	8mm circle for 75% [default]
10mm	10mm circle for 75%



Recommendations:

1. This one is personal, and, I think, somewhat dependent upon the types of things you shoot. For example, landscape photographers might prefer to use 6mm to lower the potential impact of the sky on exposures. Likewise sports photographers might want to narrow their center weight circle if the playing field background isn't middle toned (e.g. ice hockey arenas, some basketball courts, etc.).

2. I'm not a big fan of center-weighted metering, so I simply leave my camera set on the default and use spot metering when I don't want to rely upon the matrix metering system. Center weighted metering is essentially a two-zone matrix that is heavily weighted to the central area. I find both those things somewhat limiting, though photographers used to older SLR metering systems may have developed exposure practices using center weighting and thus may prefer it.
3. Note that this function *only* applies when using the Program, Aperture-priority, Shutter-priority, and Manual exposure modes. In the Scene exposure modes this Custom Setting is ignored.

#B4 Meter Compensation

(Fine tune optimal exposure)

The D90 has a Custom Setting that allows you to individually dial in a permanent exposure compensation for each metering system. This fine tuning of the meter systems is “hidden”; in other words, it doesn't show up in the metering displays as exposure compensation.

To use it, you first have to agree that you know the compensation won't show up in the camera displays.



After this, you pick the metering system you want to alter and then the value (using the Direction pad keys, each press of the ▲ and ▼ keys alters the value by 1/6 of a stop).



Recommendations:

1. Personally, I'd stay away from altering the matrix meter system. Because the matrix metering system already dials in secret compensations based upon the pattern of lighting and the colors of the subjects it sees and the scene it thinks it recognizes, you really would be adding meter compensation on top of an unknown. I've seen situations where the matrix meter gets the exposure dead on and others where it misses by a half stop or so. So if you dial in a half stop compensation, case one is now off by a half stop and case two is "fixed." Did you gain anything? I think not. If the matrix metering system is inaccurate for you in some situations, use one of the other metering systems instead.
2. If you *always* spot meter off of a gray card, consider dialing in the appropriate compensation for the spot metering system to compensate for the slight difference in the way camera meters are calibrated. Note I said "always." This Custom Setting would always override the metering null value, so you have to meter consistently for this to be of exceptional use. Gray cards can vary as much as a half stop from what would be middle gray (128,128,128), and if you spot meter with multiple cameras, they can easily be different by as much as a half stop due to manufacturing tolerances. This is one way to compensate for such differences.
3. If you don't use a gray card to meter but find that you're consistently dialing in a specific exposure compensation *in all situations*, consider using this custom setting to adjust the camera. The ISO standard for meter calibration

allows up to about a half stop of error, so it is entirely possible that your camera is calibrated incorrectly. If so, this is the function to use to fix that.

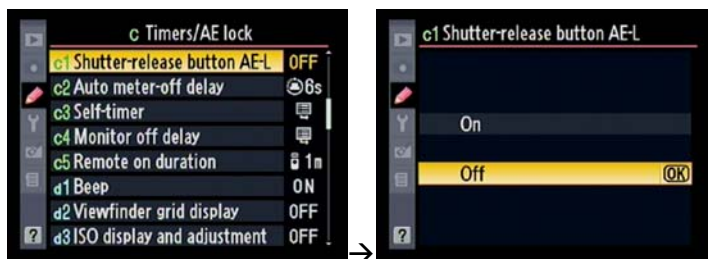
#C1 Shutter Release Exposure Locking

(Shutter-release button AE-L)

Many consumer cameras automatically lock the exposure when the shutter release is pressed partway, but the D90 (and most other Nikon DSLRs) behave differently:

On Exposure locks when *either* the shutter release is held partway down or the **AE-L/AF-L** button (at its default setting) is pressed.

Off Exposure locks only when the **AE-L/AF-L** button (at its default setting) is pressed [default]



Recommendations:

1. If you're used to having exposure lock when you press the shutter release partway—the behavior of most consumer cameras—then consider setting this option to a value of **On**. Note that if you like to set exposure and then pan over to your final composition, you need to either set this option or get in the habit of using the **AE-L/AF-L** button.
2. A little known fact about the **AE-L/AF-L** button is that it doesn't actually lock the aperture and shutter speed: it locks the overall exposure. In the automated exposure

modes you can actually hold the button in and then use the Front and/or Rear Command dials (depending upon your exposure mode setting) to change the combination of aperture/shutter speed that is used—the overall exposure will remain locked. In other words, with the exposure “locked” in Aperture-priority exposure mode, turning the Front Command dial to get the next smaller aperture (e.g. f/8 instead of f/5.6) would cause the camera to use the next longer shutter speed (e.g. 1/125 instead of 1/250).

#C2 Meter/Camera Active Time

(Auto meter-off delay)

The D90, like all Nikon bodies, has a higher power demand when it is “active” (metering, autofocus, etc.). Thus, Nikon has programmed an aggressive time-out for the camera’s basic functions. Normally, the camera stays active only while the shutter release is held partway down, and for ten seconds after you release it. This delay can be changed:

4 s	Four second delay before camera goes inactive
6 s	Six second delay before camera goes inactive [default]
8 s	Eight second delay before camera goes inactive
16 s	Sixteen second delay before camera goes inactive
30 s	Thirty second delay before camera goes inactive
1 m	One minute delay before camera goes inactive
5 m	Five minute delay before camera goes inactive
10 m	Ten minute delay before camera goes inactive
30 m	Thirty minute delay before camera goes inactive

No Limit The metering never goes inactive



Recommendations:

1. If you need more battery conservation, change the camera to a 4-second timeout. You'll get slightly more exposures per battery charge (assuming you work quickly and setting the timeout lower doesn't force you to trigger the meter more often). However, the only time that I find this strategy useful is when I'm far away from a charger or extra battery and have a low main battery.
2. Avoid the 30-second and longer delays, and the **No limit** settings unless you have extra batteries.
3. If you use an external power source, you don't need to worry about this setting, as the camera sets a value of **No limit** as long as power is plugged into the **DC In** socket.
4. Sports photographers tend to like **No limit** (indeed, they were the ones that asked for it in the first place). Why? Because they don't want any lags in their camera, as it might make the difference between getting "the moment" and not. If the camera's metering and focusing system goes inactive, there's a very short, but still real delay before they come up again. Sports photographers love to just follow action through the viewfinder and be able to punch the shutter release at any time without worrying about whether the camera is active or not.

#C3 Self Timer Delay Setting

(Self-timer delay)

The D90 allows you to set four different delay times for the self timer (the delay time is the time between pressing the shutter release and the shutter actually being opened for exposure), and between 1 and 9 shots for each activation



Delay:



- 2s** Two second delay
- 5s** Five second delay
- 10s** Ten second delay [default]
- 20s** Twenty second delay

Shots:



- 1-9** Number of shots (taken immediately in succession at end of delay)

Recommendations:

1. If all you're looking for is a short delay to counter any camera movement triggered by your pressing the shutter release, use the 2-second delay. Better still, consider using a remote control cable or look at Custom Setting #D10 (see "One Second Shutter Delay" on page <515>). If you get any camera movement with those suggestions, your tripod seriously needs upgrading.
2. Remember, the white Autofocus Assist lamp on the front of the camera tells you the status of the countdown. It flashes during the first part and then lights steadily during the last two seconds prior to exposure. If Beep (Custom Setting #D1) is set, the camera gives audible feedback, as well.

#C4 Color LCD Active Time

(Monitor off delay)

The D90 uses more battery power when the color LCD is active. This function allows you to program the amount of time the LCD stays active for several different uses of the display (Playback, Menus, Shooting Info, and Image Review). The active length can be changed:

- 4 s** Four second delay before the color LCD is turned off [default for Image Review]
- 10 s** Ten second delay before the color LCD is turned off [default for Playback and Shooting Info]
- 20 s** Twenty second delay before the color LCD is turned off [default for Menus]
- 1 min.** One minute delay before the color LCD is turned off
- 5 min.** Five minute delay before the color LCD is turned off
- 10 min.** Ten minute delay before the color LCD is turned off



Recommendations:

1. The defaults for Image Review and Shooting Info are a bit low for my tastes. I'd make Image Review 10 seconds and Shooting Info 20 seconds. This also makes the sub-activities (review and camera control) have the same lengths for each option they support, which I also prefer.
2. Avoid the 1 to 10-minute delays unless you have extra batteries handy.
3. If you're working with AC power or any battery connected to the DC In connector, you don't need to worry about this setting—it is automatically set to 10 minutes and you can't alter that.

#C5 Remote Control Activation Time

(Remote On Duration)

The D90 allows you to set four different times for how long the remote control signal will be looked for before the camera automatically cancels the function. This setting is needed to conserve battery power (the camera consumes more power when it is looking for the remote).

1 min One minute active length [default]

5 min Five minute active length

10 min Ten minute active length

15 min Fifteen minute active length



Recommendation:

1. Keep it as short as you dare, as the camera consumes extra power while the remote detection is active. Generally I find Nikon's default works fine for me, but some people will want to set the active timer to **5 min.**

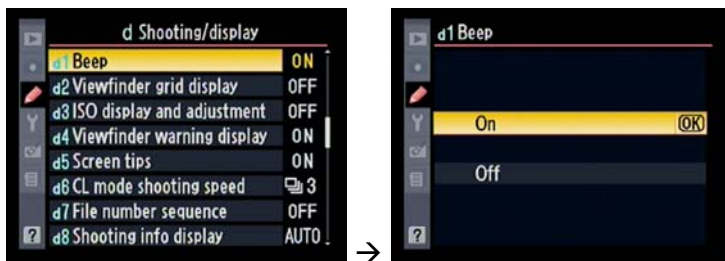
#D1 Sound Feedback Setting

(Beep)

The D90 has the usual Nikon consumer body beeping sound capability; it's the default setting. This can be altered:

On Camera beeps during countdowns and focusing [default]

Off Camera emits no beeps



Recommendation:

1. If you're new to DSLRs, the beep sound is useful in that it tells you when the AF system has acquired focus (i.e. you can't take a picture in Single Servo AF until you hear the beep). Otherwise, I find it annoying and recommend you turn it off once you've gotten familiar with how and the speed at which the AF system works.

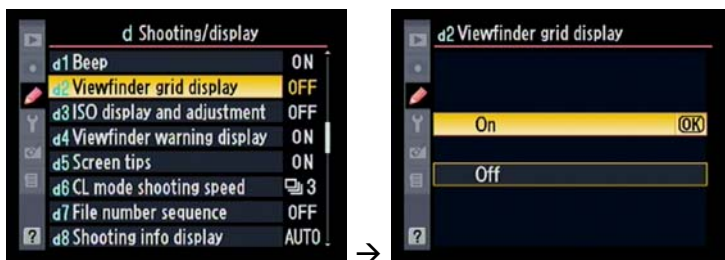
#D2 Grid Line Display in Viewfinder

(Viewfinder grid display)

The D90 has the ability to show grid lines overlaid in the viewfinder, which help with alignment.

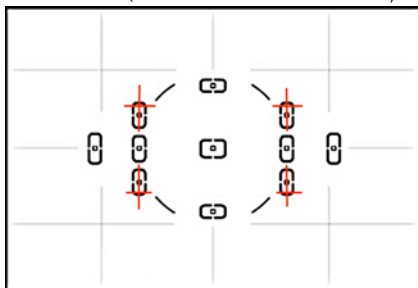
On Grid lines are shown in the viewfinder

Off Grid lines are not shown in the viewfinder
[default]



Recommendations:

1. Your choice. I happen to like the gridlines. However, note that I've never found a Nikon viewfinder with them to be 100% perfectly aligned. Often the lines are a small fraction of a degree off from absolute horizontal and vertical.
2. For some reason, Nikon has chosen to put the grid lines at one-quarter points rather than the one-third points that many compose with. If you're a fan of the one-thirds framing rule (I'm not), the AF sensors give you a better indicator (see red intersections, below):



3. Note that Custom Setting #F3 allows you to program a *temporary* variant of this function. If you only sometimes use gridlines and don't need the **FUNC** button for anything else, consider using Custom Setting #F3 instead of this Custom Setting.

#D3 ISO Display and Setting

(ISO display and adjustment)

The D90 allows you to choose whether you see the ISO value or the Frame Counter in the viewfinder and top LCD.

Show ISO sensitivity	ISO shown in viewfinder and top LCD
Show ISO/Easy ISO	ISO shown in viewfinder and top LCD <i>plus</i> ISO changed by Command dial
Show frame count	Frame count in viewfinder and top LCD [default]



Recommendations:

1. If you're using Auto ISO, you may want to consider **Show ISO sensitivity**. However you lose the frame counter display by doing so.
2. The **Show ISO/Easy ISO** option is a little tricky and dangerous. Not only does the ISO value now replace the frame counter value in the two displays, but ISO values are set directly by using the Command dials (Rear if you're in Aperture-priority exposure mode, Front if you're in Program or Shutter-priority exposure mode, *neither* if you're in Manual exposure mode). It also disables Easy Exposure Compensation (Custom Setting #B2) if set. That's a lot of caveats and subtleties to remember, especially considering that the D90 has a dedicated **ISO** button that would work fine with **Show ISO sensitivity**. I say avoid the **Show ISO/Easy ISO** option.

#D4 Viewfinder Warnings Display

(Viewfinder warning display)

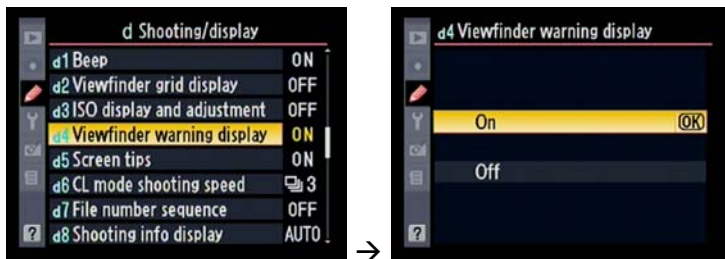
Another LCD overlay function in the viewfinder is a set of icons in the lower left corner to remind you when the battery is low, when you have no card in the camera (or the card is empty), and when you're shooting in black and white.

The warnings: **B/W**  

This is an either/or choice: you get all the warnings enabled or none:

On Camera displays the warnings [default]

Off Camera doesn't display warnings



Recommendation:

1. A good idea, but not fully fleshed out. There are more things I'd like to be warned about than shooting in black and white, low battery, and missing card. And I'd like to control which warnings would appear and which don't (otherwise you could end up with a lot of overlay icons in the image area). Most users should probably leave the warnings enabled, as having the battery status get highlighted when low is a useful reminder that's hard to ignore.

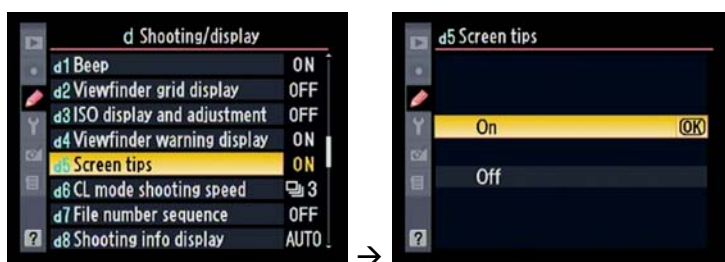
#D5 Show Tips on Shooting Info Items

(Screen tips)

The D90 has the unique ability to screen tips to help identify the selected item on the Shooting Information screen.

On Screen tips are shown [default]

Off Screen tips are not show



Recommendation:

1. Your choice. I happen to like them. But they do overlay other information you might want to see better.

#D6 Continuous Low Shooting Speed

(CL mode shooting speed)

The D90 is a responsive camera. In either of the Continuous release shooting method settings the camera can rattle off a burst of more images faster than you might expect from a single shutter press.



You can vary the speed at which the Continuous Low shooting method operates:

4fps	4 frames per second
3fps	3 frames per second [default]
2fps	2 frames per second
1fps	1 frame per second

Recommendation:

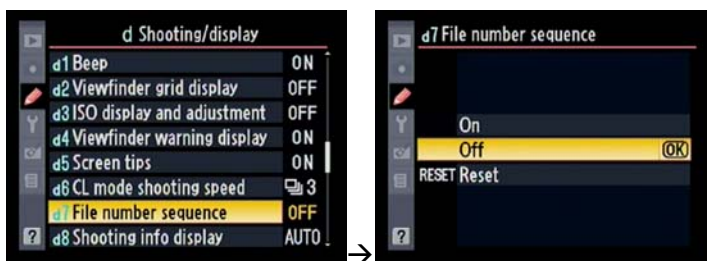
1. Keep your camera set at one of the lower speeds for **CL** (I leave mine set at **1 fps**). This gives you a continuous shooting option that doesn't chew through card space and for which it's easy to keep count of how many images you're taking (at **3 fps** and above you'll lose track quickly). It also means you're less likely to jab the shutter release hard and get multiple shots.

#D7 File Number Sequence

(File number sequence)

You may remember from the section on filenames (see page <190>) that the D90 has two basic capabilities for naming files: file numbers are reset to **0001** by a number of actions (formatting, new card, new folder, etc.), or they aren't reset until you hit **9999**. This is where you set that behavior:

- On** File numbering picks up after last number
- Off** File numbering always resets to 0001 [default]
- Reset** Same as **On** but number immediately reset to highest file number in the current folder *plus* 1.



Recommendations:

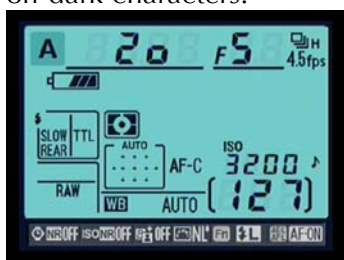
1. Set this option to **On**, otherwise you'll end up with a lot of **DSC_0001** duplicate filenames on your computer, and if you aren't disciplined about renaming files or checking for overwrites, you could easily lose images.
2. If for some reason you need to set file numbering to a specific value, use the **Reset** option for this setting, then put a file with a file name one less than where you want

to start numbering into the appropriate folder on your memory card (has to be the active folder), insert that card into the camera, then immediately set this option back to **On**.

#D8 Shooting Info Display Style

(Shooting info display)

The D90 has the ability to display a detailed shooting information display on the color LCD when you press the **info** button. This display may be dark-on-light characters or light-on-dark characters:



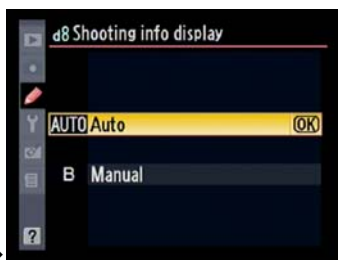
Dark-on-light



Light-on-dark

Auto Dark-on-light is used in bright light, while light-on-dark is used in dim light [default]

Manual You set which option to use



If you select **Manual**, you get a sub-menu that allows you to pick which style you wish to use:



Recommendations:

1. Leave this option set to **Auto**, as the camera generally makes good choices as to when to switch.
2. If you find that the bright dark-on-white pattern is distracting, use **Manual** to set **Light on dark**.

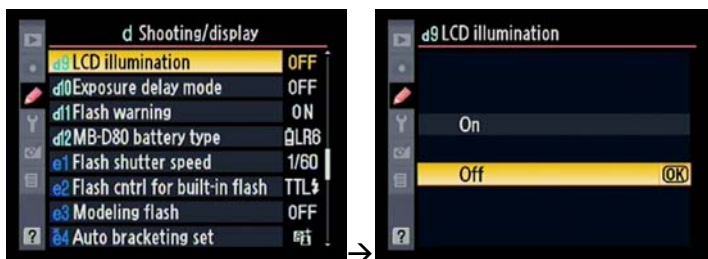
#D9 LCD Illumination Control

(LCD illumination)

The top LCD has a yellow-green backlighting that makes it easier to see at night. To preserve power, the backlighting isn't applied unless you specifically tell it to. By default, that is done by turning the Power switch to the illumination icon (☼ just past the **ON** position), which provides backlighting for about six seconds. You can change this behavior:

Off Backlighting controlled solely by power switch [default]

On Backlighting occurs when meter is active



Recommendations:

1. Nikon has made a change since the D2: the alternate setting on the D2 series was triggered by pressing any button on the camera (shutter release partway, and any of the control buttons), and was of limited duration (6 seconds). Now, the system simply looks at if the camera is active (metering) and backlights the LCD during the entire time the camera is active. For some heavy-handed users (or if you have #C2 set to a high value), that can be very long periods of time. The drawback is that battery consumption is increased by this backlighting, and it is already high when the camera is active. Thus, I tend to say you should only set this control for situational conditions (i.e. when you need it). All other times it should be **Off**.
2. Most people don't realize it, but this function is also linked to external Speedlight LCDs, and it works both ways. For example, if you set backlighting to be **On** for the SB-800 using its setup options, that setting is applied to the camera, too! Indeed, since I'm usually shooting with a flash on the camera at night, I simply leave backlighting set on my flash units and leave the camera's #D9 option set to **Off**. Just remember that you've done this.

#D10 One Second Shutter Delay

(Exposure delay mode)

This option is used to reduce vibrations or camera shake caused by the shutter press. When activated, the camera flips the mirror up immediately upon shutter release, and then opens the shutter about *one second*¹¹⁶ later (the mirror is lowered after the shot).

Off camera works normally [default]

¹¹⁶ Nikon bodies previous to the D3, D90, D300 and D700 used a delay of 0.4s, which in extreme cases didn't quite wait long enough for support system motion to dampen due to the mirror slap.

On mirror lifted one second before shutter opens



Recommendations:

1. Remember that exposure is calculated before the mirror goes up.
2. Likewise, flash exposures are calculated before the mirror goes up, so you'll see a preflash on pressing the shutter release, then the main flash one second later when the shutter opens (for normal sync; with Slow or Rear Sync you'll see the second flash at the end of the exposure). For most subjects, that is probably okay, but be careful of subjects that will be startled by the preflash. Some people will blink in response to the preflash and have their eyes closed at the main flash. Some insects and animals will bolt on the preflash. You can use FV Lock (set via one of the assignable buttons) to avoid pre-flashes every time you shoot.

#D11 Flash Indicator Low Light Warning

(Flash warning)

The D90 normally uses the consumer Nikon body practice of blinking the flash indicator when light is low (except in Scene exposure modes, where flash use is automatically controlled). You have the ability to change this behavior:

- Off** The indicator doesn't blink in low light
- On** The indicator blinks in low light [default]



Recommendation:

1. Leave it on the default if you think you need the reminder that you might want to use flash, set it to **Off** otherwise.

#D12 Battery Type in MB-D80

(MB-D80 battery type)

If you use AA batteries in the optional MB-D80, you need to tell the camera what type they are. That's because different types of batteries not only have different voltages, but they also change voltage at different rates as they expire:

- LR6 (AA Alkaline)** Use for AA Alkaline batteries [default]
- HR6 (AA Ni-MH)** Use for rechargeable AA Nickel-Metal Hydride batteries
- FR6 (AA Lithium)** Use for AA lithium batteries, such as the Eveready Lithium series
- ZR6 (AA Ni-Mn)** Use for AA Nickel-Manganese batteries (rare)



Recommendation:

1. You **must** set this function if you use AA batteries in the MB-D80; otherwise you won't get accurate and reliable power indication. In some cases, the camera could report the battery exhausted when it isn't.
2. You **don't** have to set this function if you use EN-EL3e batteries in the MB-D80; the D90 detects those automatically.
3. So what type of battery should you use in the MB-D80? EN-EL3e batteries or NiMH rechargeable AA batteries of at least 2100mAh are the two environmentally and photographer friendly choices. Lithium AA batteries are expensive, and disposing of lithium isn't exactly something you want to do regularly—it's not a great environmental friend, though it's better than some of the other materials batteries have been made of. Alkaline AA batteries are cheap and ubiquitous, but they won't last as long as NiMH or Lithium batteries, and also pose a recycling issue.
4. Note that only the full, low, and empty battery displays are shown when AA batteries are used by the camera, and the detailed **Battery info** option on the SETUP menu doesn't apply to them.

#E1 Flash Low Shutter Speed Barrier

(Flash shutter speed)

The section on flash that comes later in the eBook (see “Setting Flash Options” on page <556>) describes an option called Slow Sync. Essentially, the camera places a lower limit on the shutter speed that can be used when flash is active *unless* you tell it to ignore that limit. Custom Setting #E1 allows you to modify the limit (and the Slow Sync and Rear Sync options allow you to remove the limit):

1/60	1/60 second lower limit [default]
1/30	1/30 second lower limit

- 1/15** 1/15 second lower limit
- 1/8** 1/8 second lower limit
- 1/4** 1/4 second lower limit
- etc.



Recommendations:

1. I believe everyone should set at least **1/30**. Nikon's **1/60** default is very conservative, and will cause problems in most indoor lighting situations (for the reason why, read the full flash section).
2. I personally set **1/15** because I know I can usually hand hold the camera to that level when using flash as I describe, and it's the slowest speed where subject motion in the ambient exposure doesn't become a constant problem (it may be a bit of a problem at 1/15, but I watch for that).

#E2 Flash Mode for Internal Flash

(Flash cntrl for built-in flash)

I wish Nikon had set flash mode up differently (e.g. put the flash mode control into the Flash Pop-up button in conjunction with the command dials). Because buried down in the Custom Settings menus, and requiring multiple settings for some functions, partially negates a very useful feature. Nikon needed a way to control what method the internal flash uses when it's popped up, and this is where we set that. Just be forewarned that this gets a little involved (especially if you haven't read "Using Flash" on page <540> yet):

TTL	TTL used for flash mode [default]
Manual	Manual flash mode
Repeating flash	Repeating flash mode
Commander mode	Internal flash used to control other flashes



If you set **Manual flash**, you also need to select a power setting (see “To Set Manual Flash” on page <572> for GNs). You can set the power in one-third stop increments (the D200 only supported full stop increments):



If you set **Repeating flash**, you also need to set the power setting (suddenly renamed **Output** in this menu by Nikon), the number of times to repeat the flash during the shot, and the interval at which the flash is repeated. This is a little complex to figure out, as there’s an interaction between your shutter speed, **Times**, and **Interval** that potentially gives you something other than you want (see my Recommendations, below):



If you set **Commander mode**, you're telling the camera that you want to use the internal flash for wireless flash control. You then need to set the flash mode and flash exposure compensation for each and every flash group, including the internal flash (I'll have more to say about this in "Wireless Flash" on page <577>):



Recommendations:

1. If you're going to use **Repeating flash**, start by first establishing a shutter speed you're going to use. Let's say your shutter speed will be 1/60. Next, use **Interval** to determine how many flashes will be fired a second. An interval of 1Hz means 1 times a second, so we need to divide the lower value of our shutter speed (60) into this, which tells us that we could have as many as 1 flash while the shutter is open, which obviously isn't going to generate a "repeating" flash effect. By contrast, if your shutter speed was 1/2 and your **Interval** was **10hz**, you could get as many as 5 flashes into your shot. You'll need to jigger your shutter speed and **Interval** until you get a meaningful potential set of repetitions. Finally, set **Times** to a value less than or equal to what you just calculated.

2. **Commander mode** may be where you want to leave your camera set if you *sometimes* use wireless flash. That's because you can still run the internal flash just on its own for TTL at this setting. You have to set the flash exposure compensation in this Custom Settings menu rather than using the Flash Options button and Front Command dial on the camera, though. And you need to be aware that you'll extend the preflash sequence a bit because the camera has to look for other groups, so this might not be a good idea if you're shooting people or things that react to light. But for someone like me, who tends to shoot static objects (scenics) and often, but not always, uses multiple flashes, leaving my D90 set to **Commander mode** with my usual settings actually saves me a lot of time and fumbling in the field (especially since it's usually around dawn or dusk when I'm shooting with flash).
3. If you use visual slaves to trigger studio lighting, try leaving your D90 set at **Manual** flash mode at **1/128** power. That's generally not enough flash to do much more than produce a minor catchlight effect on your models, but it's usually enough to trigger your main studio lighting.
4. Note that if you mount an SB-400 on the camera, this Custom Setting changes to allow just the options available with that flash unit (TTL and Manual flash).

#E3 Modeling Light from Flash

(Flash warning)

All Creative Lighting System flashes (including the D90's internal flash) can produce a short sequence of pulsed flash that allows you to preview what the light might look like (especially useful for judging shadows). This "modeling light" is triggered by pressing the DOF Preview button on the camera if the Custom Setting is set to allow it:

Off DOF Preview doesn't trigger modeling flash [default]

On DOF Preview triggers modeling flash



Recommendations:

1. Set it to **On** only when you need it (and warn your subjects that you are about to trigger a series of light pulses). If you leave it set to **On** there's a good chance you'll startle someone someday.
2. The light that is produced is not useful for judging exposure or relative light balances. The primary use of the modeling light is to examine the directionality of the light from the flash and how it creates or impacts shadows.

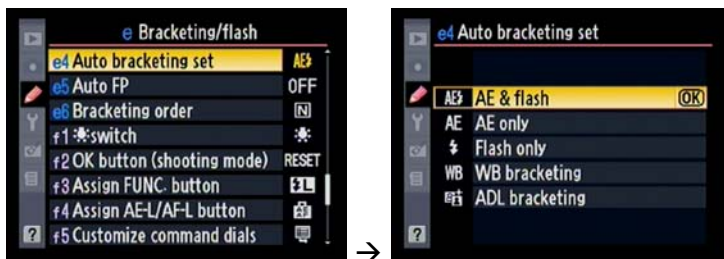
#E4 Exposure Bracketing Method

(Auto bracketing set)

Exposure bracketing can be performed entirely with ambient exposure (e.g. altering aperture or shutter speed), with flash

exposure (e.g. using flash exposure compensation), or both. This setting allows you to choose how the camera performs this bracketing (it also enables white balance bracketing):

AE & flash	If a Speedlight is attached, exposure bracketing is performed by using both flash exposure compensation and ambient exposure alteration ¹¹⁷ [default]
AE only	Bracketing is performed using only ambient exposure alteration
Flash only	Bracketing is performed using only flash exposure compensation
WB bracketing	White balance is bracketed <i>instead of</i> exposure
ADL bracketing	Active D-Lighting is bracketed <i>instead of</i> exposure



Recommendations:

1. This “feature” catches many users by surprise. Or it just puzzles them. But changing exposure via flash exposure compensation doesn’t look the same as changing it via ambient exposure compensation. This is especially true if you’ve set flash mode options such as Slow Sync. The default setting is okay, but generally is not what all users want. I tend to leave my D90 on **AE only**, as I’m using Standard TTL and setting my own flash compensation

¹¹⁷Aperture and shutter speed changes are used for ambient exposure alteration.

- value. If you use Balanced Fill-Flash, strongly consider leaving the default set.
2. White balance bracketing is an interesting option, though Nikon doesn't document it nearly well enough, and it would be more helpful if we saw real Kelvin values, not cryptic -1 and +1 indicators. Also, you only press the shutter release once when **WB bracketing** is set (unlike bracketing for exposure compensation). You still get your full number of shots, though, each with a different white balance setting. If you're wondering which white balance values are used, well, you need a white balance table handy to figure it out (see page <316>). Even then, in Nikon's documentation it's not clear what happens. What if, for example, you want a bracket value of +2 but you're already set at, say, **Flash A4**¹¹⁸? Also, note that the camera doesn't bracket white balance when **WB bracketing** is set if you are taking NEF images (it won't even allow you to make bracketing active). In short: kudos for the idea; thumbs down for the execution.
 3. **ADL bracketing** is like **WB bracketing** in that it creates a burst of images that differ in the value of **Active D-Lighting** that is applied. Unlike **WB bracketing**, there is nothing you have to choose other than turning it on or off. Also, you can apply this setting to NEF images as well as JPEG.
 4. Note that this function *only* applies when using the Program, Aperture-priority, Shutter-priority, and Manual

¹¹⁸ I'll answer it: you get **Flash A8!** What the heck is that? Well, each white balance increment (other than in **Fluorescent**, where who knows what happens due to the channel imbalances introduced) is 10 MIRE (MicroREciprocal Degree, a way of calculating color temperature). The footnote in the manual about MIRE is trying to be helpful, and is better than the footnote in previous Nikon DSLR manuals, but still a bit unclear. Amusingly, Nikon only gives you a way of calculating MIRE from the color temperature difference, and not vice versa, which is what you need. (I'm wondering if the source for this is page 43 of my *Nikon Field Guide*). Put a more useful way, each 10 MIRE shift is equivalent to using an 81 or 82 filter (depends upon which way you're going). A 20 MIRE shift is like an 81A or 82A, a 30 MIRE shift is like an 81B or 82B, etc.

exposure modes. In the Scene exposure modes this Custom Setting is ignored.

#E5 Enable/Disable FP Flash Abilities

(Auto FP)

The SB-600, SB-800, SB-900, and SB-R200 flash units support a special type of flash that can be used with shutter speeds faster than the usual flash sync speed on the D90 (1/200).

At shutter speeds up to 1/200, all Speedlights (and the internal flash) produce a single flash that “fits into” the period during which the entire shutter is open. At shutter speeds above 1/200, the D90 uses a special shutter technique where only a part of the frame is exposed at a time (don’t worry, all parts get the same amount of exposure and this happens so fast that no subject motion artifacts are created). For flash to work correctly at those faster shutter speeds, it has to fire repeatedly as the shutter opening moves across the entire scene. Nikon calls this technique FP.

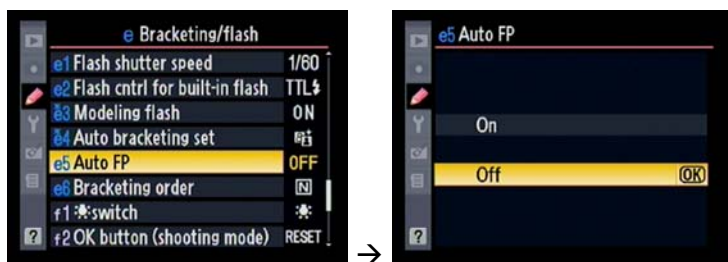
Older Nikon bodies supported only a manual FP technique (i.e., they couldn’t automatically adjust the flash exposure when FP was set: you had to set the flash exposure manually). The D90 and most recent Nikon bodies also support Auto FP, which automatically calculates flash exposure in TTL and Automatic flash modes.

Nikon incorrectly labels this Custom Setting: you’re setting FP, not just Auto FP. Put another way, if you set Auto FP to **On** you enable Auto FP for TTL and Automatic flash modes, and you enable Manual FP for both Repeating flash and Manual flash modes.

Note that the internal flash *cannot* support FP.

On Auto FP and Manual FP are enabled

Off Auto FP and Manual FP are disabled [default]



Recommendations:

1. If you never use an external flash, you can leave this setting at the default (disabled). On the other hand, if you do use an external flash that supports it, you need enable this function in order to shoot at shutter speeds faster than 1/200 with flash.
2. All is not perfect with FP, however. Enabling FP results in your flash being about 1/8 its normal power when you shoot at shutter speeds faster than 1/200. Moreover, the flash will take longer to recycle and drain its batteries faster.

#E6 Bracketing Order

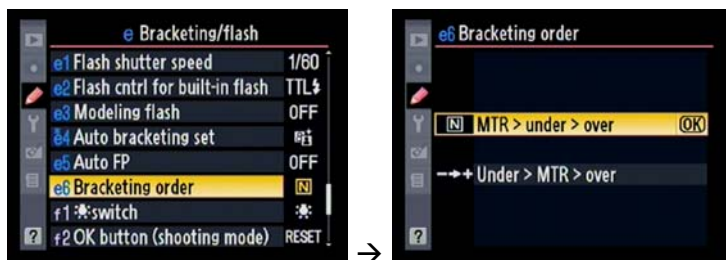
(Bracketing order)

You can select the order in which the D90 exposes the photographs when automatic bracketing is set (see “Exposure Bracketing” on page <290>):

Note: Bracketing can set sequences fewer than three exposures. The bracketing order describes what happens when at least three exposures are taken. If you’ve set bracketing to two-shot sequences, the orders shown below are still correct, but one of the values is left off. For example, if you asked the camera to set bracketing to -2F 0.5, the “overexposed” value is not taken, so just ignore its place in the order. If you set the camera to bracket more than three images, the orders shown below are correct: extra – and + compensation values are performed in order of lowest exposure to highest.

MTR > under > over Correct exposure first, then underexposed, then overexposed [default]

Under > MTR > over Underexposed first, then correct exposure, then overexposed



Recommendations:

1. Pick one and use only that setting. This is one of those things where consistency is preferable. Since the D90 names every file only with numbers, this becomes even more important. (You could browse through the EXIF data to figure out which is which.)
2. I personally prefer to have my numbered images go from underexposure to overexposure, so I select **Under>MTR>over**. That's because that's the way I used to set up bracket sequences on the light box when reviewing slides. I'm used to seeing values from low to high.
3. Note that the order applies to *flash-only*, *white balance bracketing*, and *ADL bracketing*, as well. This is another reason why I like them in order—any time I see a bracketing sequence of shots, I know that they go from low to high in whatever is bracketed.
4. Note that this function *only* applies when using the Program, Aperture-priority, Shutter-priority, and Manual exposure modes. In the Scene exposure modes this Custom Setting is ignored.

#F1 Power Switch Illumination Function

(☼ Switch)

Normally the light position on the Power switch controls illumination for only the top LCD. You can also have it display the Information Shooting panel on the color LCD, as well:

LCD backlight

Top LCD illuminated only (for six seconds) [default]

Both

Top LCD illuminated and Information Shooting display shown on color LCD



Recommendation:

1. It's nice that Nikon gives us the option, as **Both** does consume more power than **LCD backlight**. Note that using backlighting on the top LCD via either method consumes additional power and should be avoided as much as possible.

#F2 Direction Pad Center Button

(OK button (shooting mode))

The Direction pad on the D90 has an OK button in the center. Nikon's higher end cameras all allow you specify what a "center press" does while you're shooting. The D90 allows you to define this, as well:



- | | |
|-------------------------------------|---|
| Select center focus point | Selects central autofocus area (or center sensor group) [default] |
| Highlight active focus point | Briefly highlights the active autofocus area |
| Not Used | Pressing center of the button does nothing |

Recommendation:

1. Your choice. I leave my camera at the default.

#F3 FUNC Button Setting

(Assign FUNC. button)

The **Fn**¹¹⁹ button on the front of the camera can be programmed to do one of many useful things.



¹¹⁹ [sic] Nikon's manuals and menus refer to it as the FUNC. button. Apparently, there wasn't enough room to stencil FUNC on the camera body.

Framing grid	Holding the Fn button and turning the Rear Command dial toggles the on-demand grid display on and off. (Essentially a quick Custom Setting #D2.)
AF-area mode	Holding the Fn button and turning the Rear Command dial allows you to select between the various AF-area modes. (Essentially a quick Custom Setting #A1.)
Center focus point	Holding the Fn button and turning the Rear Command dial allows you to select between the various OK button settings while shooting. (Essentially a quick Custom Setting #F2.)
FV lock	The flash is preflashed once and the value for flash locked when the Fn button is pressed; a second press cancels FV lock
Flash off	Flash is disabled while the button is held
Matrix metering	Matrix metering is active while the Fn button is held down
Center-weighted	Center-weighted metering is active while the Fn button is held down
Spot metering	Spot metering is active while the Fn button is held down
Access myMenu	The top item of MyMenu is activated when the Fn button is pressed
+NEF (RAW)	When shooting in JPEG, a NEF picture will also be taken <i>for the next shots</i> when the Fn button is pressed (a second press cancels this and returns you to your last JPEG-only shooting)

Recommendations:

1. Welcome to the crazy mother lode. If there's any Custom Setting options you want to spend some time studying, this and the next are the ones. This is a bit like having programmable function keys on your computer keyboard: each of us will approach these two options differently, but we'll all find it useful. I'll only touch on a few of the possibilities.
2. The **FV lock** option is interesting because the preflash occurs before the mirror goes up on the D90. There's just enough of a pause between the preflash and main flash that you might get "blinkers" (people blinking in reaction to the pre-flash). Set this function for the solution: press the **Fn** button to get a flash reading and then shoot away; the camera won't preflash again until you press the **Fn** button again to restore normal preflash. (Note: the flash has to be in a TTL mode for this to work; other flash modes don't preflash!) Remember, flash exposures are good for only one subject distance, so you'll need to retrigger the **Fn** button every time your subject changes distance (or you shoot a new subject at a different distance).
3. I tend to use matrix metering most of the time, but every now and then I find myself in situations where I want to temporarily check areas of a scene with the spot meter. Now I can do just that without changing the Metering Method via the button on the top of the camera. By setting **Spot metering** for the **Fn** button, I have one-button spot metering at my fingertips; it's also easy to see the change in exposure settings as I press and release the button.
4. **Flash off** might not sound like a useful function at first, but think again. If you're trying to quickly evaluate the ambient/flash balance in exposures (i.e. how much impact the flash is having), being able to hold the **Fn** button while taking an exposure gives you a quick way of getting just the ambient exposure. Take one shot with flash and ambient, one with ambient only. Now in playback,

bounce back and forth comparing the two. This is more convenient than it sounds.

5. The first three options are essentially Custom Setting shortcuts. Of these, **AF-Area mode** is the most interesting, as it allows you to control the third of the autofocus options without having to dip into the menu system and all the button presses that encompasses. If you're in situations where the type of focus you need changes often, then I strongly suggest you try assigning this function to the **Fn** button.

#F4 AE-Lock Button Function

(Assign AE-L/AF-L button)

Like the **Fn** button, the **AE-L/AF-L** button can be assigned a number of different useful functions.



AE/AF lock

Holding the **AE-L/AF-L** button locks both exposure and focus [Default]

AE lock only

Holding the **AE-L/AF-L** button locks exposure

AF lock only

Holding the **AE-L/AF-L** button locks focus

AE lock (hold)

Pressing the **AE-L/AF-L** button locks exposure until the meter times out or you press the button a second time

AF-ON

Pressing the button activates the autofocus system (much like a half press of the shutter release). The shutter release no longer activates focus.

FV lock

Pressing the button fires the flash and sets a TTL exposure that is held until the next time you press the button. This also cancels preflash for subsequent flashes when the internal flash is set to **TTL**.

Recommendations:

1. Note the one overlap with the **Fn** button (Custom Setting #F3): **FV lock**. This allows you to assign this function to the **AE-L/AF-L** button and free up the **Fn** button for something else. If you're going to use **FV lock**, first figure out which of the two buttons has the most useful thing you want to use the second button for. Then you'll know which button to assign **FV lock**.
2. The **AE-L/AF-L** button on the MB-D80 grip can be assigned (via Custom Setting #A6) differently than the main camera body's version of the button. This is sometimes worth considering, as your hand position on the grip won't allow you to reach the Direction pad or **Fn** button as easily. But don't program a mismatch without considering how that's going to work in practice. Having two buttons that are labeled the same do something different can be problematic for some users.

#F5 Command Dial Functions

(Customize command dials)

Some users think that the Front Command dial is not as convenient as the Rear Command dial for setting apertures. Others don't like the direction the controls work (e.g. clockwise increases apertures normally). Fortunately, you can override three of Nikon's choices with this custom setting.



Reverse rotation

Yes The rotation of the Command dials is reversed (e.g. apertures now increase by turning the Front Command dial counterclockwise)

No Operation is as described in the manual [default]



Change main/sub

On The Command dials are swapped, with the Rear Command dial controlling apertures and the Front Command dial controlling shutter speeds, for instance.

Off Operation is as described in the manual [default]

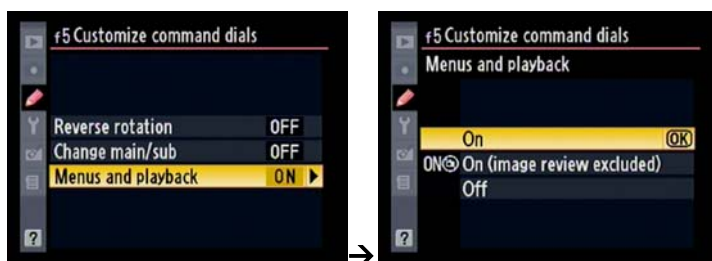


Menus and playback

On The Command dials are used to control navigation in menus and playback in addition to the Direction pad (the Rear Command dial is equivalent to the left/right keys on the Direction pad, the Front Command dial is equivalent to the up/down keys)

On (image review excluded) Same as **On** except the dials work normally during image review.

Off The Direction pad is used to control navigation in menus and playback [default]



Recommendations:

1. I don't have a problem with the way Nikon designed things to work, and perhaps other than the ability to use the aperture ring option don't see any compelling features here.
2. If you also use any Nikon body that doesn't have all these custom functions (e.g. D50), leave the D90 set on the defaults, otherwise you're likely to get confused when you move back and forth between bodies.
3. Likewise, this is a nice April Fool's joke to pull on Nikon users: just change the options to **Yes**, **On**, and **On** and watch your favorite Nikon user go mad in frustration trying to figure out what's going on with his or her camera.

#F6 Lock Camera with No Secure Digital Card

(No memory card?)

As a safeguard to keep you from thinking you're taking pictures when you aren't, the D90 normally locks the shutter release when no Secure Digital card is present in the camera.

Release locked The shutter release locks if no card is present in the camera. [default]

Enable release The shutter release is unlocked and the camera operates normally (other than being able to save images) when no card is present in the camera.



Recommendations:

1. Generally, you'd leave the default in place. You usually don't want the camera to operate as if it is functioning when it isn't saving your images! Images do appear on the color LCD when **Enable release** is set, though they will have a big red **DEMO** placed at the top to indicate to you that the image is not permanently stored.
2. If you connect the camera to a computer and use Nikon Camera Control Pro 2 to control the camera, you *don't* need to set this function to **Enable release**. Since images aren't recorded to the memory card at all, the shutter release is automatically enabled in this situation.
3. Personally, I'd suggest that you always leave a card in the camera and just leave this setting at the default. We digital

shooters have enough things to deal with without adding yet another variable to watch for in our shoots.

#F7 Reverse the Manual Metering Bar

(Reverse indicators)

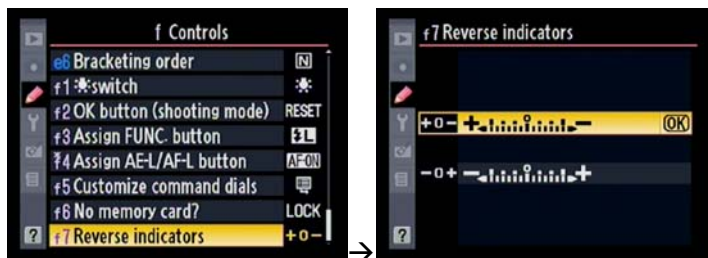
After years of complaints from users of other cameras switching to Nikon, Nikon has provided a way to make the orientation of the manual metering bar go from low to high (instead of the usual high to low).

+...0...-

The orientation Nikon has used since the N8008 and F4, and which corresponds to the lens aperture rings [default]

-...0...+

The inverted orientation found on many other camera makers' models



Recommendation:

1. Since the D90 is an amateur camera and you normally wouldn't notice why the design is as it is, let's make sure you know the reason *why* Nikon's metering bars seem the opposite of everyone else's: they reflect the direction you should turn the top of the aperture ring on the lens to correct the exposure problem you're seeing (on cameras that meter with manual focus lenses with aperture rings). Turning a Nikkor lens aperture ring to the right (from the back of the camera) provides less exposure, so if you saw a + exposure value, you'd be turning the lens ring that direction. Obviously, this isn't an issue on the D90 since it

can't use aperture rings to control exposure. Thus, you can set either option. However, if you're likely to move to one of Nikon's pro cameras someday and use lenses with aperture rings, I suggest you just leave it set at the default and get use to the reverse way in which the Nikon world seems to work.

Using Flash

Flash use with a D90 is different than with film SLRs and early Nikon DSLRs. Like all recent Nikon DSLRs the D90 uses a form of flash technology Nikon calls i-TTL.

Obviously, I'd love for all readers of this book to rush out and purchase my Nikon Digital Flash Guide. If you'd like an extended discussion of TTL modes and how flash works, consider purchasing it. For most D90 users, though, the sections that follow are probably all you need for basic flash use.

What Happens When Flash is Used

Flash isn't a magical device that simply fixes every lighting problem you're facing. Like any tool, you need to understand how it works and how to best use it. The big "gotchas" I encounter most frequently with students are these:

- *Flash only lights one distance correctly.* Light falls off with the inverse square of the distance. If a flash is providing the correct light for 8 feet, by 11 feet the light will be one stop less; at 5.6 feet it will be one stop more. The classic expectation most people have is that flash should light both a subject and a background that's many feet behind the subject. Won't happen.
- *Two exposures occur when you use flash.* Both have to be right. This is an extension of the first thing I presented: if flash is lighting only a subject at one distance correctly, something else has to provide the exposure for the background (ambient) areas. That "something else" is the same thing it always is: the existing light, and the aperture, shutter speed, and ISO are the variables you use to control them. The flash (subject) exposure, meanwhile, is controlled by flash power, aperture, and ISO. Note that only aperture and ISO overlap between the two exposures.

When set to the defaults, the D90 does its best guess at making everything work “magically.” As you’ll learn in a bit, the default settings for the camera are to “balance” flash and ambient lighting (what Nikon calls **TTL BL**). That’s not always what you want it to do, and there are things that can keep the camera from succeeding at that.

Flash Basics

A flash produces a burst of light by the reaction of the flash tube’s xenon gas to an electrical signal from the camera. For Speedlights with variable power ability, the amount of light produced is determined by when the electrical signal to the xenon is shut off:

- When a Speedlight is set to provide full power it essentially provides as much light as possible: the response from the xenon gas eventually stops when the electrical signal from the Speedlight’s capacitor decays to nothing. That takes about 1/880 of a second on an SB-900.
- When a Speedlight is set to fire at less than full power, the xenon gas response is shut down by removing the electrical impulse well before the capacitor is exhausted. On an SB-900, for example, the “flash” can be shut off in as little as 1/38,500 of a second (at 1/128 power).

In order to have any variability in flash output something has to measure the amounts of light produced and make the decision of when to shut the flash off. Either the D90 or the flash itself can both measure and control the amount of light.

Yes, this means that the D90 has something inside it that measures the light produced by the flash (the 420-pixel sensor in the viewfinder is used for this job¹²⁰). Like the ambient

¹²⁰ Note that one way the D2 series and the D90 differ is that the D2 series has an additional five-segment sensor in the mirror box, which looks at the shutter curtain. This has subtle but real implications. The D90, for example, always fires a preflash at the (first) shutter release press, the D2 series waits until the second when set to **Mup**, thus putting the flash calculations closer to the actual picture taking.

exposure, the metering sensor must get its measurements *before* the picture is taken, which is why you'll see references to something called the preflash¹²¹. Why before the exposure? Because the D90 has no way to measure the flash output *during* the exposure (none of the Nikon digital SLRs do).

If you're starting to think that there may be more "modes" and settings coming, you're right. Flash exposure is no different than regular exposure: you have to set the camera/flash to do what you want it to. And there are lots of options you need to know about.

Digital Flash Differences

For 35mm film cameras, Nikon TTL¹²² flash sensors are designed to look at reflections off the shutter curtain before exposure *and* again off the film during exposure. But the D90 doesn't have any film, and the sensor doesn't reflect light the same way that film does, so this second exposure test isn't performed.

Before we get to the D90's flash options, let's go back through a little digital flash history. Nikon originally decided to modify its flash system slightly for digital cameras to include a new flash "mode," called D-TTL, or Digital TTL. D-TTL is only supported by the D1 series, the D100, and the D2 series, with the SB-28DX, SB-50DX, SB-80DX, SB-600, and SB-800 being the only flashes that can be used for D-TTL. Other (mostly older) flash units, including the original SB-28, *cannot be used in TTL flash modes with these Nikon DSLRs*. Indeed, if you attempt to do so, the shutter release locks and you can't

¹²¹ The name preflash is a little misleading. Most newcomers expect to always see a separate flash from the main flash. But the preflash usually occurs so close to the actual flash that you usually don't distinguish it from the main flash. If you don't believe me, set your D90 to Shutter Delay (Custom Setting #D10) with the flash popped up and in a TTL mode. Press the shutter release. The mirror goes up, but before it does, the camera fires the preflash. At any shutter speed faster than 1/8 the preflash and flash are close enough together that many people can't distinguish them.

¹²² Just a reminder: TTL stands for Through the Lens. Flash measurements are performed *by the camera* looking through the lens. In theory, this is the most accurate flash capability.

take pictures until you set the Speedlight to Automatic (A) or Manual (M) flash modes.

With the D2h introduction, Nikon updated the flash system a second time to something Nikon calls i-TTL (they also call the entire set of new flash capabilities CLS, for Creative Lighting System). The D40, D40x, D50, D60, D70, D70s, D80, D90, D2h, D2hs, D2x, D2xs, D3, D200, D300, and D700 all use i-TTL capabilities. Unfortunately, a side effect of the i-TTL update is that *only* the SB-400, SB-600, SB-800, SB-900, SB-R200, and internal flashes support it. This is a critical change to note. Just to be clear:

To get any form of TTL flash on a D90 you must use the internal flash, or one of the following external Speedlights: SB-400, SB-600, SB-800, SB-900, or an SB-R200.

Let me summarize a few things that are different between the three basic Nikon flash technologies before we go on. I realize that some of the terminology may be new to you, but by the end of the section on flash you should be fully up to speed; just come back to this chart then.

	<i>Old Film TTL</i>	<i>D-TTL</i>	<i>i-TTL</i>
<i>Cameras Supporting</i>	Virtually all film cameras after the FA	D1 series, D100, D2 series	D2 series, D3, D40, D40x, D50, D60, D70, D70s, D80, D90 , D200, D300, D700
<i>Flash Units Supporting</i>	All Speedlights since the SB-24	SB-28DX, SB-50DX, SB-80DX, SB-600, SB-800, SB-R200, D100 internal flash	SB-400, SB-600, SB-800, SB-900, SB-R200, internal flash (D40, D40x, D50, D60, D70, D70s, D80, D90 , D200, D300, D700)

	<i>Old Film TTL</i>	<i>D-TTL</i>	<i>i-TTL</i>
<i>Preflash occurs</i>	After mirror up, before shutter opens	After mirror up, before shutter opens	Before mirror up, before shutter opens
<i>Flash Measurement occurs</i>	Preflash and again during exposure	Preflash only	Preflash only
<i>Flash Measured by</i>	5-segment sensor in mirror box	5-segment sensor in mirror box	CCD in viewfinder
<i>Multiple TTL flash supported?</i>	Yes with cables or wireless with SU-4	No	Yes with i-TTL wireless functions
<i>TTL controlled wirelessly?</i>	Yes, but all flashes fire at same level	No	Yes; flashes can even be grouped to fire at different levels (with SB-800, SB-900, SU-800, or internal flash set as Master)

A D90 using i-TTL is a good news, bad news situation: the good news is that this is arguably the most elaborate, user-controllable, and accurate TTL flash system Nikon—or perhaps anyone—has produced. The bad news is that you can only use the very latest flash units with it, which may mean purchasing new equipment.

Like all recent Nikon camera bodies, a flash-ready indicator is displayed in the D90 viewfinder when a flash—internal or external—is fully charged and ready to fire. This same indicator blinks for three seconds *after* a photograph is taken to indicate that the flash fired at full power, which may indicate underexposure (of the subject). (On a D90, the indicator also blinks in low light if Custom Setting #D11 is set.) Fortunately, with a D90 you can immediately review the image on the color LCD to determine if this “full power” warning actually meant underexposure.

More Hidden Flash “Gotchas”

One thing that catches a number of D90 users unaware is that the Program exposure mode limits apertures that can be used with flash based upon ISO value. And given the fast apertures of most pro lenses, you’re quite likely to bump up against this limitation at some point:

Allowable Apertures in Program and Scene Exposure Modes

ISO	Aperture Range Allowed			
	<i>Internal flash (Program and Scene modes)</i>	<i>Internal flash (macro scene mode)</i>	<i>External flash (Program and Scene modes)</i>	<i>External flash (macro scene mode)</i>
Lo 1.0	f/2.5 and up	f/5 and up	f/3.8 and up	f/7.1 and up
Lo 0.7	f/2.5 and up	f/5 and up	f/3.8 and up	f/7.1 and up
Lo 0.3	f/2.8 and up	f/5.6 and up	f/4 and up	f/8 and up
200	f/2.8 and up	f/5.6 and up	f/4 and up	f/8 and up
250	f/3.2 and up	f/6.3 and up	f/4.5 and up	f/9 and up
320	f/3.2 and up	f/6.3 and up	f/4.5 and up	f/9 and up
400	f/3.5 and up	f/7.1 and up	f/5 and up	f/10 and up
500	f/3.5 and up	f/7.1 and up	f/5 and up	f/10 and up
640	f/4 and up	f/8 and up	f/5.6 and up	f/11 and up
800	f/4 and up	f/8 and up	f/5.6 and up	f/11 and up
1000	f/4.5 and up	f/9 and up	f/6.3 and up	f/13 and up
1250	f/4.5 and up	f/9 and up	f/6.3 and up	f/13 and up
1600	f/5 and up	f/10 and up	f/7.1 and up	f/14 and up
2000	f/5 and up	f/10 and up	f/7.1 and up	f/14 and up
2500	f/5.6 and up	f/11 and up	f/8 and up	f/16 and up
3200	f/5.6 and up	f/11 and up	f/8 and up	f/16 and up
Hi 0.3	f/6.3 and up	f/13 and up	f/9 and up	f/18 and up
Hi 0.7	f/6.3 and up	f/13 and up	f/9 and up	f/18 and up
Hi 1.0	f/7.1 and up	f/14 and up	f/10 and up	f/20 and up

Yes, that table means what you think it does: if you set Program or Scene exposure modes using external flash, those fancy wide apertures of your expensive lenses won’t ever be used. In Macro (close up) Scene exposure mode, the aperture limitations are extremely acute.

Another issue to note with the D90 is that the focal lengths all Speedlights except for the SB-900 are geared towards 35mm film, not the D90’s 1.5x field of view reduction. This means

that you'll normally be lighting a wider angle than the D90 is taking in, wasting flash strength. Here's a handy table to use when shooting with a Speedlight flash:

D90 Safe Flash Head Focal Length Settings

<u>Lens Focal Length</u>	<u>Set Flash to</u>
14mm	20mm
17-18mm	24mm
20mm	28mm
24mm	35mm
35mm	50mm
50mm	70mm
60-70mm	85mm
>85mm	105mm*

**Assumes SB-800*

In other words, if you have a 20mm lens on the D90, manually zoom the flash head to the 28mm mark. The settings in the above table are the closest that guarantee full-frame coverage for the D90's reduced sensor size, and provide you the maximum flash power for that coverage, extending the distance at which you can shoot with flash.

If you're using an SB-900, you can ignore the above table *unless* you've set the **FX/DX** Custom Setting on the SB-900 to **FX**.

Flash Modes

Like most Nikon 35mm film camera bodies, the actual method used to calculate flash exposure varies considerably depending upon camera settings, flash settings, and the lens being used. A full discussion of the intricacies of Nikon's flash system can be found in my *Nikon Digital Flash Guide*, but what follows is a simple recap of what's available using a D90.

i-TTL Balanced Fill-Flash

TTL BL on the Speedlight LCD (if it has a display).

This is the *default* flash mode for most camera settings. Requires use of a D, G, P, AF, AF-I, or AF-S lens (basically any lens that has what Nikon calls a CPU in it). The camera balances exposure information from the matrix meter with additional information from the lens (focal length, aperture, and distance at which the lens is focused for D and G type lenses) and from a series of nearly invisible pre-flashes, which the metering sensor in the D90's viewfinder analyzes. When set in this mode, the D90 normally attempts to balance the flash with the ambient light. Generally, less flash is produced in this mode than if you set the flash manually for the flash-to-subject distance.

Note that *no* measurement of the light produced by the flash is made by the D90 *during* the exposure, as is done on the 35mm film camera bodies; the amount of flash produced is completely determined at the end of the pre-flash measurements, which occur before the shutter opens. Thus, if lighting conditions change rapidly, the amount of flash produced may be incorrect. That happens rarely, but the lower power of the preflash does make the accuracy of the flash exposure calculations slightly more subject to error than the during-exposure re-measurement the film bodies do.

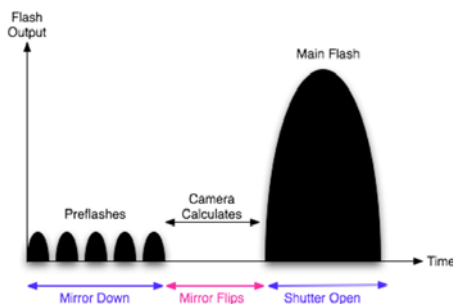
The more likely problem of preflash on the D90 is that it triggers “early blinkers.” There’s just enough time between the preflash and the actual flash that some fast-responding individuals will start to or already have blinked their eyes in response to the preflash by the time the actual flash goes off¹²³. That almost never happened with the old film TTL system.

¹²³Hint: use **FV lock** to control when the preflash is done. See Custom Setting #F3 on page <530>.

A few paragraphs back you'll note that I wrote that the D90 "normally attempts to balance the flash with the ambient light" when in Balanced Fill-Flash mode (**TTL BL**). That "normally" is an intentional qualifier that needs some discussion. Previous Nikon DSLRs tended to continue to try to balance ambient and subject light, even in dark conditions. The D90 has changes that seem to recognize low light conditions and change the strategy of **TTL BL** (as do all Nikon DSLRs introduced starting with the D200). Unlike, for example, the older D50 or D70 series models, the D90 seems to do a better job of lighting the subject independently of the background exposure when you're using flash. Thus, the old "background dim, subject dim" result that some earlier Nikon DSLRs produced seems to be partially gone. That removes one of my objections to using **TTL BL** as the default.

One other slight change that will only be of interest to seasoned Nikon flash users: there is no longer any indicator of the *type* of Balanced Fill-Flash that the camera performs if you use an older autofocus lens (the ones that didn't provide distance information to the camera). On some older Nikon bodies, subtle differences snuck into Balanced Fill-Flash levels, usually due to the metering system and lens being used, and this was indicated by different symbols on the flash LCD. With the i-TTL systems, those symbols no longer appear and Nikon doesn't try to explain any differences that may occur (other than an oblique reference to lenses without CPUs). As far as I can tell, there still are some subtle differences being made due to camera settings, but they are indeed very subtle and mostly ignorable.

Note: Unlike the SB-24 and later flashes on film bodies, the D90 internal flash, SB-400, SB-600, SB-800, SB-900, and SB-R200 always fire pre-flashes in i-TTL modes, even if the flash head is set to a bounce angle (Speedlights used on 35mm bodies cancel pre-flashes if the head is swiveled or angled at anything other than the normal position, relying only on the reflected flash measurement during exposure).



The pre-flash is usually a series of short pulses of light, with a regular pattern. The pre-flash on a D90 is triggered within 20 milliseconds after the shutter release (which occurs about 65 milliseconds after you press the shutter release button). The main flash follows the pre-flash by 60 milliseconds. Thus, the shortest time from when you press the shutter release to the flash going off is a little less than 145 milliseconds.

Standard TTL

TTL on the Speedlight LCD (if it has a display).

This flash mode is available with all autofocus lens types and AI-P lenses; the camera automatically chooses it if you select spot metering (which is the only way you can put the internal flash into Standard TTL). It also chooses a relative of Standard TTL if you use **FV Lock** with an external flash (i.e. it may use spot metering for the subject and flash exposure measurements). Unlike the Balanced Fill-Flash mode, Standard TTL attempts only to ensure that the flash provides the correct exposure for what the camera thinks is the subject. In other words, the camera does not attempt to balance background exposure with subject exposure, as it does in the Balanced Fill-Flash TTL mode.

High-Speed TTL (TTL FP)

TTL BL FP or TTL FP on the Speedlight LCD; only available on SB-600, SB-800, SB-900, and RB-200 Speedlights. Not available with internal flash.
--

The D90 supports a variant for both Balanced Fill-Flash TTL and Standard TTL: **Auto FP**. **Auto FP** doesn't change the type of TTL being performed (Standard or Balanced), it only changes the allowable shutter speeds. If **Auto FP** is active—and you make it so by setting Custom Setting #E5—the upper shutter speed limit of 1/200 for flash is removed. That may seem like something you'd want to have available all the time (it is a setting I suggest as a default), but be careful. Shutter speeds above 1/200 cause the flash to produce its light differently. Instead of a single flash burst, the output is done in a series of very short, small bursts of flash, which reduces the overall output of the flash by a bit over two stops. If you use the **TTL FP** option, make sure to pay attention to the range display on the external flash LCD whenever you shoot at faster than 1/200; the flash may not be able to cover the distance you're shooting at. Note also that the range display on most Nikon Speedlights does not appear if you've tilted or rotated the flash head.

Summary of i-TTL Flash Modes

<i>Flash Mode (as displayed on External Flash LCD)</i>	<i>Exposure Modes</i>	<i>Metering Modes</i>	<i>TTL Type Performed</i>
TTL BL Internal and External flash	Program, Aperture, Shutter, Manual	Matrix, Center- weighted	Balanced Fill Flash (shutter speed limited at 1/200)
TTL Internal and External flash	Program, Aperture, Shutter, Manual	Spot*	Standard TTL (shutter speed limited at 1/200)
TTL BL FP External flash only	Program, Aperture, Shutter, Manual	Matrix, Center- weighted	Balanced Fill Flash (no limit on shutter speed)
TTL FP External flash only	Program, Aperture, Shutter, Manual	Spot*	Standard TTL (no limit on shutter speed)
*Standard TTL mode is set automatically when you select this option.			

*Note: TTL flash modes can also be changed (if the camera isn't set to Spot metering) by using the **Mode** button on the external flash. In other words, if you see **TTL BL** on the flash LCD, pressing the **Mode** button selects **TTL** instead.*

Non-TTL Flash Modes

In the TTL flash modes just described, the *D90* performs all the calculations necessary to adjust the flash output level. When you press the shutter release, the camera tells the flash when to start firing and when to stop. The flash simply follows the camera's orders to turn on and off. Three remaining flash modes, Auto Aperture (**AA**), Automatic (**A**), and Manual (**M**) flash, differ in that the *flash* performs much of the flash exposure calculation and the camera body does not determine when the flash shuts off:

Auto Aperture

AA Displayed on the Speedlight's LCD¹²⁴. Unique to SB-800 and SB-900 flash units (some cameras support the SB-28DX and SB-80DX in this mode, but the D90 doesn't).

In Auto Aperture flash mode the Speedlight obtains the ISO value and aperture being used from the camera, as well as the signal to start the flash (i.e. "shutter's open, go ahead"). As with i-TTL modes, Auto Aperture flash mode fires a preflash, I believe to help the metering system refrain from blowing out highlights when the flash is fired and to get a measurement of white balance. During the exposure, a sensor on the *front of the Speedlight* is monitored, and when the amount of light that sensor sees reaches the level the Speedlight calculates it needs, the Speedlight stops firing.

Automatic

A Displayed on the flash unit's¹²⁵ LCD. Available with all other external flash units that have an Automatic flash mode.

In Automatic flash mode, the flash unit sees only the signal to start the flash (no preflash is fired). You must transfer the aperture and ISO used by the camera by setting this manually on the flash unit. Again, a sensor on the *front of the flash unit* is monitored, and when the amount of light it sees reaches the level the flash unit calculates it needs (based upon aperture setting and ISO value), the flash stops firing. Besides the cumbersome limitation of transferring the aperture and ISO settings to the flash unit, the flash unit's sensor doesn't see the same thing as the camera lens, which can result in errant flash levels.

¹²⁴ The SB-900 displays .

¹²⁵ You'll note the use of the words "flash unit" instead of Speedlight. That's because almost all third-party flash units support Automatic flash mode.

Note: The classic “trouble case” for both Automatic and Auto Aperture flash modes is shooting through a doorway: the flash unit’s sensor sees light reflecting off the door frame and nearby walls, while the lens may be zoomed in to only see a subject in the next room, well beyond the doorway. If you choose to use Auto Aperture or Automatic flash mode, you need to always watch to make sure the flash unit’s sensor is seeing the same subject as the lens and is not blocked by cables or other objects.

Manual

M displayed on the flash unit’s LCD. Available with any flash unit that supports Manual flash modes.

In Manual flash mode, the flash unit fires at a fixed output you select. It’s up to you to perform the calculations to ensure that the proper amount of flash is produced. Many flash units have variable power levels, plus their output is also dependent upon what focal length the flash head is set for, thus doing manual flash calculations sometimes takes a bit of time, as well as consulting a Guide Number (GN) chart. On the other hand, a correctly made manual flash calculation should always provide exactly the right amount of flash on a subject. The general formula is:

$$\text{Aperture} = \text{GN} / \text{Distance}$$

or $\text{GN} = \text{Distance} * \text{Aperture}$

or $\text{Distance} = \text{GN} / \text{Aperture}$

Make sure that the GN you plug into those formulas is expressed in the same units as the **Distance** (feet or meters), and that you’re using the correct Guide Number for the focal length set on the Speedlight. Also, make sure that the Guide Number you look up is for the ISO value set on the camera body (Nikon’s flash manuals all use ISO 100 values; to convert them to ISO 200, multiply those values by 1.4; for ISO 400, multiply by 2).

Likewise, if you're using less than full power, make sure you're using the correct Guide Number for the lower power. Most recent Speedlight models show a distance indicator on their LCD in this mode (if the flash head isn't tilted), though the limited "resolution" of this indicator means you can't totally rely upon it.

Flash modes can usually be set on the flash unit, too:

- | | |
|---------------|--|
| TTL | Only available on the internal flash, SB-400, SB-600, SB-800, SB-900, and SB-R200. With an SB-600, SB-800, or SB-900 mounted on the camera, press the Mode button on the back of the flash until TTL BL or TTL is displayed. If Custom Setting #E5 is set to allow it and you're using an SB-600, SB-800, or SB-900, FP may also appear to indicate that shutter speeds higher than 1/200 can be used, though flash power will be reduced. If you're using an SB-R200, its mode is set by the Master flash controlling it. If you're using an SB-400, it can only do TTL as controlled from the camera. If you're using the internal flash, setting spot metering switches the internal flash from TTL BL to Standard TTL. See "Summary of i-TTL Flash Modes" on page <551>. |
| Auto Aperture | Only available with the SB-800 and SB-900. Press the Mode button on the Speedlight until A/A (SB-800) or A (earlier Speedlights) or Ⓜ/A (SB-900) is displayed on the flash unit's LCD. If Custom Setting #E5 is set to allow it, FP may also appear to indicate that shutter speeds higher than 1/200 can |

be used, though flash power will be reduced.

- | | |
|-----------|---|
| Automatic | Available on all Speedlights that support Automatic flash (SB-24 through SB-80DX, for instance). Move the Flash Mode switch on the Speedlight to A (or AUTO), or press the Mode button on the Speedlight until A is displayed on the flash unit's LCD. You will need to manually transfer the ISO setting and aperture to the flash. |
| Manual | Available on all Speedlights that support Manual flash. Move the Flash Mode switch on the Speedlight to M (or a specific power level, such as 1/2, 1/4, 1/8, etc.), or press the Mode button on the Speedlight until M is displayed on the flash unit's LCD (specific power levels are usually then set by pressing the + or - buttons on the flash). You'll need to manually transfer the ISO setting. For the internal flash and the SB-400, manual flash power is set via Custom Setting #E2. |

Setting Flash Options

Setting the exact flash options used is a bit confusing to Nikon newcomers, as some of them are only available with particular equipment, some settings are done on the camera, and some are done on the flash. Nikon also uses two similar terms, “flash sync mode”¹²⁶, which determines *when* the flash is fired, and “flash mode,” which determines *how* the flash is fired and what component does the flash length calculations.

The D90 understands five flash sync options (again, Nikon calls them flash sync modes):

Front Curtain Sync

The flash fires when the shutter is first opened. Any shutter speed between 1/60 (or other value set by Custom Setting #E1) and 1/200 second is allowed in Aperture-priority and Program exposure modes. Any shutter speed between 30 seconds and 1/200 is allowed in Shutter-priority and Manual exposure modes). This is the default setting for flash options on the D90 and is indicated by no flash icons appearing on the top LCD.

*Notes: **TTL FP** removes the faster shutter speed limit (1/200). SB-24, SB-25, and SB-26 flash units should have their **Mode** switch set to **NORMAL**.*

Slow Sync



icon on top LCD

The flash fires when the shutter is first opened and any shutter speed between 30 seconds and 1/200 second in all

¹²⁶ You'll note that I've chosen to call these items “options” rather than “modes.” Nikon uses the term *mode* so frequently that it gets very confusing. For example, if I ask a student which flash mode they have set, they'll sometimes answer “Rear Sync.” That's not the answer I was looking for. I'll try to be consistent and use “flash mode” only to refer to the technique by which flash exposure is calculated (TTL, Automatic, and Manual) and “flash options” to all the other flash settings that might alter how the flash behaves.

exposure modes. Light trails caused by subject movement in long exposures seem to be in front of the subject.

Notes: **TTL FP** removes the faster shutter speed limit (1/200).
SB-24, SB-25, and SB-26 flash units should have their **Mode** switch set to **NORMAL**.

Rear Sync



icon on top LCD

The flash fires just before the shutter is closed and any shutter speed between 30 seconds and 1/200 second is allowed in all exposure modes. Light trails caused by subject movement in long exposures seem to follow the subject, a more natural-looking effect than produced by Slow Sync.

Notes: **TTL FP** removes the faster shutter speed limit (1/250).
SB-24, SB-25, and SB-26 flash units should have their **Mode** switch set to **NORMAL**.

Redeye Reduction



icon on top LCD

The external flash or the Redeye Reduction lamp (for internal flash) is fired one or more times prior to the actual picture (in order to cause the subject's pupils to close, reducing redeye). Otherwise, this option is the same as Front Curtain sync. Personally, I'd avoid this option, as it introduces huge shutter release lag, generally annoys subjects, and doesn't normally improve redeye characteristics enough to make a difference.

Notes: This option is only available with SB-26, SB-27, SB-28, SB-28DX, SB-50DX, SB-80DX, SB-400, SB-600, SB-800, SB-900, and SB-R200 flash units.
SB-24, SB-25, and SB-26 flash units should have their **Mode** switch set to **NORMAL**.

Redeye Reduction with Slow Sync

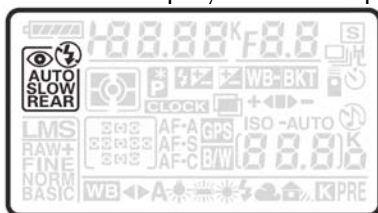


icon on top LCD

The same as Redeye Reduction, except that longer shutter speeds are allowed in Aperture-priority and Program exposure modes. Personally, I'd again avoid this option, as it introduces huge shutter release lag, generally annoys subjects, and doesn't normally improve redeye characteristics.

Notes: This option is only available with SB-26, SB-27, SB-28, SB-28DX, SB-50DX, SB-80DX, SB-400, SB-600, SB-800, SB-900, and SB-R200 flash units.

 To set all flash sync options: hold the Flash Options button down and rotate the Rear Command dial until the appropriate flash mode icon is displayed in the top LCD.



Top LCD:

*Note: The SB-24, SB-25, and SB-26 also have to be set to **NORMAL** or **REAR** depending upon which flash sync option you're using on the camera.*

Since several settings intersect one another for these options, here's a table that summarizes the information just presented:

Flash Option Interactions

<i>Exposure Mode</i>	<i>Allowable Shutter Speeds with Front Curtain</i>	<i>Allowable Shutter Speeds with Slow Sync or Rear Sync</i>	<i>Additional Shutter Speeds Allowed with FP set</i>
Program	1/60* to 1/200	30 seconds to 1/200	1/250 to 1/4000
Aperture-priority	1/60* to 1/200	30 seconds to 1/200	1/250 to 1/4000
Shutter-priority	30 seconds to 1/200	30 seconds to 1/200 (Rear only)	1/250 to 1/4000
Manual	30 seconds to 1/200	30 seconds to 1/200 (Rear only)	1/250 to 1/4000
* Can be altered to lower value using Custom Setting #E1			

FV Lock

While not technically an option the way Slow Sync and Rear Sync are, using FV Lock certainly acts like a forced option. It can be selected by setting Custom Setting #F3 to **FV Lock** and then using the **FN** button to trigger it.

Using FV Lock may change your metering! The next table describes what happens.

<i>Location of Speedlight</i>	<i>Flash Mode</i>	<i>Metering</i>
Speedlight in hot shoe or internal flash	i-TTL	Camera does metering using a ~8mm circle in frame center
Speedlight in hot shoe	AA	Flash does metering via its metering sensor
Off-camera Speedlight via wireless flash	i-TTL	Camera does metering using the entire frame (<i>not</i> the same as matrix!)
Off-camera Speedlight via wireless flash	AA or A	Flash does metering via its metering sensor

Pay close attention when using FV Lock with an i-TTL flash in the hot shoe: the metering changes radically. You may be expecting matrix metering, but you're going to get a spot-like metering. Thus, I have a strong recommendation if you use a Speedlight via the hot shoe (either mounted in the hot shoe or cabled to it with an SC-28 or similar cable): before you press the button for FV Lock in any situation, position the center of the frame on a mid-tone at your subject distance. Reframe after pressing the button for FV Lock.

Consider the following: you're taking a picture of the bride with on-camera flash using FV Lock and matrix metering. You're expecting the camera to compensate for the bride's white dress. But if the dress occupies a significant portion of that 8mm circle that is metered when you FV Lock, you're going to get flash underexposure (the dress will be underexposed, and therefore the bride, as well).

Flash Exposure Compensation

Flash exposure compensation can be set on the external flash or on the D90 body:

- On the external flash that usually involves pressing the flash unit's Direction pad in the direction of the + and – symbols while in a TTL flash mode.
- On the D90 body hold down the Flash Options button and rotate the Front Command dial.

Flash exposure compensation isn't as straightforward as you might think:

- *Balanced Fill-Flash (TTL BL) gets in the way.* If the camera is set to use balanced fill-flash (the default), you aren't actually fully in control of the flash exposure compensation value used by the camera. Nikon's Balanced Fill-Flash modes preset unknown amounts of flash exposure compensation based upon scene brightness, scene contrast, and a host of other variables. The camera may decide to ignore what you set, and it may respond slightly differently if a slightly different exposure pattern presents itself to the matrix meter. Indeed, the classic beginner mistake is to try to use exposure compensation and flash exposure compensation to override the camera's automatic decisions. The more EV change you ask for, the more the camera is likely to fight you. **Solution:** Put the camera in Standard TTL mode if you want to set exposure and flash exposure compensations yourself.
- *You don't always get what you want.* Especially for positive (e.g. +1 EV) values, the flash may not be able to produce the value that you've asked for. Students ask me why I carry laminated field charts with Guide Number values for my flashes. That's because it's the easiest way to figure out exactly what each flash is and isn't capable of. With 4 different flash units, as many as 10 zoom settings, and ISO values ranging from 100 to 6400 (on my

D90), that's more Guide Number and range possibilities than I can keep in my head.

- *Flash exposure compensation is cumulative.* Flash exposure compensation can be set on both the D90 body (using the Flash Options button and Front Command dial) or on an external flash (using the controls on the flash). Those compensations are cumulative! If you set -1.7 EV on the external flash and -1 EV on the D90 body, you'll get -2.7 EV flash exposure compensation. Thus, you need to be very careful about where you set flash exposure compensation. If the D90 is your only Nikon body then *always* set flash exposure compensation on the camera body. If you also use a Nikon DSLR that doesn't have an internal flash and always use external flash, then *always* set flash exposure compensation only on the external flash. The in-between cases are the ones that'll eventually catch you. Personally, I try to always use an external flash and always set my flash exposure compensation on the external flash. Whenever I have to set flash exposure compensation on the body (e.g. I didn't bring an external flash and am using the internal one on my D90), I always cancel whatever flash exposure compensation I set on the body immediately after using it.

Flash Features Available using a D90 with Speedlights

<i>Model</i>	<i>TTL</i>	<i>A</i>	<i>M</i>	<i>AF</i>	<i>Slow</i>	<i>Rear</i>	<i>RF</i>	<i>RE</i>	<i>FP</i>
Internal	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No
SB-R200	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes
SB-400	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No
SB-600	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes
SB-800	Yes	Yes¹	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SB-900	Yes	Yes¹	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SB-80DX	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
SB-50DX	No	No	Yes	Yes	Yes	Yes	No	Yes	No
SB-30	No	Yes	Yes	No	Yes	Yes	No	No	No
SB-29/29s	No	No	Yes	Yes ³	Yes	Yes	No	No	No
SB-28DX	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
SB-28	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
SB-27	No	Yes ²	Yes	Yes	Yes	Yes	No	Yes	No
SB-26	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
SB-25	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
SB-24	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
SB-23	No	No	Yes	Yes	Yes	Yes	No	No	No
SB-22s	No	Yes	Yes	Yes	Yes	Yes	No	No	No
SB-22	No	Yes	Yes	Yes	Yes	Yes	No	No	No
SB-21B	No	Yes	Yes	No ³	Yes	Yes	No	No	No
¹ Auto Aperture supported									
² SB-27 needs to be set to “forced A” mode (see “Flash Troubleshooting” on page <620> for details)									
³ Realistically only usable with Micro-Nikkor lenses or with other lenses focused at close distances									
A = automatic flash mode AF = autofocus assist									
FP = high-speed sync mode M = manual flash mode									
RE = red-eye reduction RF = repeating flash									
Rear = rear (second-curtain) sync Slow = Slow sync									
TTL = Through-the-lens metering									

Note: Preferred Speedlights are highlighted in bold in the table. Speedlights not listed are not recommended for use on the D90.

Tip: Flash is a very complex subject. It took me an entire book to fully describe Nikon Speedlight operations (Nikon Flash Guide, originally published by Silver Pixel Press; a new edition will appear soon under by Thom Press). If you'd like to learn more about Nikon flash operation, may I humbly suggest you get a copy of my book?

Controlled, Repeatable Flash Results

At my workshops the number one question I get concerns how to get repeatable results using flash, especially when you use flash for fill. Basically, this requires that you take control of the decisions that are being made instead of letting the camera make the decisions.

If you have the time, it always pays to turn off the automatic flash control and take charge of it yourself. The way I usually teach goes something like this:

1. Put the camera in Manual (M) exposure mode. When using flash, the aperture and shutter speed control the *background* (ambient light) exposure, flash tends to control the foreground, or *subject* exposure. In Manual exposure mode you are guaranteed to be completely in control of the background exposure.
2. If you want a full exposure on the background, use the exposure meter to set a value of **0** on the Manual Exposure Metering bar. If you want the background slightly darker than the foreground subject lit by flash, set an underexposure of the background of -0.3 to -1 stop. (It's also possible to set the background brighter than the foreground, but that is rarely something you'd want to do, and your subject would have to be in a darker light, or it, too, will end up overexposed.)
3. Turn the flash ON¹²⁷.
4. Set the flash to Standard TTL mode (on the D90, this is automatic if you're in spot metering; otherwise you'll have to press the **Mode** button on the external Speedlight to cancel the **BL** after the **TTL** symbol on the flash LCD). (Alternatively, if you want to be very precise, you can use Manual flash mode, but this usually involves more

¹²⁷ You can power the flash before Step 1, but I intentionally have you turn it ON here because, if you get in the habit of doing this, if you later switch from Manual to Program or Aperture-priority modes, you'll immediately notice if the camera changes your exposure (at least you *should*).

calculation or button pressing than you may have time for.)

If you want the flash to fully light the subject, start with a flash exposure compensation value of between -1 and 0 EV. You need to experiment a bit to see what looks good to you, and if the subject is white or black, you may need to compensate for that (just as with the main exposure meter, the flash meter in the D90 tries to make the “average” exposure middle gray. Also, in bright situations, you’d tend to use more flash compensation, in dark situations, less.

If you want the flash to provide fill light on the subject, start with a flash exposure compensation value of about -1 to -1.7 EV for people, from -1.7 to -2.3 EV for objects in shadow. Again, you need to experiment to find the value that looks right to you.

The background exposure you set in Step 2 and the subject exposure you set in Step 4 should be consistent for average toned subjects. In other words, once you determine the compensation values you like, they should remain relatively consistent in other situations, just as long as the subject or background isn’t all white or all black (i.e. for mid-tone values).

For fill flash in general, the advice I’ve been giving for the last ten years still stands:

- *Put the camera in Aperture-priority exposure mode. Why?* Because Program and Scene exposure mode restrict apertures you can use, Aperture-priority doesn’t. (If you’re shooting sports with the D90, Shutter-priority is another choice; the point is to get out of Program exposure mode.)
- *Set the Slow Sync flash option on the camera. Why?* Because this removes the 1/60 lower shutter speed limit in Aperture-priority exposure mode. On the D90 you have an alternative: use Custom Setting #E1 to set the lower

shutter speed limit to what you can hand hold. On my D90, I've set 1/15 and don't normally use Slow Sync.

- *Put the flash in Standard TTL mode.* Why? Because we want to control the exact amount of flash used. Normally, the camera makes unknown adjustments when it is in the more advanced balanced fill-flash mode (**TTL BL**), and these adjustments aren't repeatable.
- *Dial in Flash Exposure Compensation.* Again, -1 EV for people and between -1.7 for objects in shadow are good starting points with the internal flash, an SB-400, SB-600, or SB-800¹²⁸. Why? We're using flash to fill in light, not to produce the main light for our subject. I have noticed that I tend to use slightly lower settings than this on the D90 (e.g. -1.3 for people and -2 for things) than I do on the D100, though I'm unsure why this is true (probably a difference in D-TTL versus i-TTL).

Every time I post these recommendations on a Web forum, I get a lot of grief from other posters. Specifically:

- *Why do Program and Scene exposure modes make aperture restrictions with flash?* Apparently Nikon made design decisions that had to do with the guaranteed "reach" of the flash in the all-automatic modes. All I know is that if you have an f/2.8 or faster lens and you're shooting with flash in Program or Scene exposure mode, you've wasted your money on the fast lens. At some ISO values with external flash, that restriction hits f/20!
- *Doesn't Slow Sync give me shutter speeds that will show camera shake?* Perhaps. But if you're in light so dim that you can't get a 1/60 second shutter speed, you're probably not using the flash for *fill*. You probably want the flash to fully light the subject, and when you dial up the flash to provide full light, the flash *duration* becomes the effective shutter speed (the longest duration of a Nikon

¹²⁸ The SB-900 represents a unique case due to the ability to concentrate its light or fan it out more evenly. I've yet to come to any final conclusions about the right starting places for that flash as I write this.

flash is 1/830 of a second; the SB-800 is 1/1050). You may have to let the background go dark to get “perfectly sharp” photos, but I’ve taken sharp handheld shots this way with exposures as much as two seconds using a 200mm focal length. Note that you can’t have much subject motion if the background exposure is close to the subject exposure.

- *Why do I have to use Standard TTL?* Because Nikon’s Balanced Fill-Flash mode uses internal variants of both Flash Exposure Compensation *and* Exposure Compensation to “balance” the ambient (background) and subject lighting in bright light. These compensations are unknown and vary based upon scene contrast, scene brightness, focus distance, and more. In dark light, the camera alters its strategy a bit and treats the flash as the primary source of light for your subject, though it still may apply slight exposure compensations based upon what the meter sees. Thus, **TTL BL** produces results that are not always repeatable. You may take pictures in one set of lighting that are quite good, in another, somewhat on the bad side. Slight changes in camera position sometimes produce slight differences in exposure when you don’t expect them to. That’s why I tell you to take control of what the flash is doing and dial in your own compensation.

Third Party Flash Units

The i-TTL flash units required by the D90 to perform TTL mean you are restricted to the SB-400, SB-600, SB-800, SB-900, and SB-R200 if you want to purchase an external flash and retain the most available capabilities.

So it may be awhile before we see any highly desirable i-TTL units from other companies. Metz makes a flash that can operate with i-TTL, and some photographers who’ve used it recommend it. Sigma’s latest flashes are also i-TTL compatible, though I’ve personally had inconsistent results with them. Worse still, Nikon keeps tuning TTL BL with each new camera—including the D90—and that makes me a bit

leery of the companies that are reverse engineering to maintain compatibility.

But even if you want to use Automatic flash mode you'll still find many third party flashes lacking. That's because you'll often have to manually transfer ISO and aperture settings.

Thus, at present, I don't recommend third party flashes with the D90. There are just too many caveats. If you want an external flash for the D90, the SB-900 is currently the best choice. First, it'll give you significantly more power. Second, it will work wirelessly and is easy to set up for that. And finally, it adds the ability to do TTL above 1/200 (**TTL FP**), a significant feature you'd be otherwise missing.

Studio Flash

The D90 can be connected to studio lighting by connecting a standard PC Sync cable an optional AS-15 connector mounted in the hot shoe of the camera. Note that the standard ISO hot shoe on the camera should be limited to voltages of about 24 volts or less and some external lighting units can put as much as 200 volts on the pins. To play it safe, you can use an isolation connection, such as the Wien Peanut.

The Rear Sync option is only available using Speedlight units in the hot shoe, by the way.

D90 Internal Flash

The D90 has a very flexible built-in, low-power Speedlight. This internal flash is never automatically popped up and used *unless* you're in one of the Scene exposure modes. For the Program, Aperture-priority, Shutter-priority, and Manual exposure modes you manually control when it is used by popping it up into position (press the Flash Release button). If the flash is up, the flash fires¹²⁹. If the flash is down, the flash

¹²⁹ Unless you've programmed the **FN** button to **Flash off** and are holding it down, or are in a Scene exposure mode that cancels flash.

doesn't fire. So, if you don't want flash, just push the flash head down so it locks into the down position.

The internal Speedlight doesn't zoom the flash head, allow bounce, or many of the other fancy features of the external Speedlight models, but it does provide adequate illumination for many situations you'll encounter, and has a couple of nifty tricks you might not have expected. Coverage is good to about an 18mm lens, assuming that the lens is small enough and doesn't block the light from the flash. There's a tiny bit of corner falloff at 18mm, but not enough to worry about for most situations.

When you use the internal Speedlight, you need to be aware that the flash needs some time to recharge between flashes. Nikon doesn't state a recycling time specification, but generally, it's only a few seconds (1 or 2 seconds has been my observation, depending upon whether the flash fired at partial power or full power). If you attempt to take another picture using flash before the recharging has completed, the flash may not have enough power to correctly illuminate your picture.

I said that the internal flash is low power. You may wonder what that means. The Guide Number at ISO 100 for the internal Speedlight is 39 (12m). That compares to a GN of at least 62 (19m) on an SB-800 at the same 18mm coverage area (and the SB-800 can provide even more light with longer lenses). What's that mean for photographic situations? For a subject at 10 feet, the internal Speedlight would require $\sim f/4$, while the SB-800 would require $f/6.3$. That's a difference of more than one stop. (All Guide Numbers in this paragraph are stated at ISO 100.)

In practical terms, here's what the internal flash is capable of:

<u>ISO 100</u>	<u>200</u>	<u>400</u>	<u>800</u>	<u>1600</u>	<u>Range in Ft</u>	<u>Range in M</u>
f/1.4	f/2	f/2.8	f/4	f/5.6	3'3" – 28'11"	1.0 – 8.5m
f/2	f/2.8	f/4	f/5.6	f/8	2'4" – 20'	0.7 – 6.1m
f/2.8	f/4	f/5.6	f/8	f/11	2' – 13'9"	0.6 – 4.2m
f/5.6	f/5.6	f/8	f/11	f/16	2' – 9'10"	0.6 – 3.0m
f/8	f/8	f/11	f/16	f/22	2' – 6'11"	0.6 – 2.1m
f/11	f/11	f/16	f/22	f/32	2' – 4'11"	0.6 – 1.5m
f/16	f/16	f/22	f/32	f/45	2' – 3'7"	0.6 – 1.1m
f/22	f/22	f/32	f/45	f/64	2' – 2'7"	0.6 – 0.8m

There are a few things you should note about the above table:

- *The overall range is quite limited.* Assuming that you have fast enough apertures, Nikon's stated numbers give you maximum range of 3'3" to 28'11" (1 – 8.5m). If you shoot in Program or one of the Scene exposure modes, that range is restricted further (red numbers in table aren't reachable). And on most Nikkor lenses, you can't set the smallest apertures (blue numbers in table). ***To use that f/1.4 or f/2 lens with flash and maximize your range, you have to get out of Program or Scene exposure modes.***
- *The aperture you use determines what range you'll have.* If you set f/4 at ISO 200, for example, you cannot get the maximum range the flash is capable of. ***If you want to guarantee maximum range at f/4, you'll need to be at ISO 800 or 1600. At f/2.8 you can use ISO 400 and up.***
- *There's a minimum flash distance, regardless of aperture.* As with all Nikon bodies and flashes, shooting at distances shorter than 2' (0.6m) shouldn't normally be done, as the camera won't always calculate flash exposure correctly. Moreover, with the internal flash, there's an issue of whether the flash is pointed correctly for close up work. At longer distances, some lenses and lens hoods interfere with the internal flash. A few of these are listed in the D90 manual, but that list is by no means comprehensive. If you're interested in whether a combination will work or not, take a picture of a plain white wall in an otherwise dark room and examine the results to see if any shadow pattern appears (usually a crescent shadow at the bottom if the lens is blocking the light). ***The minimum distance***

you can use flash at is usually determined by whether your lens blocks the light from the flash.

The internal flash can be used in TTL modes, Repeating flash, or Manual flash mode (see “Custom Setting #E2, Flash Mode for Internal Flash” on page <519> for details on how to set the mode). It can also be used to provide wireless control of i-TTL flashes (see “Wireless Flash” on page <577>).

Internal Flash Basics

I’ve covered some of the internal flash use already, but to be consistent with the *Nikon Digital Flash Guide* and to elaborate on some of the deeper features of the internal flash unit, I’m going to provide a step-by-step section, just as I do with the common external flashes in the next section.

To Set TTL on the Internal Flash

1. Activate the flash by popping it up (press the Flash Release button). *This step happens automatically in most Scene exposure modes (and some Scene exposure modes don’t allow use of flash).*
2. If you haven’t already done so, use Custom Setting #E2 (“Flash Mode for Internal Flash”, see page <519>) to set **TTL**.
3. Select the *type* of TTL to be performed. Basically, you only have one choice: whether to cancel the Balanced Fill-Flash mode (you do so for the internal flash by setting spot metering). I generally recommend that you not use Balanced Fill Flash (TTL BL), though it works better on the D90 than on many previous Nikon consumer bodies.
4. Set the camera to Single Servo AF; flash only operates when the camera achieves focus; this step isn’t technically required, but I like to tell people to use it as a reminder that focus has to be achieved for flash to operate.
5. Set the camera’s exposure mode, if you haven’t already. In Aperture-priority (A), Shutter-priority (S), and Manual (M)

exposure modes, make any necessary aperture or shutter speed selections.

Note: In Program exposure mode you can usually override the camera's selection of aperture and shutter speed combinations by turning the camera's Rear Command dial (when the camera is active). But note that the maximum aperture you can use is restricted in Program exposure mode (the actual value depends upon ISO setting; see "Allowable Apertures in Program Mode" on page <545>.

6. You're ready to shoot.

To Set Manual Flash

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the CUSTOM SETTING menu (pink pencil icon).
3. Use the Direction pad to navigate to Custom Setting #E2, **Flash cntl for built-in flash**. Press the **▶** key or the **OK** button to enter the Flash Mode setting.

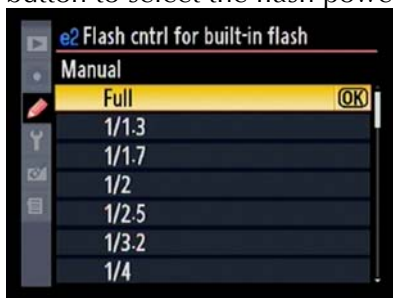


4. Use the Direction pad to navigate to **Manual** flash mode. Press the **▶** key or the **OK** button to enter the

Manual flash mode settings.



5. Use the Direction pad to navigate to the Manual flash power you want to set. Press the ► key or the **OK** button to select the flash power to be used.



6. Activate the flash by popping it up (press the Flash Release button).
7. Set the camera to Single Servo AF; flash only operates when the camera achieves focus; this step isn't technically required, but I like to tell people to use it as a reminder that focus has to be achieved for flash to operate).
8. Focus on your subject by pressing lightly on the shutter release. Note the distance on the scale on the lens.
9. $\text{Aperture} = \text{GN} / \text{Distance}$. Work the calculation and set the correct aperture. (Determine the GN by looking at the tables, below).
10. Set the D90 to the exposure mode you wish to use, and set your aperture and shutter speed, as usual. Just

make sure that the aperture you set matches the one you just calculated in Step 9!

Internal Flash Guide Numbers (Feet)

<u>Output Level</u>	<u>ISO 100</u>	<u>200</u>	<u>400</u>	<u>800</u>	<u>1600</u>
Full Power	42	59	82	115	161
1/2 Power	30	42	59	82	115
1/4 Power	21	30	42	59	83
1/8 Power	15	21	30	42	59
1/16 Power	11	15	21	30	42
1/32 Power	7.8	11	14	21	30
1/64 Power	5.6	7.8	11	14	21
1/128 Power	4	5.6	7.8	11	14

Internal Flash Guide Numbers (Meters)

<u>Output Level</u>	<u>ISO 100</u>	<u>200</u>	<u>400</u>	<u>800</u>	<u>1600</u>
Full Power	13	18	26	36	50
1/2 Power	9.3	13	18	26	36
1/4 Power	6.6	9.3	13	18	26
1/8 Power	4.7	6.6	9.3	13	18
1/16 Power	3.4	4.7	6.6	9.3	13
1/32 Power	2.4	3.4	4.7	6.6	9.3
1/64 Power	1.7	2.4	3.4	4.7	6.6
1/128 Power	1.2	1.7	2.4	3.4	4.7

Note: All numbers above 10 rounded to the nearest digit; all numbers below that rounded to the nearest tenth.

To Set Repeating Flash

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the CUSTOM SETTING menu (pink pencil icon).
3. Use the Direction pad to navigate to Custom Setting #E2, **Flash cntrl for built-in flash**. Press the ► key or

the **OK** button to enter the Flash Mode setting.



4. Use the Direction pad to navigate to **Repeating flash** mode. Press the **►** key or the **OK** button to enter the Repeating Flash mode settings.

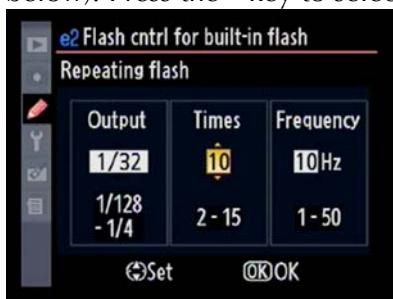


5. Use the **▲** and **▼** keys on the Direction pad to choose the Manual flash power you desire. Only powers of 1/4 to 1/128 are allowed. Press the **►** key to select the flash power to be used.



6. Use the **▲** and **▼** keys on the Direction pad to set the number of flash repeats you desire. Only 2 to 35 repeats are allowed (number depends upon flash power and frequency; higher flash powers have less flexibility in the number of repeats allowed; see table

below). Press the **▶** key to select the repeats to be used.



1/4 power:	2 repeats maximum
1/8 power:	2 to 5 repeats
1/16 power:	2 to 10 repeats
1/32 power:	2 to 10, or 15 repeats
1/64 power:	2 to 10, 15, 20, or 25 repeats
1/128 power:	2 to 10, 15, 20, 25, 30, or 35 repeats

- Use the **▲** and **▼** keys on the Direction pad to set the frequency of repeats you desire. Only frequencies of 1 to 50 times per second are allowed. Frequency should be higher than the number of repeats you set in Step 6. Press the **▶** key to set the flash frequency you've indicated.



Note: As described in the Custom Settings section (see page <477>), getting the right Frequency and Times values for Repeating Flash takes calculation. Start by first establishing a shutter speed you're going to use. Let's say your shutter speed is 1/2. Next, determine the frequency (how many flashes will be fired a second; Step 7). A frequency of 10Hz means 10 times a second, so we need to divide the lower value of our shutter speed (2) into this, which tells us that we could have as

many as 5 flashes while the shutter is open, which we set in our repeats value (Step 6 in the above; as you can see from the steps in setting procedure, Nikon got things backwards—we'd really want to perform Step 7 first, not Step 6).

8. Activate the flash by popping it up (press the Flash Release button).
9. Set the camera to Single Servo AF; flash only operates when the camera achieves focus; this step isn't technically required, but I like to tell people to use it as a reminder that focus has to be achieved for flash to operate).
10. Focus on your subject by pressing lightly on the shutter release. Note the distance on the scale on the lens.
11. Select an exposure mode. Typically Shutter priority or Manual exposure modes work best, as we're constrained by shutter speed due to our calculations in Step 7.
12. Set your shutter speed to the one you used in calculating the repeating flash effect.
13. Set your aperture based on your calculating

$$\text{Aperture} = \text{GN} / \text{Distance}.$$
Determine the GN by looking at the tables in the Manual flash section, above. You know the distance from Step 10. If the aperture you calculate here can't be obtained, you'll need to go back and reset the manual flash power (Step 1d). If you can set the calculated aperture on your lens, do so and you're ready to shoot.

Wireless Flash

The big trick in the D90 internal flash arsenal is its ability to completely control a multiple wireless flash setup. Specifically, the D90's internal flash is a "Commander" and the other external flashes are "Remotes."

The way this works is that the Commander (internal flash) sends queries and instructions to each set of Remotes (external flashes) by using special preflash sequences. Only i-TTL capable flashes can be used for wireless work, which means SB-600, SB-800, SB-900, or SB-R200 flashes must be used for Remotes.

For the wireless flash system to work, the remote flash units need to be able to see the light output of the D90's internal flash, and the D90 needs to be able to see the light output of the remote flashes.

You're probably wondering about these preflash queries and instructions. Let's say I have the full set of two Remotes in addition to my D90 internal flash (Commander). The preflash sequence that occurs when you press the shutter release now looks something like this:

<i>Commander:</i>	Remote Groups fire a preflash
<i>Remote Groups:</i>	Preflash fires (Commander also fires, if active)
[Camera calculates exposure]	
<i>Commander:</i>	Remote Group A should fire at Level X
<i>Commander:</i>	Remote Group B should fire at Level Y
[Camera mirror moves up, shutter opens]	
<i>Commander:</i>	Fire!
<i>All flashes:</i>	All flashes fire at calculated levels

Believe it or not, it's a *lot* more complex than that simplification. All the Flash Options, like Rear Sync, still come into play, which means that the Commander has to do a lot more instructing than just ask for a preflash and a TTL fire level.

Incredibly, all this communicating happens very quickly. Normally, from the first preflash to the opening of the shutter is about 60ms. If you're not watching specifically for it, you can't see the sequence of communication. On the other hand, you will almost surely note that there is more lag in the

shutter release and that the preflash sequence seems longer. It is, and that can trigger fast blinkers¹³⁰.

Since the actual communicating is done via the near IR energy in the light each flash produces, there are limitations on both the distance and the environment where wireless flash will work. Outdoors has more ambient near IR and fewer reflections, so distance is usually restricted and there usually has to be direct line-of-sight between camera and remote flash units. Because of bounces off walls and ceilings, wireless flash is a bit more flexible indoors—you sometimes can hide a remote flash out of line-of-sight of the camera because its light reflects well enough for the camera to still see.

The jargon starts to get a little confusing, as Nikon uses different names at different places in its documentation. For example, Commander mode and Master flash get a little confusing if you read multiple Nikon manuals. I'll try to stay a little more consistent.

The D90 can control up to two groups of Remotes. Indeed, Nikon uses the label **Groups** instead of the Remotes name that I've been using. Each remote group can have multiple flashes in it, though Nikon doesn't recommend more than three flashes in a remote group, and I don't recommend that you use multiple flashes in a remote group unless they're all trying to light the same thing and you need more power than a single flash would provide. That's because the more flashes you set up, the more likely it becomes that one isn't seen in the preflash sequence.

But for a three-flash setup (the camera's internal plus two remotes), the D90's wireless abilities are excellent, and all that you need. (If you need more than two remote groups, you

¹³⁰ The solution for that is the same as I'll outline a little later in this section for SU-4 type wireless: use FV lock. FV lock removes the preflash sequence from the shutter release, moving it instead to the **FN** button. Thus, you set flash exposure by pressing **FN**. Then you wait to press the shutter release for the right moment of action (or inaction, depending upon your subject ;~). You only have to press **FN** and do another preflash sequence if lighting conditions change.

need to substitute an SU-800, SB-800, or SB-900 on the D90 as the Commander instead of the internal flash. But that's a subject for another book...)

Here's how to set up a three flash wireless shoot (I'll use one SB-600 and one SB-800 as the Remotes so that we step through the remote setup for each; you could instead have two of either or even SB-900's or SB-R200's; those flashes have an easier, more intuitive setup):

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the CUSTOM SETTING menu (pink pencil icon).
3. Use the Direction pad to navigate to Custom Setting #E2, **Flash cntrl for built-in flash**. Press the **▶** key or the **OK** button to enter the Flash Mode setting.



4. Use the Direction pad to navigate to **Commander mode**. Press the **▶** key to enter the Commander Mode settings.



5. You must set two things for each participating flash: the flash mode it'll use (**Mode**) and the flash output

level (**Comp.**¹³¹). You navigate to fill-in-boxes with the ◀ and ▶ keys on the Direction pad; you set value in the boxes with the ▼ and ▲ keys on the Direction pad.

- a. For each flash (internal, Group A, Group B), set the flash mode. You can set **TTL**, **AA** (not for internal flash), **M**, or **--**. The last item, **--**, means that this flash or Group will not participate in the exposure.



- b. For each flash (internal, Group A, Group B), set the flash exposure compensation (for TTL) or power output level (for Manual flash).



6. Finally, use the ▶ key to navigate to **Channel** and then use the keys to set one of the four channels that the

¹³¹ I guess **Comp.** is supposed to stand for “compensation.” But that’s not quite accurate. If a flash is set to **TTL**, **Comp.** sets *flash* exposure compensation for *that flash*. If a flash is instead set to **M** (Manual), **Comp.** sets the power level (1/1 = full, 1/2 = half, etc.) for that flash.

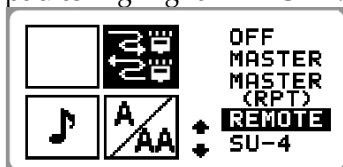
preflash sequence uses.



7. Let's move on to our first remote flash, which for illustration purposes will be an SB-800.
 - a. Press the **SEL** button on the SB-800 for more than two seconds to get to the Custom Settings for the flash.
 - b. Use the ▼ and ▲ keys on the SB-800 Direction pad to highlight the wireless flash icon.

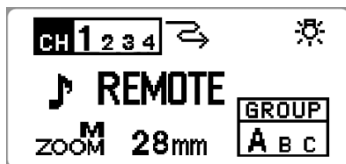


- c. Press the **SEL** button to get to the options for wireless flash.
 - d. Use the ▼ and ▲ keys on the SB-800 Direction pad to highlight **REMOTE**.



- e. Hold the **SEL** button down for two seconds to leave Custom Settings on the flash. The SB-800

should now be set for remote use:



- f. To set the Channel, press¹³² the **SEL** button until **CH** is highlighted (inverted white letters on black), then use the ▼ and ▲ keys on the SB-800 Direction pad until the channel number you set in Step 6 is highlighted.
 - g. To set the Group, press the **SEL** button until **GROUP** is highlighted (inverted white letters on black), then use the ▼ and ▲ keys on the SB-800 Direction pad until the first Group letter you set in Step 5 is highlighted.
 - h. Orient the SB-800 so that its infrared receiver is looking towards the D90's internal flash (note that you can rotate the flash head to fix the orientation, if necessary).
8. Now to our final flash, this time an SB-600:
- a. Simultaneously hold down the **Zoom** and **-** buttons on the SB-600 for more than two seconds to get to the Custom Settings for the flash.
 - b. Use the ▼ and ▲ keys on the SB-600 Direction pad to highlight the wireless flash icon.

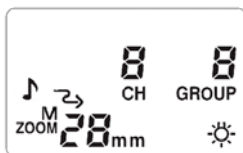


¹³² I'm specific in word use. This is not the "hold down" that you used to get to the Custom Settings for the flash. Instead, when I say press, I mean a quick jab of the button. It may take multiple jabs to get to the right item, which is why I say "press...until."

- c. Press the **Zoom** button until **0n** shows above the wireless icon.



- d. Press the **On/Off** button briefly to leave Custom Settings. The SB-600 should be set for remote use:



Actual channel and group will vary—you'll set them below.

- e. To set the Channel, press¹³³ the SB-600 **Mode** button until the number above **CH** is blinking, then use the ▼ and ▲ keys on the SB-600 Direction pad until the channel number you set in Step 6 is highlighted.
 - f. To set the Group, press the SB-600 **Mode** button again until the number above **GROUP** is blinking, then use the ▼ and ▲ keys on the SB-600 Direction pad until the first Group letter you set in Step 5 is highlighted.
 - g. Orient the SB-600 so that its infrared receiver is looking towards the D90's internal flash (note that you can rotate the flash head to fix the orientation, if necessary).
9. Activate the internal flash on the D90 by popping it up. (Press the Flash Release button.)

¹³³ Again, I'm specific in word use. This is not the "hold down" that you used to get to the Custom Settings for the flash. Instead, when I say press, I mean a quick jab of the button. It may take multiple jabs to get to the right item, which is why I say "press...until."

10. Set the camera to Single Servo AF; this step isn't technically required, but I like to tell people to use it as a reminder that focus has to be achieved for flash to operate.
11. Set the camera's exposure mode, if you haven't already. In Aperture-priority (A), Shutter-priority (S), and Manual (M) exposure modes, make any necessary aperture or shutter speed selections.

Note: In Program exposure mode you can usually override the camera's selection of aperture and shutter speed combinations by turning the camera's Rear Command dial (when the camera is active). But note that the maximum aperture you can use is restricted in Program exposure mode (the actual value depends upon ISO setting; see "Allowable Apertures in Program and Scene Exposure Modes" on page <545>.

You're ready to shoot.

Nikon includes a drawing showing where remote flashes need to be positioned relative to the D90. I've actually found their suggestions to be relatively conservative, especially in low light, where the infrared component of the preflash is easily seen by the remote flashes. In general, here are a few positioning guidelines:

- In low light, the remote flash sensor doesn't always have to have a direct line of sight to the camera's internal flash. I've successfully hidden a remote flash behind the subject (to light the background or provide rim light). This works better over short distances, though.
- You should be able to achieve Nikon's stated 33 feet (10m) distance (within a 60° angle) in most situations, but beware of situations where there is a great deal of infrared energy present (some incandescent lighting produces infrared)—you may have to give up some distance where other infrared sources are present, as they'll overwhelm the sensor and it won't see the faint output of the internal flash.

- I've been able to achieve remote triggers at better than 120° angles, but only at close distances (10 feet [3m]).
- Triggering the remote flashes is only part of the equation. In general, remote flashes doing TTL need to be within 30° of the camera-subject axis. In other words, the angle formed by the flash/subject/camera needs to be 30° or less. Why? Because when subjects are lit from the side, the camera—which after all is doing the flash calculations—doesn't see the full reflection of the flash's output and may adjust its exposure incorrectly.

Finally, there's yet one more wireless trick that isn't described in the Nikon manuals that every D90 user should know: Flash Lock (called **FV lock** by Nikon in the menu system; FV stands for Flash Value). This answers the problem of getting the internal flash to trigger a multiple wireless TTL set up when you *don't* have i-TTL flashes as remotes¹³⁴. For example, Nikon sells a wireless flash accessory called the SU-4, and some Nikon flash models can emulate that wireless function without being connected to an SU-4 (for example, the older SB-26, the SB-800, and the SB-900). The critical element of the SU-4 circuitry is this: it triggers the flash connected to it to fire whenever it sees another flash fire, and it shuts down its connected flash when it sees the other flash stop firing. Since the D90's internal flash is already set to the right flash exposure via FV Lock, the flashes connected to the SU-4's just do the same exact thing.

As long as the flashes aren't all throwing their light on the same spot (e.g., one is used for filling light on one side of the face while another is used for the background while the internal flash is used for key light), this trick works well. But even if they are all firing their light on the same spot, you can easily control this by simply dialing down the internal flash with flash exposure compensation—every other flash will

¹³⁴ Okay, it's not perfectly TTL, as the other flashes aren't considered in the exposure setting, but with a little trial and error, it effectively works like TTL.

respond in kind, so it's usually pretty easy to dial in the right compensation.

Here's the trick in more detail:

1. Set the Custom Setting #F3 on the D90 to **FV Lock**.
2. Set Custom Setting #E2 to **TTL** (if it isn't already set to that).
3. Pop up the internal flash (press the Flash Release button to do this).
4. *Before* turning on your remote flashes, fire off a test exposure by pressing the **FN** button on the camera (the internal flash should fire). Get your main flash setting correct before proceeding.
5. Turn the remote flash units on. They all either need to be connected to an SU-4 or have a built-in SU-4 type of wireless mode selected.
6. Take your picture. All the flashes should participate in the exposure.
7. Since the remote flash units may be more powerful than the internal flash, you may have to adjust the position of the external flashes to be further from the subject (or use their diffusion domes to limit their power). When I'm feeling especially daring and creative, I actually set my exposure in Step #4 to underexposure and then *try* to get the remote Speedlights to fire a little hotter than the internal flash, but this is a big trial and error process you'll just have to experiment with yourself.

External Flash Models for the D90

SB-400

The SB-400 is the simplest of the five external Speedlights that can provide TTL flash with the D90. This small flash was introduced with the D40 models in 2006.



Specifications

GN:	98 (ft), 30 (m) (at ISO 200)
Weight:	4.5 oz. (127g) (w/o batteries)
Size:	2.2" (56.5mm) tall x 2.6" (66mm) wide x 3.1" (80mm) deep
Power:	two AA batteries
Recycle Time:	3.9 seconds minimum (full discharge)
# of Flashes:	~140
Flash Duration:	1/1300 at full output
Coverage:	18mm lens for DX, 27mm lens for FX
Case:	SS-400 included
Key Features:	TTL flash control on the D90. Rear curtain sync. Red-eye reduction. Head tilts from horizontal up to 90 degrees above horizontal.

To Set TTL Flash

1. Activate the flash by turning its Power switch to **ON**.
2. Select the type of TTL to be performed. Basically, you only have one choice: whether to cancel the "balanced fill-flash" mode (you can do so on a D90 only by selecting Spot metering on the camera); see "Summary of i-TTL Flash Modes," on page <551>).

3. Set the camera to Single Servo AF (flash only operates when the camera achieves focus; this isn't technically required, but I like to tell people to use it as a reminder that focus has to be achieved for flash to operate).
4. Set the camera's exposure mode, if you haven't already. In Aperture-priority (A), Shutter-priority (S), and Manual (M) exposure modes, make any necessary aperture or shutter speed selections.

Note: In Program exposure mode you can usually override the camera's selection of aperture and shutter speed combinations by turning the D90's Rear Command dial (when the camera is active). But note that the maximum aperture you can use is restricted in Program exposure mode (the actual value depends upon ISO setting; see "Allowable Apertures in Program and Scene Exposure Modes," on page <545>.

Note: The D90 may warn you of several possible errors when you partially press the shutter release to verify settings:

- *The lens must be set on its minimum aperture, or else the error message **FE** appears in the viewfinder.*
- *Any **H** visible in the viewfinder indicates that overexposure (of the background exposure) is likely.*
- *The shutter speed will be automatically reset to 1/200 if you selected a faster shutter speed in Shutter (S) or Manual (M) exposure mode. (If FP is set, however, the camera will use any shutter speed.)*
- *In Manual (M) exposure mode, under and overexposure is indicated solely by the analog exposure display. If the exposure bar goes to either side of the **0** point, the ambient-only lighting exposure will not be correct.*

5. Focus on your subject by pressing lightly on the shutter release. Confirm that the subject is within flash distance. Unfortunately, the SB-400 does not have a distance scale on it, so you'll have to use the chart below. Assuming you've confirmed the distance, you're ready to shoot.

SB-400 Usable Apertures and Flash Range in TTL mode (Feet)

<u>ISO 100</u>	<u>200</u>	<u>400</u>	<u>800</u>	<u>1600</u>	<u>3200</u>	<u>Range (ft)</u>	<u>Range (m)</u>
<i>f/1</i>	<i>f/1.4</i>	<i>f/2</i>	<i>f/2.8</i>	f/4	f/5.6	6.2 – 65'	1.9 – 20m
<i>f/1.4</i>	<i>f/2</i>	<i>f/2.8</i>	f/4	f/5.6	f/8	4.6 – 49'	1.4 – 14.8m
<i>f/2</i>	<i>f/2.8</i>	f/4	f/5.6	f/8	f/11	3.3 – 34'	1 – 10.5m
<i>f/2.8</i>	f/4	f/5.6	f/8	f/11	f/16	2.3 – 24.3'	0.7 – 7.4m
f/4	f/5.6	f/8	f/11	f/16	f/22	2.0 – 17'	0.6 – 5.2m
f/5.6	f/8	f/11	f/16	f/22	f/32	2.0 – 12.1'	0.6 – 3.7m
f/8	f/11	f/16	f/22	<i>f/32</i>	<i>f/45</i>	2.0 – 8.5'	0.6 – 2.6m
f/11	f/16	f/22	<i>f/32</i>	<i>f/45</i>	<i>f/64</i>	2.0 – 5.9'	0.6 – 1.8m
f/16	f/22	<i>f/32</i>	<i>f/45</i>	<i>f/64</i>	<i>f/90</i>	2.0 – 4.3'	0.6 – 1.3m

Red apertures not available in Program exposure mode

Blue apertures not available on most lenses

To Set Manual Flash

Manual flash for the SB-400 is set using Custom Setting #E2 on the D90 body.

SB-600

The SB-600 is one of five external Speedlights that can provide TTL flash with the D90. The SB-600 is similar to the SB-800, but with fewer features and lower power ratings. The SB-600 was announced with the D70 and arrived in stores in spring 2004.



Specifications

GN:	138 (ft), 42 (m) (at 35mm head position and ISO 200)
Weight:	10.6 oz. (300g) (w/o batteries)
Size:	4.9" (123.5mm) tall x 2.7" (68mm) wide x 3.5" (90mm) deep
Power:	four AA batteries
Recycle Time:	3.5 seconds minimum (full discharge)
# of Flashes:	~200 at full manual
Flash Duration:	1/900 to 1/25000
Coverage:	(120 degrees horizontal, 110 degrees vertical) 14mm lens; also supports 24mm, 28mm, 35mm, 50mm, 70mm, and 85mm coverage
Case:	SS-600 included

Key Features: TTL flash control on the D90; Full power TTL, seven power level manual settings. LCD panel shows settings. Rear curtain sync. Red-eye reduction. The SB-600 can synchronize with up to nine additional flash units, in groups of three controlled by one SB-800 master flash. Head tilts from -7 degrees below horizontal up to 90 degrees above horizontal, and rotates -270 degrees to plus 180 degrees clockwise. Built-in diffuser card. Stand included. Automatic or Manual wireless remote firing possible. Wide angle autofocus assist light.

To Set TTL Flash

1. Activate the flash. If it's already in Standby, a partial press of the shutter release activates it; otherwise, press the power (ON/OFF) button on the SB-600 to turn the flash ON.
2. Select the type of TTL to be performed. Basically, you only have one choice: whether to cancel the "balanced fill-flash" mode (you do so by pressing the **Mode** button on the flash until only the **TTL** indicator appears; if **TTL BL** appears, the camera is in a Balanced Fill-Flash mode; see "Summary of i-TTL Flash Modes," on page <551>).

Note: When the D90 is set for spot metering, Standard TTL is set automatically.

3. Set the camera to Single Servo AF (flash only operates when the camera achieves focus; this isn't technically required, but I like to tell people to use it as a reminder that focus has to be achieved for flash to operate).
4. Set the camera's exposure mode, if you haven't already. In Aperture-priority (A), Shutter-priority (S), and Manual (M) exposure modes, make any necessary aperture or shutter speed selections.

Note: In Program exposure mode you can usually override the camera's selection of aperture and shutter speed combinations by turning the D90's Rear Command dial (when the camera is active). But note that the maximum aperture you can use is restricted in Program exposure

mode (the actual value depends upon ISO setting; see “Allowable Apertures in Program and Scene Exposure Modes,” on page <545>.

Note: The D90 and SB-600 may warn you of several possible errors when you partially press the shutter release to verify settings:

- The lens must be set on its minimum aperture, or else the error message **FEE** appears in the viewfinder.
- Any **h** visible in the viewfinder indicates that overexposure (of the background exposure) is likely.
- The shutter speed will be automatically reset to 1/200 if you selected a faster shutter speed in Shutter (S) or Manual (M) exposure mode. (If FP is set, however, the camera will use any shutter speed.)
- In Manual (M) exposure mode, under and overexposure is indicated solely by the analog exposure display. If the exposure bar goes to either side of the **0** point, the ambient-only lighting exposure will not be correct.

5. Focus on your subject by pressing lightly on the shutter release. Confirm that the subject is within flash distance. Unfortunately, the SB-600 does not have a distance scale on it, so you'll have to either carry one of the charts duplicated below or memorize what distance it can reach at each zoom setting. Assuming you've confirmed the distance, you're ready to shoot.

SB-600 Usable Apertures and Flash Range in TTL mode (Feet)

<u>iso100</u>	<u>200</u>	<u>400</u>	<u>800</u>	<u>1600</u>	<u>14mm</u>	<u>24mm</u>	<u>35mm</u>	<u>50mm</u>	<u>85mm</u>
f/1.4	f/2	f/2.8	f/4	f/5.6	3 – 32	4.9 – 52	5.9 – 62	6.6 – 66	8.2 – 66
f/2	f/2.8	f/4	f/5.6	f/8	2.3 – 23	3.6 – 36	4.3 – 46	4.9 – 52	5.9 – 66
f/2.8	f/4	f/5.6	f/8	f/11	2 – 16	2.6 – 27	3 – 32	3.3 – 36	3.9 – 44
f/4	f/5.6	f/8	f/11	f/16	2 – 11	2 – 19	2.3 – 23	2.6 – 26	2.9 – 33
f/5.6	f/8	f/11	f/16	f/22	2 – 7.9	2 – 13	2 – 16	2 – 18	2.3 – 23
f/8	f/11	f/16	f/22	f/32	2 – 5.6	2 – 9.2	2 – 11	2 – 13	2 – 16
f/11	f/16	f/22	f/32	f/45	2 – 3.9	2 – 6.6	2 – 7.9	2 – 9.2	2 – 11
f/16	f/22	f/32	f/45	f/64	2 – 2.6	2 – 4.6	2 – 5.6	2 – 6.6	2 – 8.2

Note: The SB-600 manual is incorrect in some of its range specifications. The above table is correct (though rounded slightly in some places). Red numbers can't be set in

Program and Scene exposure modes; blue numbers can't be set on many Nikkor lenses.

To Set Manual Flash

1. Activate the flash. If it's already in Standby, a partial press of the shutter release activates it; otherwise, press the power (ON/OFF) button on the SB-600 to turn the flash ON.
2. Press the SB-600's **Mode** button until  appears on the LCD.
3. Set the D90 to Aperture-priority (A) or Manual (M) exposure mode and set your aperture and shutter speed, as usual.
4. Set the camera to Single Servo AF. While not absolutely required, this generally makes the camera's response more predictable.
5. Focus on your subject by pressing lightly on the shutter release. Note the distance on the scale on the lens.
6. Simply changing the aperture on the camera causes the SB-600 to match it. Unfortunately, the SB-600 doesn't have a distance scale, so you'll have to use $\text{aperture} = \text{GN} / \text{distance}$ to determine the correct flash exposure, and use the Guide Number tables below to determine the GN.

Note: With lenses that don't have CPUs (AI and AI-S), the aperture on the camera isn't linked with the flash, so you have to adjust flash power settings on the SB-600 to control the flash output.

Note: The power setting of the SB-600 is controlled in 1/6 stop increments between 1/2 and 1/64 power (plus you can set full power, 1/1). You control the setting by pressing the ◀ and ▶ buttons on the flash direction pad to choose a value. Wait a moment and the flash locks in the current value.

Note: The SB-600 is capable of keeping up with the D90 at 4.5 fps at powers of 1/8, 1/16, 1/32, or 1/64 as follows:

<i>1/8</i>	<i>4 consecutive frames</i>
<i>1/16</i>	<i>8 consecutive frames</i>
<i>1/32</i>	<i>16 consecutive frames</i>
<i>1/64</i>	<i>30 consecutive frames</i>

However, let the flash cool at least 10 minutes after firing 40 consecutive flashes (normally this is 15 flashes in higher power and TTL modes).

SB-600 Guide Numbers at ISO 100 (feet)

<i>Power</i>	<i>14mm</i>	<i>24mm</i>	<i>28mm</i>	<i>35mm</i>	<i>50mm</i>	<i>70mm</i>	<i>85mm</i>
Full (1/1)	46	85	92	98	118	125	131
1/2	33	60	65	70	84	88	93
1/4	23	43	46	49	59	62	67
1/8	16	30	33	35	42	44	46
1/16	11.5	21	23	25	30	31	33
1/32	8.2	15.1	16	17	21	22	23
1/64	5.9	10.8	11.5	12.5	14.8	15.7	16.4

SB-600 Guide Numbers at ISO 100 (meters)

<i>Power</i>	<i>14mm</i>	<i>24mm</i>	<i>28mm</i>	<i>35mm</i>	<i>50mm</i>	<i>70mm</i>	<i>85mm</i>
Full (1/1)	14	26	28	30	36	38	40
1/2	9.9	18	20	21	26	27	28
1/4	7	13	14	15	18	19	20
1/8	4.9	9.2	9.9	10.6	12.7	13.4	14.1
1/16	3.5	6.5	7	7.5	9	9.5	10
1/32	2.5	4.6	4.9	5.3	6.4	6.7	7.1
1/64	1.8	3.3	3.5	3.8	4.5	4.8	5

Note: All numbers above 16 may be rounded to the nearest integer. That shouldn't impact calculations by enough to be visible.

To Manually Set the Zoom Head

1. Press the **Zoom** button on the flash direction pad to change the zoom setting. Each button press selects the next higher logical setting (and you'll eventually loop back to the lowest setting). The **zoom** symbol appears on the LCD when the setting doesn't correspond to focal length of the lens.

Note: To cancel automatic zoom head setting and lock a manual setting, hold the **Zoom** and **-** buttons for two seconds to enter the custom setting mode for the flash. Next, press the **+** button until you see the **zoom^M**, and then press the **Mode** button to turn manual zoom **On**. Hold the **Zoom** and **-** buttons for two seconds to complete the setting.

2. To cancel a manual zoom setting, press the **Zoom** button on the flash Direction pad until the **m** no longer appears on the LCD (e.g., until the setting matches the lens being used).

Note: Remember that the Guide Number of the flash changes with the zoom setting.

Note: If you pull out the built-in wide angle adapter and move it into position in front of the flashtube, the SB-600 is set to the 14mm and the automatic zoom head function cannot be set to another setting.

To Set Flash Exposure Compensation

Use the **+** and **-** buttons on the flash Direction pad to adjust the amount of compensation. The SB-600 allows a maximum of +3 stop and -3 stops of flash compensation, which is indicated in one-third stop increments on the flash compensation indicator.

Note: The flash may not be able to produce +3 compensation in some situations (e.g., if it's already firing at full power).

To cancel compensation, repeat the process outlined above and set a value of 0.0.

Note: Flash compensation does not change the background exposure calculated by the camera.

Tip: It's probably best to avoid flash compensation in any of the Balanced Fill-Flash TTL modes. You don't know what level of compensation the camera is already making, so any changes you make are in addition to this unknown, camera-calculated compensation. If you need absolute control,

switch to Manual flash mode, where any compensation you dial in will be from a known flash level.

To Set Red-Eye Reduction

Set Red-eye reduction on the D90 by holding the Flash Options button on the camera and turning the Rear Command dial until  appears on the D90's LCD).

Note: Red-eye reduction works in most flash modes, but not in the Repeating Flash mode.

SB-600 Notes

- The D90's focus mode should usually be set to Single Servo AF (**AF-S**), since the flash will generally not fire unless the camera has achieved focus.
- The Autofocus Assist light on the SB-600 is used automatically if the ambient light is low and you haven't turned this function off on the flash. Autofocus assist only works at distances from 3.3 feet (1m) up to 33 feet (10m), and is only guaranteed to work with lenses from 24mm to 105mm.

Note: The Autofocus Assist illuminator will not function unless the central autofocus sensor is selected or Auto-area AF is in effect.

*Note: You can turn off the Autofocus Assist illuminator on the SB-600 by holding the **Zoom** and **-** buttons down for two seconds and using the SB-600's Direction pad to navigate to the option and turn it OFF. **No AF-ILL** will appear in the flash's LCD.*

- The SB-600 has an automatic standby power system. The SB-600 automatically turns off 40 seconds after the camera's meter turns OFF (**STBY** is displayed on the flash's LCD). A light press on the shutter release turns the D90's light meter back ON, and the SB-600 turns ON at the same time.

Note: The SB-600 has a "special" No Standby mode that can be set. Like the other flash command mode settings, you get to

*this function by holding the **Zoom** and - buttons down for two seconds and then navigating the options with the Direction pad on the flash.*

- After the flash fires, an icon may appear in the flash's LCD along with a value. This indicates potential underexposure. This indicator only appears for three seconds after the shot.
- The Rear Sync option must be selected on the camera. (Some earlier flash units had this selection on the flash, so I've included this note here just in case folks who previously had one of those Speedlights are wondering.)
- While the SB-600 has "click stops" for commonly used flash head positions (45, 60, 75, and 90 degrees for tilt, every 30 degrees for rotation), you aren't restricted to those positions. Setting an intermediary position is allowed (though it can easily be dislodged).
- Viewfinder Ready Light Warnings (blinking) occurs in the following conditions:
 - When you press the shutter release halfway and the SB-600 is not correctly mounted on the hot shoe.
 - After the flash fires at full power, indicating possible underexposure.

SB-800

The SB-800 is basically the same flash as the SB-80DX, but with additional features and support for the new i-TTL flash system. The SB-800 was announced in July 2003 and arrived in stores in fall 2003. It was discontinued in fall 2008.



Specifications

GN:	125 (ft), 38 (m) (at 35mm head position)
Weight:	11.8 oz. (335g) (w/o batteries)
Size:	5" (127.5mm) tall x 2.8" (80.5mm) wide x 3.6" (91.5mm) deep
Power:	four AA batteries
Recycle Time:	6 seconds minimum (full discharge)
# of Flashes:	~150 at full manual
Flash Duration:	1/1050 to 1/41600
Coverage:	(120 degrees horizontal, 110 degrees vertical) 14mm lens; also supports 17mm, 24mm, 28mm, 35mm, 50mm, 70mm, 85mm, and 105mm coverage
Case:	SS-800 included
Key Features:	TTL flash control on the D90; Full power TTL, eight power level manual, and Automatic settings. LCD panel shows settings. Rear curtain sync. High Speed sync,

Repeating flash, and red-eye reduction. The SB-800 can synchronize with up to nine additional flash units, in groups of three controlled by one master flash. Head tilts from -7 degrees below horizontal up to 90 degrees above horizontal, and rotates -270 degrees to plus 180 degrees clockwise. Built-in diffuser card. Diffusion dome included, sample filter set included. Automatic or Manual wireless remote firing possible. Modeling light. Wide angle autofocus assist light.

To Set TTL Flash

1. Activate the flash. If it's already in Standby, a partial press of the shutter release activates it; otherwise, press the power (ON/OFF) button on the SB-800 to turn the flash ON.
2. Select the type of TTL to be performed. Basically, you only have one choice: whether to cancel the "balanced fill-flash" mode (you do so by pressing the **Mode** button on the flash until only the **TTL** indicator appears; if **TTL BL** appears, the camera is in a Balanced Fill-Flash mode; see "Summary of i-TTL Flash Modes" on page <551>).

Note: The **FP** indicator may also appear. This indicates that the flash is ready to perform high speed sync at shutter speeds faster than 1/200 if necessary.

Note: When the D90 is set for spot metering, Standard TTL is set automatically.

3. Set the camera to Single Servo AF (flash operates best when the camera achieves focus; this isn't technically necessary, but I like to tell people to use it as a reminder that focus has to be achieved for flash to operate).
4. Set the camera's exposure mode, if you haven't already. In Aperture-priority (A), Shutter-priority (S), and Manual (M) exposure modes, make any necessary aperture or shutter speed selections.

Note: In Program exposure mode you can usually override the camera's selection of aperture and shutter speed combinations by turning the D90's Rear Command dial (when the camera is active). But note that the maximum aperture you can use is restricted in Program exposure mode (the actual value depends upon ISO setting; see "Allowable Apertures in Program and Scene Exposure Modes" on page <545>.

Note: The aperture the D90 (or you) selected also appears on the SB-800's LCD panel when you partially press the shutter release, as does the allowable flash-to-subject distance range.

Note: The D90 and SB-800 may warn you of several possible errors when you partially press the shutter release to verify settings:

- The lens must be set on its minimum aperture, or else the error message **FE** appears in the viewfinder.*
- Any **H** visible in the viewfinder indicates that overexposure (of the background exposure) is likely.*
- The shutter speed will be automatically reset to 1/200 if you selected a faster shutter speed in Shutter (S) or Manual (M) exposure mode.*
- In Manual (M) exposure mode, under and overexposure is indicated solely by the analog exposure display. If the exposure bar goes to either side of the **0** point, the ambient-only lighting exposure will not be correct.*

5. Focus on your subject by pressing lightly on the shutter release. Confirm that the subject is within flash distance by looking at the Shooting Range displayed on the SB-800's LCD. Assuming you've confirmed the distance, you're ready to shoot.

SB-800 Usable Apertures and Flash Range in TTL mode (Feet)

<u>iso100</u>	<u>200</u>	<u>400</u>	<u>800</u>	<u>1600</u>	<u>14mm</u>	<u>24mm</u>	<u>35mm</u>	<u>50mm</u>	<u>85mm</u>
f/1.4	f/2	f/2.8	f/4	f/5.6	3.5 – 27	6.6 – 66	7.8 – 66	8.8 – 66	10 – 66
f/2	f/2.8	f/4	f/5.6	f/8	2.5 – 27	4.6 – 52	5.5 – 62	6.2 – 66	7.2 – 66
f/2.8	f/4	f/5.6	f/8	f/11	2 – 20	3.3 – 37	3.9 – 44	4.4 – 50	5.1 – 56
f/4	f/5.6	f/8	f/11	f/16	2 – 14	2.3 – 26	2.8 – 31	3.1 – 35	3.6 – 39
f/5.6	f/8	f/11	f/16	f/22	2 – 10	2 – 19	2 – 22	2.2 – 26	2.6 – 29
f/8	f/11	f/16	f/22	f/32	2 – 7	2 – 13	2 – 16	2 – 18	2 – 20
f/11	f/16	f/22	f/32	f/45	2 – 4.9	2 – 9.3	2 – 11	2 – 12	2 – 14
f/16	f/22	f/32	f/45	f/64	2 – 3.5	2 – 6.6	2 – 7.8	2 – 8.8	2 – 10

Note: Red numbers can't be set in Program and Scene exposure modes; blue numbers can't be set on many Nikkor lenses.

To Set Manual Flash

1. Activate the flash. If it's already in Standby, a partial press of the shutter release activates it; otherwise, press the power (ON/OFF) button on the SB-800 to turn the flash ON.
2. Press the SB-800's **Mode** button until  appears on the LCD.
3. Set the D90 to Aperture-preferred (A) or Manual (M) exposure mode and set your aperture and your exposure, as usual.
4. Set the camera to Single Servo AF (flash operates best when the camera achieves focus; this isn't technically necessary, but I like to tell people to use it as a reminder that focus has to be achieved for flash to operate).
5. Focus on your subject by pressing lightly on the shutter release. Note the distance on the scale on the lens.
6. Simply changing the aperture on the camera causes the SB-800 to match it. You should see the aperture change on the flash unit's LCD and the Shooting Range distance changes, as well. You have two choices (you can also use a combination of both):

- a. Change apertures (on the camera) until the distance noted in Step 5 is also shown in the flash unit's LCD.
- b. Press the ▼ and ▲ buttons on the SB-800 to change the flash's power level until the distance noted in Step 5 is shown in the flash unit's LCD.

Note: With lenses that don't have CPUs (AI and AI-S), the aperture on the camera isn't linked with the flash, so you should adjust both aperture and flash power settings on the SB-800 until the Shooting Range on the flash unit's LCD indicates the distance you noted in Step 5. Then set the aperture on the camera to match that shown on the SB-800.

Note: The power setting of the SB-800 is controlled in 1/6 stop increments between 1/2 and 1/128 power (plus you can set full power, 1/1). You control the setting by pressing the ◀ and ▶ buttons on the flash direction pad to choose a value. Wait a moment and the flash locks in the current value.

Note: The SB-800 is capable of keeping up with the D90 at 4.5 fps at powers of 1/8, 1/16, 1/32, 1/64, or 1/128 as follows:

1/8	4 consecutive frames
1/16	8 consecutive frames
1/32	16 consecutive frames
1/64	30 consecutive frames
1/128	40 consecutive frames

However, let the flash cool at least 10 minutes after firing 40 consecutive flashes (normally this is 15 flashes in higher power, TTL, and A modes).

To Set Repeating Flash

1. Activate the flash. If it's already in Standby, a partial press of the shutter release activates it; otherwise, press the power (ON/OFF) button on the SB-800 to turn the flash ON.
2. Press the flash's **Mode** button until **RPT** appears on the LCD.

3. Put the camera in Manual (M) exposure mode.
4. Press the middle button on the flash direction pad (**SEL**)
 - a. Then press the **+** and **-** buttons to choose the flash power setting (only settings between 1/8 and 1/128 are allowed).
 - b. Press the middle button (**SEL**) again to lock in that value and the next portion of the entry is highlighted.
5. The number (frequency of flashes) next to the **Hz** should be highlighted. If not, Press the **SEL** button until the number next to the label **Hz** is highlighted.
 - a. Then press the **+** and **-** buttons on the flash direction pad until the frequency you want is shown on the LCD.
 - b. Press the middle button (**SEL**) again to lock in that value and the next portion of the entry is highlighted.
6. The number (number of flashes) at the far left of the LCD should be highlighted. If not, Press the **SEL** button until it is.
 - a. Then press the **+** and **-** buttons on the flash direction pad until the number you want is shown on the LCD.
 - b. Press the middle button (**SEL**) again to lock in that value.

Maximum Number of Repeating Flashes at Each Power Setting

	<u>1/8</u>	<u>1/16</u>	<u>1/32</u>	<u>1/64</u>	<u>1/128</u>
1-2 hz	14	30	60	90	90
3 hz	12	30	60	90	90
4 hz	10	20	50	80	80
5 hz	8	20	40	70	70
6 hz	6	20	32	56	56
7 hz	6	20	28	44	44

8 hz	5	10	24	36	36
9 hz	5	10	22	32	32
10 hz	4	8	20	28	28
20-100hz	4	8	12	24	24

7. Set your shutter speed. It must be equal to or slower than **Number of Flashes / Frequency of Flashes**. For example, with 4 flashes at 8 Hertz, you'd need a shutter speed of 1/2 second or longer.
8. Note the distance displayed on the SB-800's LCD. (Note: changing the zoom head setting also changes the shooting distance.) This is the flash-to-subject distance you must use (e.g. if your subject is further away than this distance, you're going to have to move closer or change your settings).

Note: Nikon's flash documentation for repeating flash says the exposure "is the correct exposure for the first flash in the sequence." Actually, it's the correct exposure for each flash in the sequence, but if your subject doesn't move between exposures, the overlap may result in overexposure. If you're in doubt, bracket (though in this case, you'd bracket the number of exposures or frequency).

Also: place your subject against a dark background or underexpose the background. Failure to do so may result in one of two problems: (1) the background receives light from the multiple flashes and becomes overexposed; or (2) the subject appears to fade into the background (especially true if you're off by a bit in your distance). If in doubt, bracket your exposures for the background!

To Manually Set the Zoom Head

1. Press the ◀ and ▶ buttons on the flash direction pad to change the zoom setting. Each button press selects the next higher logical setting (and you'll eventually loop back to the lowest setting). The **zoom^M** symbol appears on

the LCD when the setting doesn't correspond to focal length of the lens.

Note: To cancel automatic zoom head setting and lock a manual setting, hold the **SEL** button for two seconds to enter the command setting mode for the flash. Next, press the **OK** button until you see the *m* above *zoom* and the words **SEL** and **OFF** on the LCD. Then use the **◀** and **▶** buttons to change the value (**ON** means the manual focus setting is locked, **OFF** means it isn't). Hold the **SEL** button for two seconds to complete the setting. To cancel the lock, repeat the process and select the other value.

2. To cancel a manual zoom setting, press the **◀** and **▶** buttons on the flash direction pad until the **m** no longer appears on the LCD (e.g. until the setting matches the lens being used).

Note: Remember that the Guide Number of the flash changes with the zoom setting.

Note: If you pull out the built-in wide angle adapter and move it into position in front of the flashtube, the SB-800 is set to the 14mm or 17mm focal length and the automatic zoom head function cannot be set to another setting. Likewise, if you put the diffusion dome on the flash head, the SB-800 sets 14mm as the focal length, and this can't be changed.

To Set the Distance Scale to Feet or Meters

1. Hold the **SEL** button for two seconds to enter the command setting mode for the flash.
2. Press the **▶** until you see the **m/ft** box highlighted on the LCD.
3. Press the **SEL** button again.
4. Use the **▲** and **▼** buttons on the flash direction pad to highlight the value you desire (**m** for meters, **ft** for feet).
5. Hold the **SEL** button for two seconds to complete the setting.

To cancel the lock, repeat the process and select the other value.

To Set Flash Exposure Compensation

Use the **+** and **-** buttons to adjust the amount of compensation. The SB-800 allows a maximum of +3 stop and -3 stops of flash compensation, which is indicated in one-third stop increments on the flash compensation indicator.

Note: You may not be able to achieve +3 flash exposure compensation in some situations.

To cancel compensation, repeat the process outlined above and set a value of 0.0.

Note: Flash compensation does not change the background exposure calculated by the camera.

Note: You can also set flash exposure compensation on camera bodies that have an internal flash, such as the D90 body. If you do this, the value is cumulative with that you set on the external flash. Get in the habit of only setting the flash exposure compensation in one place, if possible (hint: if you own a D1, D2h, D2x, or D3, flash exposure compensation should be set on the flash, since that's the only place you can set it!).

Tip: It's probably best to avoid flash compensation in any of the Balanced Fill-Flash TTL modes. You don't know what level of compensation the camera is already making, so any changes you make are in addition to this unknown, camera-calculated compensation. If you need absolute control, switch to the Auto Aperture or Manual flash modes, where any compensation you dial in will be from a known flash level.

To Set Red-Eye Reduction

Set Red-eye reduction on the D90 by holding the Flash Options button on the camera and turning the Rear Command dial until  appears on the D90's top LCD).

Note: Red-eye reduction works in most flash modes, but not in the Repeating Flash mode.

SB-800 Notes

- The SB-800 uses the same European style power connector as the SB-28DX, thus the SD-8A is the high performance battery pack to use, not the SD-8.
- The D90's focus mode should usually be set to Single Servo AF, since the flash will not fire unless the subject is in focus.
- The Autofocus Assist light on the SB-800 is used automatically if the ambient light is low and you haven't turned this function off on the flash. Autofocus assist only works at distances from 3.3 feet (1m) up to 33 feet (10m), and is only guaranteed to work with lenses from 24mm to 105mm.

Note: The Autofocus Assist illuminator will not function unless the central autofocus sensor is selected or Auto-area AF is in effect.

*Note: You can turn off the Autofocus Assist illuminator on the SB-800 by holding the **Sel** button down for two seconds and using the SB-800's Direction pad to navigate to the option and turn it OFF. **No AF-ILL** will appear in the flash's LCD.*

- If the **F** indicator on the SB-800's LCD panel is blinking, that means that the flash needs you to set the aperture. This happens in several situations: (1) in Automatic (A) flash mode; or (2) when using lenses without a CPU (AI or AI-S lenses). If the **F** is blinking, use the **+** and **-** buttons to set the correct aperture on the flash (e.g. the aperture that matches what is set on the camera).
- The SB-800 has an automatic standby power system. The SB-800 automatically turns off 40 seconds after the camera's meter turns OFF (**STBY** is displayed on the flash's LCD). A light press on the shutter release turns the D90's light meter back ON, and the SB-800 turns ON at the same time.

*Note: The SB-800 has a “special” No Standby mode that can be set, as well as the ability to set different time-out values (80, 160, 300 seconds). Like the other flash command mode settings, you get to this function by holding the **Sel** button down for two seconds and then navigating the options with the Direction pad on the flash.*

- After the flash fires, an icon may appear in the flash’s LCD along with a value. This indicates potential underexposure. This indicator only appears for three seconds after the shot.
- The Rear Sync option must be selected on the camera. (Some earlier flash units had this selection on the flash, so I’ve included this note here just in case folks who previously had one of those Speedlights are wondering.)
- While the SB-800 has “click stops” for commonly used flash head positions (45, 60, 75, and 90 degrees for tilt, every 30 degrees for rotation), you aren’t restricted to those positions. Setting an intermediary position is allowed (though it can easily be dislodged).
- Viewfinder Ready Light Warnings (blinking) occurs in the following conditions:
 - When you press the shutter release halfway and the SB-800 is not correctly mounted on the hot shoe.
 - After the flash fires at full power, indicating possible underexposure.

SB-900

The SB-900 is a complete re-work of the SB-900, with several new features and a redesigned user interface. The SB-900 was announced in July 2008 and is the current Nikon flagship flash unit.



Specifications

GN:	111.5 (ft), 34 (m) (at 35mm head position)
Weight:	14.6 oz. (415g) (w/o batteries)
Size:	5.7" (146mm) tall x 3" (78mm) wide x 4.7" (118.5mm) deep
Power:	four AA batteries
Recycle Time:	2.3 seconds minimum (full discharge, NiMH)
# of Flashes:	~165+ at full manual (NiMH)
Flash Duration:	1/880 to 1/38500
Coverage:	(130 degrees horizontal, 120 degrees vertical) supports 12mm, 14mm, 17mm, 18mm, 20mm, 24mm, 28mm, 35mm, 50mm, 70mm, 85mm, 105mm, 120mm, 135mm, 180mm, and 200mm coverage; automatic DX correction
Case:	SS-900 included
Key Features:	TTL flash control on the D90; Full power TTL, eight power level manual, and Automatic settings. Three illumination patterns. LCD panel shows settings. Rear curtain sync. High Speed sync, Repeating flash, and red-eye reduction. The SB-900 can synchronize with up to nine additional flash units, in groups of three controlled by one master flash. Head tilts from -7 degrees below horizontal up to 90 degrees above horizontal, and rotates 180 degrees in each direction. Built-in diffuser card.

Diffusion dome included, filter set included. Automatic or Manual wireless remote firing possible. Modeling light. Wide angle autofocus assist light.

To Set TTL Flash

1. Activate the flash. If it's already in Standby, a partial press of the shutter release activates it; otherwise, rotate the main switch on the SB-900 to the **ON** position.
2. Select the type of TTL to be performed. Basically, you only have one choice: whether to cancel the "balanced fill-flash" mode (you do so by pressing the **Mode** button on the flash until only the **TTL** indicator appears; if **TTL BL** appears, the camera is in a Balanced Fill-Flash mode; see "Summary of i-TTL Flash Modes" on page <551>).

Note: The **FP** indicator may also appear. This indicates that the flash is ready to perform high speed sync at shutter speeds faster than 1/200 if necessary.

Note: When the D90 is set for spot metering, Standard TTL is set automatically.

3. Set the camera to Single Servo AF (flash operates best when the camera achieves focus; this isn't technically necessary, but I like to tell people to use it as a reminder that focus has to be achieved for flash to operate).
4. Set the camera's exposure mode, if you haven't already. In Aperture-priority (A), Shutter-priority (S), and Manual (M) exposure modes, make any necessary aperture or shutter speed selections.

Note: In Program exposure mode you can usually override the camera's selection of aperture and shutter speed combinations by turning the D90's Rear Command dial (when the camera is active). But note that the maximum aperture you can use is restricted in Program exposure mode (the actual value depends upon ISO setting; see

“Allowable Apertures in Program and Scene Exposure Modes” on page <545>.

Note: The aperture the D90 (or you) selected also appears on the SB-900’s LCD panel when you partially press the shutter release, as does the allowable flash-to-subject distance range if the flash head is in the normal position.

Note: The D90 and SB-900 may warn you of several possible errors when you partially press the shutter release to verify settings:

- The lens must be set on its minimum aperture, or else the error message **FE** appears in the viewfinder.*
- Any **H** visible in the viewfinder indicates that overexposure (of the background exposure) is likely.*
- The shutter speed will be automatically reset to 1/200 if you selected a faster shutter speed in Shutter (S) or Manual (M) exposure mode.*
- In Manual (M) exposure mode, under and overexposure is indicated solely by the analog exposure display. If the exposure bar goes to either side of the **0** point, the ambient-only lighting exposure will not be correct.*

5. Focus on your subject by pressing lightly on the shutter release. Confirm that the subject is within flash distance by looking at the Shooting Range displayed on the SB-900’s LCD (if the flash head is in the normal position). Assuming you’ve confirmed the distance, you’re ready to shoot.

SB-900 Usable Apertures and Flash Range in TTL mode (Feet)

<u>iso100</u>	<u>200</u>	<u>400</u>	<u>800</u>	<u>1600</u>	<u>14mm*</u>	<u>18mm</u>	<u>28mm</u>	<u>50mm</u>	<u>85mm</u>
f/1.4	f/2	f/2.8	f/4	f/5.6	2 – 30	3.6 – 53	4.6 – 66	5.9 – 66	6.9 – 66
f/2	f/2.8	f/4	f/5.6	f/8	2 – 21	2.6 – 38	3.2 – 49	4.3 – 66	4.9 – 66
f/2.8	f/4	f/5.6	f/8	f/11	2 – 15	2 – 27	2.3 – 35	3 – 46	3.6 – 54
f/4	f/5.6	f/8	f/11	f/16	2 – 10.5	2 – 19	2 – 25	2.3 – 33	2.6 – 38
f/5.6	f/8	f/11	f/16	f/22	2 – 7.2	2 – 13	2 – 17	2 – 23	2 – 27
f/8	f/11	f/16	f/22	f/32	2 – 5.2	2 – 9.2	2 – 12	2 – 16	2 – 19
f/11	f/16	f/22	f/32	f/45	2 – 3.6	2 – 6.6	2 – 8.5	2 – 11.5	2 – 13
f/16	f/22	f/32	f/45	f/64	2 – 2.6	2 – 4.6	2 – 5.9	2 – 8.2	2 – 9.5

**With diffusion dome and wide adapter in place*

Note: Red numbers can't be set in Program and Scene exposure modes; blue numbers can't be set on many Nikkor lenses.

To Set Manual Flash

1. Activate the flash. If it's already in Standby, a partial press of the shutter release activates it; otherwise, move the main switch on the SB-900 to the **ON** position.
2. Press the SB-900's **Mode** button until  appears on the LCD.
3. Set the D90 to Aperture-preferred (A) or Manual (M) exposure mode and set your aperture and your exposure, as usual.
4. Set the camera to Single Servo AF (flash operates best when the camera achieves focus; this isn't technically necessary, but I like to tell people to use it as a reminder that focus has to be achieved for flash to operate).
5. Focus on your subject by pressing lightly on the shutter release. Note the distance on the scale on the lens.
6. Simply changing the aperture on the camera causes the SB-900 to match it. You should see the aperture change on the flash unit's LCD and the Shooting Range distance changes, as well. You have two choices (you can also use a combination of both).
 - a. Change apertures (on the camera) until the distance noted in Step 5 is also shown in the flash unit's LCD (assumes flash head is in normal position).
 - b. Press the button labeled **M** (label is on the LCD) on the SB-900 to change the flash's power level until the distance noted in Step 5 is shown in the flash unit's LCD.

Note: With lenses that don't have CPUs (AI and AI-S), the aperture on the camera isn't linked with the flash, so you should adjust both aperture and flash power settings on the SB-900 until the Shooting Range on the flash unit's LCD indicates the distance you noted in Step 5. Then set the aperture on the camera to match that shown on the SB-900.

*Note: The power setting of the SB-900 is controlled in 1/3 stop increments between 1/2 and 1/128 power (plus you can set full power, 1/1). You control the setting by pressing button labeled **M** (label is on the LCD) on the SB-900 to choose a value. Wait a moment and the flash locks in the current value.*

Note: The SB-900 is capable of keeping up with the D90 at 4.5 fps at powers of 1/8, 1/16, 1/32, 1/64, or 1/128 as follows:

1/8	4 consecutive frames
1/16	8 consecutive frames
1/32	16 consecutive frames
1/64	30 consecutive frames
1/128	40 consecutive frames

However, let the flash cool at least 10 minutes after firing 40 consecutive flashes (normally this is 15 flashes in higher power, TTL, and A modes).

To Set Repeating Flash

1. Activate the flash. If it's already in Standby, a partial press of the shutter release activates it; otherwise, move the main switch on the SB-900 to the **ON** position.
2. Press the flash's **Mode** button until **RPT** appears on the LCD.
3. Put the camera in Manual (M) exposure mode.
4. Press the leftmost button under the LCD (labeled **M** on the LCD) until the flash power you desire is set (only settings between 1/8 and 1/128 are allowed).

5. Press the third button from the left under the LCD (labeled **Hz** on the LCD) until the frequency of flashes you want is set. The actual setting is very small and is just above the distance display.
6. Press the second button from the left under the LCD (labeled **Times** on the LCD) until the number of flashes you desire is set (the following table indicates what is possible). The actual setting is very small and is just above the distance display.

Maximum Number of Repeating Flashes at Each Power Setting

	<u>1/8</u>	<u>1/16</u>	<u>1/32</u>	<u>1/64</u>	<u>1/128</u>
1-2 hz	14	30	60	90	90
3 hz	12	30	60	90	90
4 hz	10	20	50	80	80
5 hz	8	20	40	70	70
6 hz	6	20	32	56	56
7 hz	6	20	28	44	44
8 hz	5	10	24	36	36
9 hz	5	10	22	32	32
10 hz	4	8	20	28	28
20-100hz	4	8	12	24	24

7. Set your shutter speed. It must be equal to or slower than **Times / Hz** (that's **Number of Flashes / Frequency of Flashes** in plain language). For example, with 4 flashes at 8 Hertz, you'd need a shutter speed of 1/2 second or longer.
8. Note the distance displayed on the SB-900's LCD. (Note: changing the zoom head setting also changes the shooting distance.) This is the flash-to-subject distance you must use (e.g. if your subject is further away than this distance, you're going to have to move closer or change your settings; start with the setting in Step 4, but also consider your ISO and aperture).

Note: Nikon's flash documentation for repeating flash says the exposure "is the correct exposure for the first flash in the sequence." Actually, it's the correct exposure for each flash in the sequence, but if your subject doesn't move between exposures, the overlap may result in overexposure. If you're in doubt, bracket (though in this case, you'd bracket the number of exposures or frequency).

Also: place your subject against a dark background or underexpose the background. Failure to do so may result in one of two problems: (1) the background receives light from the multiple flashes and becomes overexposed; or (2) the subject appears to fade into the background (especially true if you're off by a bit in your distance). If in doubt, bracket your exposures for the background!

To Manually Set the Zoom Head

Normally, the SB-900's flash head zooms automatically to match the focal length of the lens you're using (and self corrects for DX bodies like the D90). If you'd like to pick something other than what the camera does:

1. Press the **Zoom** button on the SB-900 to change the zoom setting. Each button press selects the next higher logical setting (and you'll eventually loop back to the lowest setting). The **zooM** symbol appears on the LCD when the setting doesn't correspond to focal length of the lens.

*Note: To cancel automatic zoom head setting and lock a manual setting, hold the **OK** button for two seconds to enter the command setting mode for the flash. Next, rotate the control wheel until you get to the **zooM** icon. Press the **OK** button to enter the selection process, then use the control wheel to select **On** (ON means that you're in manual control of the focal length setting, OFF means the camera controls the focal length; yes, this seems a bit confusing). Press the **OK** button one more time, then press the **EXIT** button (leftmost button under the LCD, labeled on the LCD) to complete the process.*

2. To restore automatic zoom head setting:
 - a. Hold the **OK** button for two seconds to enter the command setting mode for the flash.
 - b. Rotate the control wheel until you get to the  icon.
 - c. Press the **OK** button to enter the selection process.
 - d. Use the control wheel to select **On**.
 - e. Press the **OK** button again and use the control wheel to select **Off**.
 - f. Press the **OK** button one more time, then press the **EXIT** button (leftmost button under the LCD, labeled on the LCD) to complete the process. (Yes, this is a poor process, and I suspect that Nikon will fix it with a flash firmware update.)

Note: Remember that the Guide Number of the flash changes with the zoom setting.

Note: If you pull out the built-in wide angle adapter and move it into position in front of the flashtube, the SB-900 is set to the 8mm (!) focal length and the automatic zoom head function cannot be set to another setting. Likewise, if you put the diffusion dome on the flash head, the SB-900 sets 8mm as the focal length, and this can't be changed.

To Set the Distance Scale to Feet or Meters

1. Hold the **OK** button for two seconds to enter the command setting mode for the flash.
2. Rotate the control wheel until you get to the **m/ft** icon.
3. Press the **OK** button to enter the selection process.
4. Use the control wheel to select **ft** (feet) or **m** (meters)

5. Press the **OK** button one more time, then press the **EXIT** button (leftmost button under the LCD, labeled on the LCD) to complete the process.

To Set Flash Exposure Compensation

1. Press the  button on the flash (leftmost button under the LCD; labeled on the LCD).
2. Rotate the control wheel until you get to the value you wish.

The SB-900 allows a maximum of +3 stop and -3 stops of flash compensation, which is indicated in one-third stop increments on the flash LCD.

Note: You may not be able to achieve +3 flash exposure compensation in some situations.

To cancel compensation, repeat the process outlined above and set a value of 0.0.

Note: Flash compensation does not change the background exposure calculated by the camera.

Note: You can also set flash exposure compensation on camera bodies that have an internal flash, such as the D90 body. If you do this, the value is cumulative with that you set on the external flash. Get in the habit of only setting the flash exposure compensation in one place, if possible (hint: if you own a D1, D2h, D2x, or D3, flash exposure compensation should be set on the flash, since that's the only place you can set it!).

Tip: It's probably best to avoid flash compensation in any of the Balanced Fill-Flash TTL modes. You don't know what level of compensation the camera is already making, so any changes you make are in addition to this unknown, camera-calculated compensation. If you need absolute control, switch to the Auto Aperture or Manual flash modes, where any compensation you dial in will be from a known flash level.

To Set Red-Eye Reduction

Set Red-eye reduction on the D90 by holding the Flash Options button on the camera and turning the Rear Command dial until  appears on the D90's top LCD).

Note: Red-eye reduction works in most flash modes, but not in the Repeating Flash mode.

SB-900 Notes

- The SB-800 uses the same European style power connector as the SB-28DX, thus the SD-8A is the high performance battery pack to use, not the SD-8.
- The D90's focus mode should usually be set to Single Servo AF, since the flash will not fire unless the subject is in focus.
- The Autofocus Assist light on the SB-900 is used automatically if the ambient light is low and you haven't turned this function off on the flash. Autofocus assist only works at distances from 3.3 feet (1m) up to 33 feet (10m), and is only guaranteed to work with lenses from 17mm to 135mm.

Note: The Autofocus Assist illuminator generally requires you to be in AF-S or AF-A autofocus mode, and if you're selecting the autofocus sensor, then the center sensor must usually be selected on a D90.

*Note: You can turn off the Autofocus Assist illuminator on the SB-900 by holding the **OK** button down for two seconds and using the SB-900's Control wheel to navigate to the option and turn it OFF. **AF** appears next to the flash icon in the flash's LCD when active.*

- The SB-900 has an automatic standby power system. The SB-900 automatically turns off when the camera's meter turns OFF (the **STBY** icon is then displayed on the flash's LCD). A light press on the shutter release turns the D90's light meter back ON, and the SB-900 turns ON at the same time.

*Note: The SB-900 has a “special” No Standby mode that can be set, as well as the ability to set different time-out values (40, 80, 160, 300 seconds). Like the other flash command mode settings, you get to this function by holding the **OK** button down for two seconds and then navigating the options with the Control wheel on the flash.*

- After the flash fires, an icon may appear in the flash’s LCD along with a value. This indicates potential underexposure. This indicator only appears for three seconds after the shot.
- The Rear Sync option must be selected on the camera. (Some earlier flash units had this selection on the flash, so I’ve included this note here just in case folks who previously had one of those Speedlights are wondering.)
- While the SB-900 has “click stops” for commonly used flash head positions (45, 60, 75, and 90 degrees for tilt, every 30 degrees for rotation), you aren’t restricted to those positions. Setting an intermediary position is allowed (though it can easily be dislodged).
- Viewfinder Ready Light Warnings (blinking) occurs in the following conditions:
 - When you press the shutter release halfway and the SB-900 is not correctly mounted on the hot shoe.
 - After the flash fires at full power, indicating possible underexposure.

Flash Troubleshooting

Problem: Your SU-4 doesn’t seem to trigger the remote flash correctly in TTL mode.

Solution: The D90 is not really compatible with the SU-4 in TTL modes. Nikon states that you must set the triggering flash unit to Automatic (A) flash mode. That’s not 100% correct. You can use **FV Lock** to get around the preflash prematurely triggering a remote SU-4 (see “Wireless Flash” on page <577> for an example of this). A better solution is to purchase additional SB-800’s and use them in wireless TTL mode.

Problem: You can't get an SB-27 Speedlight to work on a D90.

Solution: Non-DX flash units need to be set to Automatic or Manual flash mode, and the SB-27 has some unusual wrinkles concerning Automatic flash mode. If you want to use manual flash mode, just slide the flash mode selector switch on the SB-27 to **M** and perform manual flash as usual. To use Automatic flash mode with the SB-27, you need to open the battery compartment of the flash unit and make sure that the switch inside is *not* set to TTL (the default). Then, starting with the flash power OFF, hold down the **ZOOM** button on the SB-27 while turning its power switch to **AUTO**. You may have to perform this last action more than once, as each time you perform it the flash cycles through to only the next available flash mode. You want the "Forced Auto" mode, and the indicator for that is that the **A** on the SB-27's LCD blinks.

Problem: The Flexible Program function in Program exposure mode doesn't seem to change the shutter speed or aperture at all; the top LCD shows **P*** but the shutter speed and aperture don't change.

Solution: *Get out of Program mode!* If you read the Nikon manuals closely enough, interpret between the lines, consult a good tarot card reader, and sacrifice enough chickens you learn that:

- In Program exposure mode, the maximum aperture that can be used is highly restricted. On a D90 at the lowest ISO, the largest aperture you can set with an external flash is f/3.8.
- In Program exposure mode, the minimum shutter speed is locked at 1/60.
- In Program mode in dim conditions (and f/4 at 1/60 isn't all that dim, is it?), you not only are locked into basically one aperture/shutter speed combo, but the ambient light in the scene *will be severely underexposed*.

At a minimum, you should use the Slow Sync option or Custom Setting #E1 (see page <518>) to lose the slow shutter

speed restriction. But I'd recommend that you switch to Aperture-preferred exposure mode to also remove the aperture limitation.

Using a D90 in the Field

Using a D90 is very much like using a Nikon film SLR with slide film. Very few practical differences enter into the picture. This section deals with those differences and other more generic issues that come up while shooting with the D90.

The “Routine”

Here’s a simple, structured set of things to consider at different points in your shooting routine:

General Settings You Make Once

- Adjust the viewfinder’s diopter setting.
- Set the date, time, and language.
- Set Custom Settings that control camera defaults for how you normally want the camera configured (Beep, Instant review, etc.).

I usually double-check the diopter and Custom Settings every time I change the battery. It’s easy to dislodge the diopter setting, and if I’ve handed the camera to anyone else (common during workshops) I’ve found it wise to double-check my custom settings at that time, too.

Things to Do Before You Head Out on a Shoot

- *Clean the mirror box and sensor.* I know I’ll get grief over this one, as it’s a lot of hassle, and if you haven’t changed lenses lately it shouldn’t matter, right? Wrong. The sensor has a propensity to attract small particles, regardless of whether you had the lens off or not. Even if the sensor was cleaned last time you used the camera, there’s a chance that another particle has already migrated to the interior of the camera, especially since the mirror flip and curtain open move a bit of air around. Unlike film cameras, where you tend to clean *after* a shoot, I’ve found it more useful to do all my cleaning with digital bodies *before* a shoot. So do a **Clean image sensor** activation, take a quick shot at f/22 to verify that the sensor is clean, then do

a brush or wet clean if the shaker mechanism isn't getting everything off.

- *Likewise, clean your camera bag and accessories.* Dust comes from two sources: the environment you shoot in, which requires defensive techniques to control; and unclean working practices, such as allowing a camera bag to accumulate dirt and dust, not cleaning lenses after use, etc. At least start the shooting session with everything clean; it'll postpone the inevitable dust specks.
- *Format the Secure Digital cards you'll be using.* First, though, check to see if it has any files on it (see "Things to do After Each Shooting Session" on page <628>). Formatting deals with any bad sector and fragmentation problems, and if you're using the D90 and other cameras with the same card, can help keep folder proliferation and the renumbering it causes to a minimum.
- *Top off your batteries.* I carry a converter/charger in my auto just in case I forgot to top off my battery—as a last resort I run a charge while driving to the shoot. Fortunately, the D90's battery handles "top-offs" just fine (some other batteries prefer to be completely discharged prior to charging). Don't forget the batteries for your flash and accessories, if any.
- *Verify that you have everything you need for the shoot.* Personally, I like checklists, which keep me from forgetting various cords I might need or my backup storage devices. With a D90, that list needs to include things like the BF-1A camera body cap, and emergency cleaning equipment. If I'm teaching a workshop, I have to remember my video cable and extension.

Simplified Checklist (a more elaborate, printable checklist is on the disc—look for **D90 Checklist**):

- ___ Camera body (bodies)
- ___ Extra batteries
- ___ Charger (if needed, with cables)

-
- ___ Lenses
 - ___ Lens accessories (filters, hoods, teleconverters, extension tubes)
 - ___ Support (tripod, head, monopod, plates, etc.)
 - ___ Flash
 - ___ Batteries for flash (or cable to external battery)
 - ___ Flash bracket, sync cable (SC-28), etc.
 - ___ Cleaning equipment (AC power, swabs, fluid, air, etc.)
 - ___ Caps (body cap, lens caps, etc.)
 - ___ Storage (Secure Digital cards, Coolwalker, etc.)
 - ___ Cards (gray card, white balance card, etc.)
 - ___ Cables (FireWire, video, AC power, etc.)
 - ___ Laptop with Nikon ViewNX/Capture NX2 and plenty of storage space
 - ___ Other (card reader/PCMCIA adapter, rain cover, etc.)

Check Each Time You Turn the Camera ON

- *Check the battery level.* Put in fresh battery, if necessary. This is important because if the camera sits unused for a long period of time, the battery will still deplete, as it powers the overlay to the viewfinder even when the camera is turned OFF.
- *Check the frames remaining indicator.* Format or replace the Secure Digital card, if necessary. If it seems like the frames remaining number is lower than it should be, **check your Image Quality setting!** Also check to make sure that there aren't images remaining on the card that you haven't yet saved to the computer.
- *Check that you haven't overridden any settings.* Check especially for exposure compensation, bracketing, ISO value, frame advance, and image quality and size settings.
- *Take one more careful look at the top LCD, and pull up the INFO display on the color LCD.* This is a redundancy check for all three previous checks. After checking the values on these displays, partially press the shutter release

(sometimes this triggers blinking of an icon, which may remind you that you set something you need to restore).

Settings You Change Rarely (and then only for a reason)

- *Set a shooting method.* Single frame or one of the Continuous advance options are the primary choices. But you might also set the self timer or remote control options for certain circumstances.
- *Set focus options.* Single Servo (**AF-S**), Continuous Servo (**AF-C**), Auto Servo (**AF-A**), plus **Single point**, **Dynamic area**, **Auto-area**, and **3D-tracking (11 points)** are your primary choices. The camera's defaults are a good starting point for newcomers, but will slow autofocus operations in almost any continuous movement situation, so you'll want to learn how to use the other options and set them situationally.
- *Set a metering method.* Matrix, center-weight, or spot meter are the choices. Matrix is your usual choice. Get in the habit of looking at the indicator often; it's conveniently right next to the viewfinder, so a quick glance at it before you put your eye to the camera is simple to do.
- *Set ISO sensitivity.* Use the lowest ISO that gives you acceptable shutter speeds.
- *Set an exposure mode.* Avoid Program and the Scene exposure modes if you can, especially with flash. Aperture priority is my usual choice.
- *Set a flash mode.* This one's a little tricky. The external flash mode (TTL, Automatic, Manual, etc.) is controlled with the **Mode** button on the flash. The internal flash mode is controlled by Custom Setting #E2 (see page <519>). If you've set TTL, the type of TTL performed (Balanced Fill-Flash, Standard TTL) is affected by other camera settings (spot metering) for the internal flash, but can be manually set for external flash units. Because of that difference, you need to pay careful attention to flash settings when going back and forth between internal and

external flash use. The internal flash mode (TTL, Repeating, Manual, Commander) is controlled with Custom Setting #E2 and the type of TTL is only controlled by metering selection (matrix and centerweighted metering produce TTL BL, spot metering produces Standard TTL).

- *Most Custom Settings.* Very few of the custom settings are things that you'd change often.
- *Set **Image quality** and, if you're shooting JPEG, an **Image size**.* Most photographers shoot either **NEF, JPEG fine Large**, or a specific size determined by their needs.
- *Multiple exposures.* This item tends to be used for special purposes.

I try to make it a practice to check these settings every time I replace a battery or Secure Digital card, just as I used to do when switching rolls of film on a 35mm film body. **Always watch the ISO setting!** You never want to shoot with a high ISO set unless you absolutely have to, as noise is higher, producing less desirable image quality results.

Settings You Change Often

- *Set a white balance value.* **Auto** works only in a limited range of lighting, so learn to recognize when you're outside that range and set either a specific value or use a gray card with **Preset manual**.
- *Select a focus area.* For **Single point** you're selecting the actual sensor used, for **Dynamic Area** you're selecting the starting focus sensor. In **Auto-area** your selection is ignored.
- *Set exposure compensation.* Especially true if you use matrix metering and are moving in and out of high contrast scenes, which the meter doesn't handle as well. Use the histogram to determine if you need to change the exposure.
- *Set exposure bracketing.* Pay close attention, though, as the D90 can be set to bracket white balance and **Active D-Lighting** as well as exposure; the controls are the same

and Custom Setting #E4 selects which is in effect (see page <523>).

- *Set apertures and/or shutter speeds (or override the Program exposure mode).*

It pays to get in the habit of making a quick visual check for these settings as often as possible (e.g. just before every shot, if possible). Fortunately, the D90 has almost all of your critical settings visible in the viewfinder (the only critical missing ones are white balance and ISO, which can be found on the INFO Shooting screen).

Tip: The big “gotchas” are white balance and exposure compensation. When you’re working in a hurry, it’s easy to forget that you overrode the camera for these. Fortunately, the viewfinder reminds you of your settings for the latter, and the top LCD displays the former. Get in the habit of looking at both those settings when shooting. Better yet, get in the habit of pulling up the INFO display to review all settings every once in a while, as it displays more of the options that are set than any other display.

Things to Do After Each Shooting Session

- *Move the image files to your computer ASAP.* Working in the digital realm requires discipline. Remember, the D90 is labeling files with numbers, and the Nikon DSLRs have the entertaining trait of restarting the numbering in a variety of ways that’ll catch you off guard. If you don’t make it a habit to move files to meaningful folders (and meaningfully rename the files, see the section on “Digital Workflow” in *Introduction to Nikon Software*), you’ll end up with hundreds of files with similar and possibly duplicate names that you have to slog through to find the one you want. Besides, if you make it a practice to immediately download the image files, you won’t ever accidentally format a card with information you wanted to keep.
- *Verify that the files transferred correctly!* Open one or two of the files to make sure that they transferred without

error. Many serious photographers also burn a CD-ROM backup of their original files at this stage and securely store this as their “original negative.” Personally, I use portable hard drives for backup, as it makes the process faster and I only have to keep track of one extra thing. Both workflow solutions I use allow me to create the backup at the time of download.

- *Format the Secure Digital cards immediately after you download the files from them.* Yes, I told you to format them just before each shooting session, so this seems redundant. But if you follow both instructions, any card you notice with files on it probably hasn’t been downloaded to the computer yet, giving you one last chance to recover those original files before you erase them.
- *If you’re going to shoot again within the next week, put your partially exhausted batteries on the charger.* Since you can’t count on running into a drugstore and buy batteries that’ll run the D90, you also need to stay disciplined in keeping your batteries topped off, lest you find yourself in a situation where you run out of power at the most inopportune time (yes, it’s happened to me; don’t let it happen to you). If you’re not going to be shooting with your D90 in the next month or so, make sure the battery has a mid-level charge (not full or empty) in it before storing it outside the camera.
- *Cancel any special settings you made.* In particular, set the camera back to:
 - No exposure compensation.
 - Bracketing OFF.
 - The lowest numbered ISO value.
 - Your preferred exposure and flash mode.
 - Automatic white balance.
 - Return any one-time custom settings to their usual value.
- *Clean the camera.* Don’t put the camera away dirty, as this just tends to leave dirt and dust around that will

eventually make its way into the mirror box. Since I use my D90 in the backcountry, I make a habit of opening all the doors and blowing dirt and dust out of every nook and cranny. I don't clean my sensor when I return from a shoot, as I've noticed that if my camera sits for a day or two, dust always seems to settle on the clean sensor. Thus I always leave my sensor cleaning for just before leaving for shoots.

Keeping Track of Batteries

If you use the D90 heavily you may find that one battery doesn't always get you through a full day of shooting (it might though). Thus, most D90 users carry multiple batteries with them.

The EN-EL3e battery doesn't have any external mechanism for showing whether it is fully charged or not. If you carry three batteries, as I sometimes do, you need some way of telling the charged batteries from the used ones. Here are some of the methods I've heard:

- *Number the batteries.* Using some sort of permanent marker, number each of your batteries, and then use them in numbered order. If you pull battery #2 out of the camera, you know to use battery #3 next (and that batteries #1 and #2 need charging). (If you put a small label on the battery you can also put "tick" marks on the label each time you charge it, which helps you balance the use of your batteries.)
- *Use rubber bands.* When I take a battery off the charger, I slip a small rubber band¹³⁵ over its body. Since I can't put the battery into the camera without taking the rubber band off, any battery I find in my pack with the rubber band on must be charged and ready for use. To keep the rubber band from falling off, make sure to wrap it around the battery so that it falls in the "crease."

¹³⁵Rubber bands are also useful for getting stuck filters off the lens.

- *Use the battery cap.* One clever user has placed green and red stickers on the bottom of his EN-EL3 batteries and then cut out a section of the plastic battery cap that Nikon supplies so that the color shows through. By careful placement of the stickers and by reversing the cap, either the red or the green sticker shows through.



Maintaining Image Quality

You'll get the highest quality images out of the D90 if you:

- *Shoot NEF format.* You have the original sensor data to deal with, and can apply different interpolation routines on it after the fact. The D90 JPEG engine seems just a teeny bit “soft” to me, though not nearly as bad as the D100 was. If you don't shoot NEF, see “Dealing with JPEG” on page <635>. Note that you don't have to shoot **NEF(RAW)+JPEG** if all you're looking for is a for-position-only JPEG. All you need is a tool to extract the embedded JPEG preview from the NEF file.
- *Get the exposure right.* Incorrect exposure has impacts on all kinds of image quality issues, including visibility of noise, contrast, and much more. See “How to Interpret Histograms” on page <252>. Any underexposure of a D90 image tends to produce more visible noise, especially if you adjust the exposure later in post-processing. Note that you can check channels individually on the D90, so there's no excuse for blowing a channel, either. However, to keep from doing so when you're shooting NEF, you should also set the proper white balance setting (the

histograms are calculated from the embedded JPEG, which means that the white balance data is reflected in the histogram!).

- *Keep the sensor clean.* Even with Photoshop's Healing Tool or Capture NX2's Dust Off function, you'll still end up spending a lot of time cleaning up dust bunnies in large bright areas of images shot at small apertures. Plenty of quick and good cleaning options exist now, so use one regularly, such as the SensorBrush. See my Web site for more (<http://www.bythom.com/cleaning.htm>). Also see the section on cleaning the sensor that comes later in this eBook (see page <654>).
- *Shoot at the lowest ISO you can,* and use **Long exp. NR** (noise reduction; on the SHOOTING menu) on exposures over 8 seconds. (This form of noise reduction does not lower detail.) Once noise is recorded in an image, getting it out is difficult at best, impossible at worst. ISO 200 is where you want to be as often as possible—at this value the D90's images are remarkably noise free and have a great deal of detail and clarity. If you shoot at high ISO values you have to make a choice: detail or not. Turning on **High ISO NR** (noise reduction) will cause loss of some detail in JPEG images, though the noise will be better controlled.
- *Watch your focus.* If you intend to print at sizes larger than 8x10" (~ISO A4), you should realize that depth of field on a D90 is a bit smaller than for the same focal length, focus distance, and aperture combination on a 35mm body (see "Depth of Field Preview" on page <389>). Most of us who shoot NEF set **Sharpening** (in our Picture Control) to **5** or **6** on our D90's. This allows us to use the D90's excellent thumbnail zoom capability to examine and better evaluate focus. If you leave your sharpening value set lower, the slight graininess of the color LCD coupled with the interpolation the camera is doing on the thumbnail will make it harder to see the actual focus point.

- *Learn to recognize what triggers moiré.* Any regular pattern of small detail can trigger the dreaded moiré. This colored pattern is even more difficult to remove from images than noise. Changing focal length and camera-to-subject distance are your only real tools in reducing moiré. Fortunately, it takes a very small, tight pattern to trigger moiré on the D90, and these don't occur as often as the patterns that trigger the problem on the D70.

Which Type of Photographer are You?

Most D90 users will fall into one of two camps of photographers:

- *"I want mostly automatic."* This type of photographer wants the quality a DSLR produces, but generally doesn't want to have to pay a lot of attention to details. They're likely to drop their photos off to a lab to be printed, and less likely to crack open a software program to "fix" or adjust their images after the fact.
- *"I'm willing to invest time to get it right."* This type of photographer wants the very best quality images they can produce with their D90, and is willing to spend as much time and energy that it takes to get everything right.

The first of these—the automatic shooters—should probably have their camera set the following way most of the time (note that the settings shown with an *, are *not the camera defaults*, so you'll have to set them manually once):

Long exp. NR	On*
High ISO NR	Off*
Image quality	JPEG fine
Image size	Large
White balance	Auto (or actual setting)
ISO	Auto ISO to 800, maybe 1600*
Picture Control	Neutral
	Sharpening 4 or higher*
	Contrast 0
	Brightness 0

	Saturation 0
Color Space	sRGB
Active D-Lighting	Low* (high contrast scenes only) or Off
Autofocus Mode	AF-A (Auto Servo)
Autofocus Area Mode	Auto-area
Metering Method	Matrix Metering
Internal Flash Mode	TTL
File No. Seq.	ON*
Image Rotation	ON

As for exposure mode, I'd suggest Aperture-priority, though Program exposure mode is okay if you avoid using the flash.

With the camera set as described, you'll get very usable, slightly warm pictures out of the camera with minimal hassle. These photos will work on the Web, with PictBridge printers, and with most labs. You're compromising a bit on image quality (automatic white balance can produce slightly off color images, but usually only slightly). Read the section on "Dealing with JPEG," below, for more tips on image quality.

The Autofocus system will work hard to figure out what is and isn't the subject, but it will get focus wrong some of the time (most often when the subject of choice is behind something else, when the subject of choice has little or no contrast, or when the subject is moving quickly).

If you're trying to get the most quality you can out of your D90, then you'll be changing your settings to optimize for each situation you encounter. A few, however, need to be called out here:

Image quality	NEF (Raw)*
ISO	200 to 800 max, Lo 1.0 in low contrast
White balance	Preset manual* or actual condition
Color Space	sRGB ¹³⁶

¹³⁶ Because the color LCD is close to sRGB. When you convert your image on the computer, you'll assign a different Color Space

Autofocus Mode
Autofocus Area Mode

AF-C* (Continuous Servo)
Dynamic area*

The remainder of the settings would either be the same as for the automatic shooter, or would vary with every situation you encounter. Again, I'd suggest Aperture-priority exposure mode (unless you're shooting sports, in which case I'd suggest Shutter-priority exposure mode).

The reason you go to NEF for the highest quality is to try to get every last bit of color capability out of the camera—to do that you need to shoot raw files and convert them after the fact in the largest Color Space possible. Using a measured White Balance (**Preset manual**) is the best way to get the best color and exposure out of the D90, but if you know what you're doing, you can set Kelvin directly.

Dealing with JPEG

If you shoot JPEG with a D90, you need to master the camera's digital manipulation settings. In particular, white balance, contrast, and sharpening settings often determine how good the final picture is:

- *Consider using **-1** or lower for **Contrast*** (in your Picture Control). If contrast is set to **0**, or worse still, one of the higher values, you may discover that the highlights are blown out and unrecoverable on your JPEGs (and the shadow areas may be dark and muddy in color). Some D90 users go further and suggest the **-2** value as the proper one. If you shoot in higher contrast scenes then perhaps this is a better call, though it'll mean that you have to post-process your images more often. The point is: don't let the camera make the call (**A** for auto), and set something on the low side, not the high side.
- *Don't overexpose!* Coupled with the contrast changes introduced with the JPEG format is a related issue: any overexposed area in the resulting shot is very likely to have blown-out (detail-less) highlights. You're better off trying to "recover" information in the shadows on JPEGs

than from the highlights; indeed, the camera has a built-in capability called **Active D-Lighting** to help you do so (see page <301>). (Someone once tried to explain the math to me, which, since it involved complex Fourier transforms, went a bit over my head. But the essence of the message was this: because of the way JPEG transforms individual pixel data into formulas, you're slightly more able to "recover" useful information in dark areas than bright.)

- *Use any Sharpening setting at ISO Lo 1.0 and 200.* Amazingly, the D90 usually manages to not produce visible sharpening artifacts, even in JPEG images. Whatever rendering Nikon is using (remember, it's prior to reduction to 8-bit), the edges are generally clean and free from mosquito artifacts, at least at the lower ISOs. Indeed, most D90 images that are sharpened in camera can even be sharpened again in post processing without much worry, something that wasn't true on most previous Nikon bodies. I tend to set my D90 to **4** or higher sharpening in camera, as it helps me evaluate focus when zooming in on the preview image on the color LCD. Note, however, that as you go up the ISO ladder, you almost certainly will want to begin reducing your sharpening value.

Custom Curves

You'll need Nikon Camera Control Pro 2 and a USB cable between your computer and your D90 to set and use Custom Curves, which replace the **Contrast** setting in your Picture Control. However, if you shoot primarily JPEG images, you may find this ability useful.

I describe this fully in the appropriate section of *Introduction to Nikon Software*.

Color Profiles and Color Spaces

Color management is a topic worthy of its own book (indeed, it has one: [Real World Color Management](#) by Bruce Fraser, Chris Murphy, and Fred Bunting). But if you want to get the

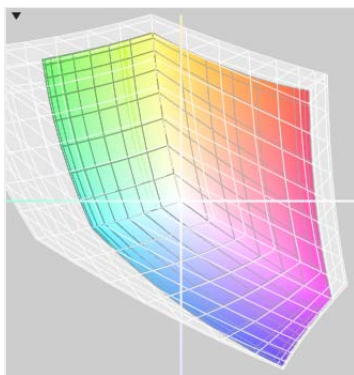
best possible results from your camera, you need to know a few things about profiles, Color Spaces, and Color Modes.

The D90 allows the user to choose between two Color Spaces: **sRGB** and **AdobeRGB**. Color Modes, which interacted with Color Spaces, are now a thing of the past and don't appear in the D90 menus.

Color Spaces (also sometimes called gamuts) define the range of colors that are available to be reproduced. Imagine a world where there are only five shades of a red versus a hundred shades of red. Identical scenes would look different in those two worlds, no? In a simplified way, that's what we face with color reproduction methods. Television screens (and monitors) can reproduce one range of colors, an inexpensive printer another range, and expensive multi-plate print technologies yet a different range. The inks in printing (or the phosphors and shadow mask in monitors) can limit (or increase) the color range.

In a perfect world, the color range of your capture device (e.g., your D90) would match that of your editing device (e.g., your monitor), which in turn would match that of your printer. In that perfect world, colors captured by the camera would be maintained perfectly, right through to the final printed image.

A Color Space defines how narrow or wide the color range is and what a particular RGB value should represent. The D90 allows you to "set" the Color Space. Nikon has chosen two logical candidates, **sRGB** and **AdobeRGB**.



sRGB is a narrow gamut Color Space (the inner, colored area in the CIE wireframe chart, shown above) best suited for computer monitors and many commercial lab printers, while **AdobeRGB** (the outer, gray-shaded area) is a wider gamut Color Space that is generally better for printing on high-fidelity equipment. As you can see, both Color Spaces are nearly equal in the blue corner, but sRGB extends less into the red (upper right) and quite a bit less into the possible green range (upper left).

Tip: If you've got a Macintosh and want to compare gamuts, start the **ColorSync Utility** application, click the **Profiles** icon, choose a Color Space, click the little triangle in the upper left corner of the plot area and then select **Hold for Comparison** from the pop-up menu that appears. Then select another Color Space. You'll get a dual-plot similar to what I've shown above.

sRGB tends to produce intense, saturated colors at the expense of subtle tonality. Microsoft and Hewlett-Packard originally co-developed the sRGB Color Space for computer monitors. Their choice was to use the lowest-common denominator approach: what was the largest Color Space that every monitor can reproduce? The result was a narrow range that tends to exaggerate saturation, which also adds a perceptual increase in contrast to most images.

Note: In case you haven't already figured it out, the color LCD on the D90's back is no different than a small computer

*monitor. It matches the sRGB Color Space fairly closely. If you want to assess color—even crudely—on the D90's color LCD, the camera needs to be set to **sRGB**.*

If you shoot pictures to be used on Web sites or in computer-based products, **sRGB** is the Color Space to use, though its narrow nature doesn't give you much flexibility in subtle color adjustments. Also, if you expect to print directly from your storage card (either on a DPOF or PictBridge-aware printer or at a photofinisher that uses, say, a Fuji Frontier), then you should probably choose **sRGB** as your Color Space.

AdobeRGB is a wider Color Space, intended for print technologies that can reproduce a large range of subtle color differences. If you intend to take JPEG or TIFF pictures for print on your own personal inkjet or high-end digital printer, I suggest that you select **AdobeRGB** as your Color Space. Note that colors may seem to be less saturated when displayed on your computer (especially if you haven't profiled your monitor using a product such as Colorvision's Spyder hardware and Optical software [see the review on my site: <http://www.bythom.com/colorvision.htm>]), but the color is more representative of what you'll see in final prints.

*Note: And now the opposite is true of the last note: if you've set the camera to a Color Space of **AdobeRGB** you **can't** really use the color LCD on the D90 to assess color.*

The Color Spaces on the D90 appear to be accurate, and I applaud Nikon for giving us a choice.

Unfortunately, it's not just a simple matter of setting the camera's Color Space using the option on the SHOOTING menu (more on that in a bit, too). Instead of embedding the actual Color Space information, as is often done in graphic design firms with their files, all that choosing a Color Space does is place a marker in the EXIF data as to what the camera is set to, and it also changes the position of the underline (_) in the filename. A lot of older software ignores that marker or

the filename change! Here are some of the things you're not told in the D90 manual:

- *Set your working Color Space in all your software programs to match what you use in the camera.* Most good digital editing programs, including Nikon Capture NX2 and Photoshop CS4, have an option (usually in the **Preference** or **Color Settings** menu item) for setting the Color Space the program uses to display values. Make sure that you set this! Your Color Space choice should match the camera setting you choose. (*Note:* a few recent programs, such as Adobe Lightroom and Apple Aperture set the largest possible Color Space and convert images to that, if necessary; these programs have no Color Space function to set.)
- *Learn whether your program recognizes the tag and filename change or not.* For the most part, JPEG files are automatically recognized as being sRGB by most older software, regardless of the camera's chosen Color Space. That's probably because the software engineers simply followed the original EXIF specification, which used to state that any EXIF file is in the sRGB Color Space¹³⁷. If you use AdobeRGB, you may have to set your program to *ignore or discard* the Color Space, or *assign* the correct one.
- *NEF output often works a bit differently.* Nikon Capture NX2 assigns the correct Color Space and *attaches the color profile information* to the TIFF and Photoshop PSD files it outputs (assuming that you've set the program's preferences correctly). In other words, it actually passes a real color profile to other software rather than assume the software understands the Color Space by file name or EXIF data methods.

¹³⁷ The latest EXIF standard allows for two file naming conventions, each of which defines a different Color Space. A **DSC_#####** file would be sRGB, while a **_DSC#####** file would be AdobeRGB. Unfortunately, not all software has caught up to the EXIF standard changes. (Photoshop and Photoshop Elements have, by the way.)

Note: I used the words color profile in that last bullet. So what's a color profile? It's a description of how a device deviates from (or adheres to) a Color Space definition. In essence, a color profile defines both the Color Space used and tells software how the device's data may deviate from the precise definitions expected by the Color Space. That's one reason why "profile" and "space" get so mixed up in descriptions of color. More information on this is on my Web site at: <http://www.bythom.com/qadcolor.htm>.

If you have doubts about whether you've got the right settings in each of your programs, shoot a standard color reference in known lighting with the proper white balance setting, such as the GretagMacbeth ColorChecker chart in sunlight with the camera set to the **Direct sunlight** white balance setting. Then watch for shifts in color as you bring the resulting image through your workflow. If your monitor is calibrated correctly and your programs set to the right color space settings, you shouldn't see *any* color shifts from original to on-screen final version.

Setting Color Spaces in the Camera

📷 To set the Color Space your camera uses:

1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).
3. Use the Direction pad to navigate to the **Color space** item and press the ► key on the Direction pad or the **OK** button to select it.



4. Use the Direction pad to navigate to the Color Space you wish to use and press the **▶** key on the Direction pad or the **OK** button to select it.



Setting Color Spaces and Profiles in Your Software

But simply setting a Color Space in camera isn't always enough to get perfect color. You also have to set the Color Space in your software.

Moreover, slight variances in device abilities can cause them to deviate from the defined Color Space. Thus we often “profile” a particular device. That's exactly what we do with our monitors when we use a calibration tool such as Pantone's Huey or Colorvision's Spyder.

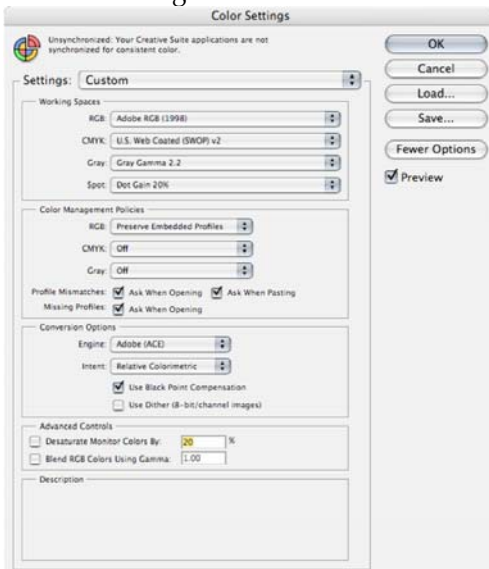
Color profiles are where color management gets a bit confusing. For example, when you calibrate your monitor with Colorvision's hardware or software (or any of the alternative choices—I use Colorvision as an example because its low price and decent quality make it a good match for most D90 users), what happens? Well, Colorvision's software alters information that your video driver uses to send signals to your monitor. For example, if the Colorvision Spyder detected that your monitor wasn't producing enough blue, it would alter the video driver to produce “more blue” in colors sent to the monitor.

However, the video driver changes only occur for what I'll call “color aware” programs on Window, while virtually all Macintosh programs use the value set in ColorSync and are automatically color aware. Photoshop, for example, is color

aware and the profiled monitor settings the Colorvision makes and installs are used when you're viewing pictures on your display.

You do have to set some values in your software programs, though. Let's start with Photoshop CS3 and Color Space settings (older versions of Photoshop have similar choices):

1. In Photoshop, select **Color Settings** from the **Edit** menu.
2. On the pop-up for **Working Spaces**, select **Adobe RGB (1998)** (or the Color Space you set on the camera; or, if you're a Lightroom user, you might want to set **ProPhoto RGB**).
3. Under **Color Management Policies**, select **Preserve Embedded Profiles** and check all the boxes that begin with **Ask...**



Other Programs pose different problems and require us to make additional settings. Nikon Capture NX2 on Windows, for example, *isn't* automatically color aware! Even on a Macintosh you'll want to check what's set: Choose **Preferences** and use the **Color Management** tab to see

what's being used:



*Note: Nikon has their own Color Space definitions, and yes, they are very subtly different from the ones Adobe supplies (note the name **Nikon Adobe RGB 4.0.0.3000** in the above screen shot versus the name **Adobe RGB (1988)** in the Photoshop CS3 screen shot, above). If you're paranoid and use both Capture NX2 and Photoshop CS3, you can use the same Color Space definition in both products (i.e. both options should appear in the pop-up list).*

Be sure to select the printer profile that is for your printer and paper if you want to soft proof in Capture NX2.

Fine Tuning the Color

In this abbreviated color management lesson we only suggested that you *profile* your monitor. In general, once you've done this and set your working Color Spaces in your software correctly, you should be able to take a picture with known colors in it and follow it all the way through to print without seeing any major deviations.

Note the word "major" in the last sentence. If you *do* see a big color shift, something isn't set right and you shouldn't try to proceed until you've corrected whatever's wrong. It might simply be that you got the white balance wrong while shooting or selected a non-default paper while printing. But major deviations of color at this point would usually indicate that you've set something wrong in the color management dialogs or haven't correctly profiled your monitor (or have

dueling profiles, as sometimes happens when you've got Adobe Gamma loading at startup.)

If you *can* follow color from camera to print and get good-but-not-perfect results, you probably see very minor color shifts that you want to correct. My advice: isolate whether the shift occurs camera-to-computer or computer-to-printer. If you see both, work on the camera-to-computer side first.

You should be able to shoot a known color source, such as the GretagMacbeth ColorChecker chart using a custom white balance and see the correct colors on your monitor. I haven't seen differences in color rendering between different D90 bodies, so I generally don't find that profiling the camera is useful, as even small white balance issues will more grossly affect color than individual camera variation. Thus, camera-to-computer color shifts are almost always the result of incorrect settings on your computer software (e.g. Color Space doesn't match what the camera set).

Once your camera-to-computer color issues are resolved and you get repeatable, accurate results on the display, then and only then work on the print side. First, examine all the options for your printer driver and make sure that one of those doesn't "fix" your problem.

More often than not, selecting the right paper and ink choices are all that it takes to get close (especially on Epson inkjets using Epson papers). If you use custom papers or inks, you may have to profile your printer, which is out of the realm of this book (but do go to <http://www.inkjetmall.com> and look at their paper/ink/profiles; these are as accurate as you can make on your own).

Another thing to look for is that only one program or driver is doing the color correction for printing. If you print from Photoshop, for instance, it's possible to set your system up so that both Photoshop and your Epson print driver are both trying to handle color correction. Check the various Epson

printing articles on Michael Reichmann's site (<http://www.luminous-landscape.com>) for some help in dialing in the right options so that only one program is managing color.

Finally, you need to learn about "soft proofing." My Epson inkjet printer can't really reproduce some of the blues my camera can capture, for example. By having the right paper profile set in my software and turning soft proofing on, I can see this while editing, and attempt to adjust for it.

*Tip: **Advanced users only.** Technically, the sensor of the D90 doesn't have a Color Space, because it should "capture" any color of light that hits the photosites within the spectral range that it allows through. (It would need a color profile, though, because there may be some anomalies in the capture process and spectral linearity.)*

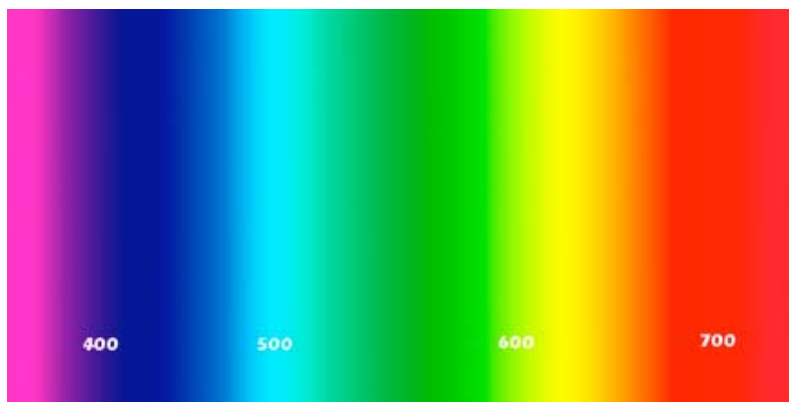
*Many pros believe that if you shoot raw files (NEF), you should use the largest possible Color Space possible when working on those images. That would be **ProPhoto RGB**. Indeed, many pros (and Lightroom and Aperture by default) set their raw conversion software to this or a similar Color Space in order to preserve every last bit of color accuracy and subtlety. (You don't need to, and can't, set the camera to this Color Space, just your software. But that only works for NEF files.)*

*In practice, though, most amateurs needn't go to that trouble (**ProPhoto RGB** chews up computer memory and may slow you down, amongst other things), as the Epson inkjets most people typically print with won't reveal any tangible differences. That's because the Epson printers have a Color Space very similar to AdobeRGB. Still, even the Epson printers do have a bit of color ability that's outside the AdobeRGB space, so if you're into getting the maximum possible quality, you might want to explore ProPhotoRGB.*

Special Lighting Issues

UV and Infrared

Most of the visible light spectrum seen by humans is between 400 and 700 nanometers (nm) in wavelength. Very roughly speaking, blue pixels are generated from information in the 400 to 500nm span, green pixels from the 500 to 600nm area, and red pixels from data in the 600 to 700nm range. Yet, over half the light (energy) that reaches our planet's surface is outside this limited spectrum. At the low end, you'll find ultraviolet light, while at the higher wavelength values lays the infrared.



The visible and near visible spectrum goes from UV (left) through blue, green, and eventually red, up to near IR (right).

The D90's sensor is barely sensitive to light outside the visible spectrum. Each successive Nikon DSLR seems to be less responsive to UV and infrared, with the D3 being the least sensitive to date. The D90 isn't quite as bad as the D3, but it's close. Thus, the D90 isn't the best candidate for either type of shooting—the D100 is much more responsive to these light ranges than the D90. That's not to say that you can't use a D90 for UV or IR photography, but expect to get very long exposures when you do so.

Ultraviolet

Most glass used in lenses does a poor job of transmitting ultraviolet light through to the imager. That, coupled with the low sensitivity to ultraviolet of the sensor makes taking ultraviolet images difficult, though not impossible.

Nikon made a special lens, the 105mm UV Micro-Nikkor f/4.5, specifically for lab work that needed a lens that efficiently passed low wavelength light to the film plane (and also did so without needing focus adjustments). Couple this lens, which passes 70% of the light from 220 to 900 nanometers, with a filter that blocks the visible spectrum and you can take some very interesting pictures.

Indeed, one Scandinavian photographer, Bjørn Rørslett, has specialized in doing just that (see <http://www.naturfotograf.com/index2.html>). Coupling a Hoya U-360 filter that blocks the visible spectrum with a Tiffen Hot Mirror filter to hold back the infrared spectrum slightly, he takes what he calls “invisible images” using his Nikon bodies. (You can also use a Nikon FF or a Wratten 18A to block visible light, by the way.) Note that if you try to duplicate his work with a regular lens, you’ll find that exposure times are exceedingly long on a D90 (as I noted earlier, most glass in regular lenses isn’t very efficient in passing ultraviolet light, and the D90 isn’t very responsive to UV, either). You may have to fiddle with focus adjustments, as well (lenses are generally optimized to focus only the visible spectrum at the film plane). If you really get into UV photography, note that Nikon made a UV lens, the 105mm UV Micro-Nikkor f/4.5, and a UV flash, the Speedlight SB-140, which, though hard to find, would allow you to take your experiments indoors, as well.

Still, the bottom line is simple: if you’re really into UV shooting, get a different Nikon DSLR, preferably one of the first generation models (D1 series or D100). As Bjorn notes in his reviews of recent Nikon DSLRs, they just aren’t very

responsive to UV, making using them for such work very frustrating, at a minimum.

Infrared

At the other end of the light spectrum, the D90 does a marginally better job at the near infrared spectrum.

Most photographers associate infrared images with the grainy, moody black and white photos generated by Kodak's old infrared film. You can duplicate those with your D90, too. Typically, you'd place a Wratten 89B filter on your camera (and later use Photoshop to make the conversion to grayscale).

The D90's meter is inaccurate for near infrared photography (white balance should be set normally), so you may want to bracket until you find the right exposure for the filter you use. Since you're filtering out a fair amount of light and have a camera that isn't terrifically receptive to near infrared, you'll certainly end up with tripod-inducing shutter speeds. The Hoya filter I use removes virtually all the visible spectrum, and I find that I have to add significant exposure to what the meter recommends, and end up with exposures measured in seconds no matter what aperture and ISO I use.

If you want to duplicate the grain aspect of Kodak's infrared film, set one of the two highest ISO values on your camera with noise reduction set as low as you can make it—the D90's noise pattern is relatively chroma free, so you'll get a grainy-type of rendering that's very appropriate.

The exact wavelength at which light is filtered varies considerably in filters labeled as "Infrared." The visible spectrum ends at about 780 nanometers (and the near-infrared is usually said to start at that point), but "infrared" filters are available to start filtering anywhere from 610 to 1000 nanometers. To add to the confusion, different filter makers use different designations for the filter point. Here's a table of some of what's available:

<u>Filter</u>	<u>Cutoff</u>	<u>Manufacturers</u>
RG 610	610 nm	Heliopan
RG 630	630	Heliopan
RG 645	645	Heliopan
RG 665	665	Heliopan
RG 695	695	Heliopan
89B,BW092	710	Kodak, B&W, others
RG 715	715	Heliopan
88A		Kodak, others
87, RG 780	780	Heliopan, Kodak, others
87C, RG830, BW093	830	Heliopan, B&W, Kodak
RG 850	850	Heliopan
RG 1000	1000	Heliopan

Tip: If you want the false-color infrared associated with Kodak's near-infrared slide films, you can use another technique: stack polarizing filters!

If you're an infrared junkie, you probably would like to get rid of the hot mirror filter over the sensor and replace it with a visible spectrum blocker (like the above filters). This would let you use the camera almost normally, but the camera would *always* take near IR pictures instead of visible light pictures (i.e. once converted, the camera isn't usable for normal photography).

Well, if you want to throw caution to the wind, you can make such a modification: <http://www.lifepixel.com> has the details on how it's done, but note that this is major surgery and, done incorrectly, will render your D90 useless. Fortunately, they also offer a modification service. I had one of my D70's converted this way, and carry this extra body with me when I want to do infrared photography. Here's what a picture taken with my converted camera looks like:



Iguazu Falls, Argentina. I've pulled the little bit of color out of the original IR image to make it strictly a black and white image, but otherwise haven't done any other processing. Note how the blues (sky, river) have gone dark, while the greens (foliage) have gone white.

Shooting Under Fluorescent Lighting

Fluorescent lighting makes it particularly difficult to photograph well. Not only is the method used to create the light different than most other light sources, but also there is considerable variance between fluorescent tube manufacturers. Fortunately, Nikon did something about this last by adding support for different types of bulbs in the **Fluorescent** white balance setting (*Tip*: remember that you can use Live View to set white balance, so to find the right fluorescent setting just use Live View!).

Heat produces the light emitted by the sun, incandescent bulbs, halogen bulbs, and most other sources. Heat-generated light has the property of emitting a continuous spectrum of colors, though the balance of these colors is different for various sources (which is one reason why the white balance setting for sunlight is different than for incandescent light, for example). Another property of most light emitters is that their

color balance is relatively stable (e.g. two brief measurements of color temperature taken a second apart would be virtually the same).

Fluorescent lights are neither heat-produced nor color stable. Fluorescent light is produced by periodically striking an ultraviolet arc. The arc is on for about 2 milliseconds, then decays for 2 to 3 milliseconds, then is completely off for 3 to 4 milliseconds; this pattern repeats approximately 120 times a second (in the US; 100 times a second in the UK and Europe, or double the AC frequency). The arc, in turn, excites colored phosphors within the tube, which are what actually emit the visible light. Unfortunately, red, blue, and green phosphors react in differing fashions to the triggering arc. Green phosphors, for example, tend to react quicker and decay slower in reaction to UV triggers, while red phosphors are slow to react and decay quickly.

If you take photographs with shutter speeds faster than 1/125 either early or late in a fluorescent light's cycle, your images show an additional green cast. If you take photographs at shutter speeds faster than 1/125 midway through a fluorescent light's cycle, resulting pictures tend to get an additional magenta cast. That's in addition to any overall cast the tube may have (again, fluorescent color balances vary from manufacturer to manufacturer). Thus, there are two rules to follow when shooting under fluorescent light with a D90:

- *Use either the specific fluorescent setting that matches the lights (determined via Live View) or a **Preset manual white balance**.* If you shoot under the same lighting all the time, shoot a Macbeth Color Checker chart under the lighting using all variants from -3 to +3 for fluorescent white balance, then examine the neutral gray patches for color casts; if one of the variants has little or no color cast, use that white balance setting in the future. Better still, use one of the dedicated white balance presets to record the actual value and name it for the venue.

- *Shoot only at shutter speeds that are multiples of 1/120* (e.g. 1/125¹³⁸, 1/60, 1/30, 1/15, or in Europe 1/100, 1/50, 1/25). Never use shutter speeds faster than 1/125 (or 1/100 in Europe). Shutter speeds that are not multiples of the AC cycle means that you don't get complete color decays from one or more of the phosphors.

¹³⁸ I've had people report to me that even 1/125 isn't always safe (the shutter speed *should* be 1/120 to match the AC frequency in the US). I haven't had problems with this shutter speed, so I suspect that it has to do with the specific fluorescent bulbs encountered.

Other Field Shooting Issues

Keeping the Sensor Clean

Probably the most difficult aspect of using a D90 in the field is keeping the sensor clean. To minimize the need to clean the sensor, you should:

- *Minimize lens changes, especially in dusty environments.* Each time you change lenses, you expose the mirror box area, and ultimately the sensor, to the elements.
- *If you can, change lenses with the front of the camera pointed downward.* Dust settles downward, thus if you point the front of the camera upwards while changing lenses, you increase the possibility of dust getting into the mirror box.
- *Use the built-in cleaning function.* Set **Clean image sensor** (SETUP menu) to run when you turn the camera off, or use it periodically.
- *Keep the camera in the bag.* Assuming you keep your camera bag clean, each ring of protection you can put around the D90 can decrease the chance that dust gets anywhere near the sensor. In dusty Africa, when I'm not using a camera body, I put it in a plastic bag (with the air removed), and then place the plastic bag in my camera case. Then I put my coat over the camera case. I also make sure that the sensor orientation during travel is downwards, so that any dust already in the camera settles on the back of the shutter, not the sensor.

Dust appearance in images is aperture related. At very large apertures (e.g. f/1.4), you won't see the dust in your images. At small apertures (e.g. f/32), it often appears as a nearly in-focus black dot.

Still, even with the utmost care you may find that the sensor collects dust. To examine your D90's sensor for dust, use one of these methods:

- *Take a picture of an evenly lit surface* (like a wall or the sky) at the lowest ISO value using the smallest available aperture (e.g. f/22). Examine the resulting image carefully on your computer at 100% size, looking for dark spots. Some D90 users run the resulting image through Photoshop's **Auto Levels** command, which tremendously exaggerates the dust pattern.
- *Set the camera to Bulb* (or a 30 second exposure). Remove the lens and trip the shutter so that the mirror moves out of the way. Shine a light into the mirror box so that you can see the surface of the filter that sits over the sensor (tip: use an LED headlamp, like those sold at camping stores). Significant dust can usually be seen using this method, but most of the smaller stuff is beyond your ability to see (to put size in perspective, several hundred photosites would occupy the space on this -).

If you use Capture NX2, it is possible to use what Nikon calls a “dust reference photo” to perform a software “dust removal.” Here’s how it works:

1. Before taking your photos for a session, make a dust reference photo. Make sure the camera has a lens on it that has a CPU (i.e. no manual focus or older non-D-type autofocus lenses).
2. Press the **MENU** button to see the menu system.
3. Use the Direction pad to navigate to the SETUP menu (yellow wrench icon).
4. Use the Direction pad to navigate to the **Image Dust Off ref photo** option and press the ► key or the **OK**

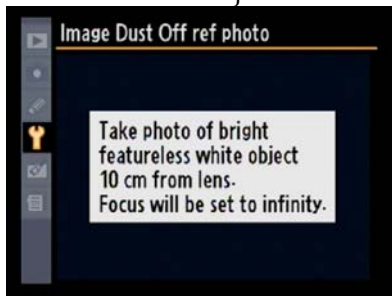
button to select it.



5. Use the Direction pad to one of the options and press the ► key or the **OK** button to select it. Normally you'd want to clean the sensor before starting, the second choice:

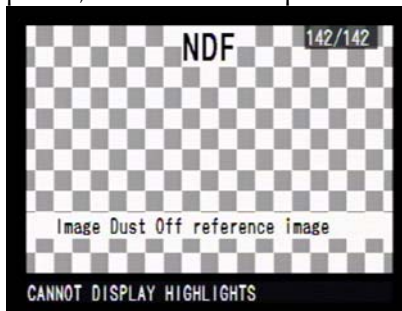


6. Follow the instructions on the display, which instruct you to take a picture of a white object (card or sheet of paper) 10cm (4") from the front of the lens. Fill the frame with this object.



7. Press the shutter release. If you get the message **INAPPROPRIATE EXPOSURE CONDITIONS** followed by the instructions in Step 6 repeated, the image wasn't good enough; make sure that you've got

enough light and are only seeing the white card and try again. Otherwise, you'll end up with a reference photo, which shows up like this on playback:



8. When you edit your image using Capture NX2, make sure the **Image Dust Off** tool in the **Camera & Lens Corrections** section of the **Develop** step is enabled and that the proper dust off photo is in the same directory as the one you're trying to correct.

While not perfect, this function does work well enough to keep your cloning and post-processing fixes to a minimum, but it's not a replacement for sensor cleaning. You're sacrificing some detail using this function *and* dust will continue to build up on the sensor, which means that, short of taking a reference photo for every image you make, it may not correct every defect. Moreover, at some point there will be a dust particle that resists being corrected in this fashion. I should also point out that the Capture NX2 tool has a maximum number of dust particles it can fix; once your sensor gets past certain "dustiness," you'll find that Capture NX2 refuses to correct images.

Note: If you see dust in the upper left corner of your image, the actual dust is in the lower left corner of the sensor as you face it. Remember, the lens reverses up for down to the sensor (software in the camera flips it around so you see the image in the correct orientation).

📷 The D90 has a built-in ability to do modest dust removal from the filter over the sensor by shaking it:

1. Press the **MENU** button to see the menu system.
2. Use the Direction pad to navigate to the SETUP menu (yellow wrench icon).
3. Use the Direction pad to navigate to the **Clean image sensor** option and press the **►** key to select it.



4. Use the Direction pad to navigate to the **Clean now** option and press the **►** key to select it.

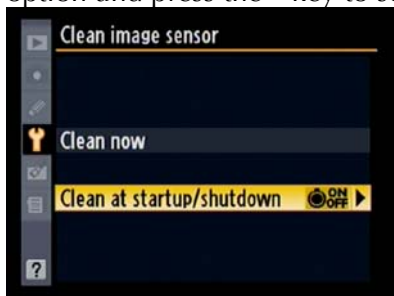


5. There will be a brief pause during which **Cleaning image sensor** is displayed, after which the camera will report that the cleaning has been completed.



6. This is a good time to decide how you want this automatic sensor cleaning to be performed in the

future (the default is **Cleaning off**). Use the Direction pad to navigate to the **Clean at startup/shutdown** option and press the ► key to select it.



7. I personally prefer **Clean at shutdown**, but if you're in dusty conditions, consider using **Clean at startup & shutdown** instead. Use the Direction pad to navigate to your choice and press the ► key to select it.



Assuming that you still have dust on the sensor after using the built-in function, there's not a lot else you can do about it in the field (trying to remove the dust in an environment where dust may still be present can prove to be a very futile endeavor). So the dust reference photo technique is worth using as a stop-gap measure until you can get back to an environment that is more conducive to cleaning.

Note: If you see dust in the upper left corner of your image, the actual dust is in the lower left corner of the sensor as you face it. Remember, the lens reverses up for down to the sensor (software in the camera flips it around so you see the image in the correct orientation).

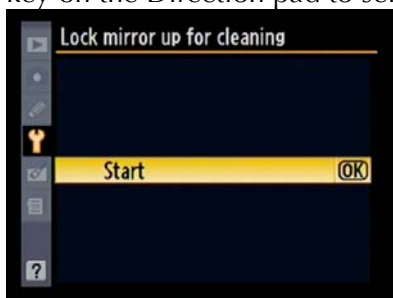
📷 If you're in a reasonably clean environment and have an EH-5a AC adapter or a fully charged battery, to clean the sensor¹³⁹:

1. With the camera off, if you're going to use AC power plug the EH-5a adapter into the camera (and into an AC wall socket. Better yet, use an UPS [*uninterruptible power supply*]). I strongly suggest that you have a fully charged battery in the camera, as well.
2. Remove the lens.
3. Turn the camera on.
4. Press the **MENU** button to bring up the menu system.
5. Use the Direction pad to navigate to the SETUP menu (yellow wrench icon).
6. Use the Direction pad to navigate to **Lock mirror up for cleaning** and press the **▶** key on the Direction pad to select it.

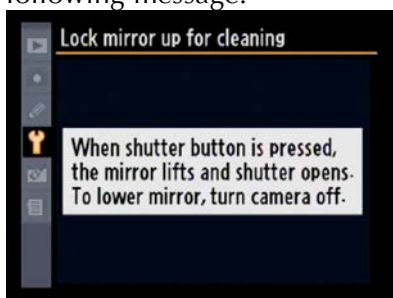


¹³⁹ A slightly more elaborate description of sensor cleaning is on my Web site at <http://www.bythom.com/cleaning.htm>. There I describe the two commercial methods I use here—Sensor Brush and Sensor Swabs—but do-it-yourselfers can create their own versions of each. For a brush you need a soft nylon brush that is free from additives and glues (try makeup counters and art supply stores). For a swab support, use a narrow Rubbermaid spatula cut to size or a soft plastic or wood stick (I use artist palette knives found at a local art store). The swab material needs to be lint-free, soft material, such as PecPads. However, do-it-yourselfers should read the disclaimer on the Copyright page (i.e. I won't be responsible for damage to your camera). The commercial solutions work well, and in the case of Sensor Swabs, there's a damage-free guarantee that's worth noting.

7. Use the Direction pad to navigate to **Start**. Press the **▶** key on the Direction pad to select it.



8. Hold the camera so that dust won't resettle on the sensor or back in the mirror box. You should see the following message:



9. Press the shutter release to raise the mirror and open the shutter curtain, revealing the sensor.
10. Use a manually powered bulb blower to blow out any large chunks of grit (usually hairs).
11. Use a Sensor Brush to swipe across the sensor area (remember to "recharge" the brush before each pass using compressed air)

or

If the problem area doesn't come off with brushing, then use a Sensor Swab wet with E2 solution (see <http://www.photosol.com>)¹⁴⁰.

12. Remove your tools from the camera and turn the camera off. The shutter curtain should close and the mirror should return to its normal position.
13. Remount the lens on the camera.
14. Unplug the EH-5a AC adapter.

Note: Anecdotal evidence seems to indicate that dust is more easily removed from a cold sensor. I wouldn't advocate putting your D90 in a refrigerator prior to cleaning, though, as condensation becomes an issue. It probably is wise to avoid cleaning the camera immediately after it has been used, though, as the components are probably still warmer than the surrounding environment. This is especially true if you've used the camera for Live View or D-Movies. Also, if you can postpone a cleaning until you're in a cooler environment (e.g. an air-conditioned building in warm climes), you'll probably find it easier to clean your sensor.

If these methods fail to remove the dust, you'll need to have a Nikon service center clean your camera. Remember, Nikon specifically disclaims use of any method that touches the filter array on top of the sensor. I'm describing the methods that most of us pros have resorted to because we simply can't keep returning the camera to Nikon for cleaning every time our sensors get dirty (we'd never have use of our cameras!).

*Caution: If you use **Lock mirror up for cleaning** with a fully charged battery, the camera will start to shut down when battery power reaches three bars in the top LCD indicator (a full battery shows five bars). In theory, the camera*

¹⁴⁰ Yes, Nikon's documentation says don't touch the sensor. But Sensor Swabs are similar to the method they use to clean the sensor. Heck, Nikon even sells cleaning kits in Japan. Don't get the cloth too wet [you'll leave streaks], and don't use force in cleaning [you could grind dirt into the filter face or break the filter]. And, again, I won't pay to have your sensor replaced if you use this technique and damage your camera. If you're not comfortable using this technique at your own risk, then don't use it.

beeps and blinks the AF Assist lamp to warn you that it needs to close the shutter. Nikon's manual claims that you'll have about two minutes from the first warning until the shutter actually closes. I think that in practice, the warning is closer to the actual shutter close. I find that the shutter consistently closes in a bit less than 90 seconds on my D90, and it could be battery dependent (i.e. a battery that doesn't hold 100% charge but only 90% when fully charged would act differently).

Personally, I will only use battery powered mirror lockup for cleaning as a last resort, and then only after thoroughly charging a battery. The risk is that you still have your cleaning tool inside the camera when the shutter tries to close. This will dislodge the shutter blades, rendering your camera inoperative. While I lobbied for this feature to be added to the camera, I repeat, it's a last resort option because of the increased risk of damaging the camera. Use it at your own risk.

Toppling a Myth

Dust clings to the filter array in front of the sensor not so much because the sensor puts out a static charge, but more because of the laws of gravity and surface tension. If you store your D90 on its back, gravity will have its way, and as the inevitable dust in the air settles, it'll settle downwards onto the filter surface. If you store the D90 on its bottom, the sensor still manages to "grab" a few small dust particles due to the mechanics of surface tension. Generally, dust that sticks to the filter this way is easily removed with light bursts of plain air (the blower bulb). If possible, the best storage position for a D90 is lens-mount down.

Worst Case Scenario

Many years of experience with digital SLRs in the field has led me to this conclusion: humidity changes are your worst enemy when it comes to dust.

What happens is one of two things: (1) any slight dampness (condensation) on the filter will tend to increase the surface tension dynamics and literally suck dust right up to the filter;

or (2) dust already on the filter gets a light condensation on top of it, which “welds” the dust to the filter.

Either way, when the humidity lowers and the water vapor dries up, it tends to act as a “sealing coat” on top of the dust. In really bad conditions you may even see a faint ring (dried water) *around* the dust spot on your images (I call these dust zits). This kind of dust problem is very difficult to clean, as you have to use both strong wetting and some pressure to remove them. I learned this one the hard way by coming down from the cold dry air at 10,000 feet on a Hawaiian volcano to the warm moist air in a garden at sea level in the space of an hour. Not only did it take another couple of hours to rid the condensation out of my lenses, viewfinder, and elsewhere, but it was as if I had baked the dust onto the filter. It took me several tries to get the dust off.

Temperature Considerations

Several temperature-related issues when using a D90 should be noted:

- *Image noise increases with heat.* With long exposure times in hot climates, you’ll sometimes see some random bright pixels in your images (“hot pixels”¹⁴¹). If you shoot in hot climates or use Live View for long periods of time, you might want to look for ways to keep the D90 cool. Be careful of introducing condensation problems by moving the D90 from very cool to very warm conditions, however. If the temperature is over 80°F (27°C) and you shoot images at 8 seconds or longer, consider turning the **Long exp. NR** function **On** (SHOOTING menu). This captures the noise pattern and subtracts it from your image.
- *Batteries don’t like cold.* Lithium-Ion batteries such as the ones the D90 use *do* have decent cold weather

¹⁴¹ A “hot” pixel is one that is simply stuck, while a “dead” pixel is one that is totally non-responsive.

performance, but it's still possible in extreme cold for the battery to fail quickly. Keep a fully charged spare warmed up in an inside coat pocket and swap batteries as needed.

Humidity

Nikon's manuals have several warnings about exposing the camera to high levels of humidity. If you live in a humid climate, it is probably wise to store the camera in a cool, dry area, or with a desiccant in a plastic bag from which the air has been removed.

Changes in humidity can play a part in sensor cleanliness, as I've already noted. When condensation forms on the filter, it tends to trap dust particles. Moreover, you can get small "water rings" on the sensor. In general, it pays to be careful when moving the camera from warm to cold or cold to warm environs, especially if there's any moisture present in the air.

The trick with dealing with temperature and humidity changes is to remove the air surrounding the camera. Place the camera body in a zipper lock bag and remove as much of the air as possible before sealing it (same with each of your lenses).

White Balance Settings

With Nikon Capture NX2 (and other raw conversion programs that understand the D90's white balance information), D90 users who shoot NEF format images can retroactively apply white balance settings to an image, so many tend to think that they can ignore white balance completely.

White balance intersects with other digital imaging color issues on a D90. First, the photosites covered with blue filters are effectively less sensitive to light than the green or red ones. In low light conditions, this can be troublesome, especially if you're shooting in a situation where little or no blue wavelengths are present in the first place. At one extreme, you get noise in the channel that has little light energy hitting it; at the other end you can get a blown channel because too much light hit it. Since the histograms

are created from the embedded JPEG in NEF images and the camera’s white balance setting is used for that JPEG, setting a “wrong” white balance can produce misleading histograms. If you shoot NEF images, use the correct white balance setting or at least a white balance of **Auto**.

Second, many of Nikon’s choices for white balance settings are slightly suspect—either Nikon knows something about the photosite sensitivity and color rendering that they haven’t told users about, or they’ve chosen values based upon visual review, or the actual color temperature values reported in the manual are inaccurate¹⁴².

Consider the following table:

White Balance Color Temperatures

<i>Lighting</i>	<i>D90</i>	<i>Film</i>	<i>Likely*</i>
100-watt incandescent	3000K	3200K	2900K
Sunny daylight (noon)	5200K	5400K	5400K+
Overcast	6000K	5400K	7000K+
Flash	5400K	5400K	<6000K
* Source: Nikon Field Guide, typical color temperatures			

Using Nikon’s defaults (either in the camera or after the fact with Nikon Capture NX2) tends to produce slightly warm (red) indoor color, and a slightly cool (blue) outdoor color. Outdoors, many Nikon users tend to use an **a2** adjustment to the named white balance setting they’re using (e.g. **Cloudy a2**). Indoors, many just let the camera do its thing, as a bit of warmth is usually preferred.

Personally, I like having a reference setting, regardless of how I set my D90. With a reference, I can use Photoshop’s color controls to correct any remaining bias. How do you establish a reference? I carry a Kodak gray card and a GretagMacbeth ColorChecker with me whenever possible, and I take a shot with both cards in the scene whenever the lighting changes

¹⁴² Or, I suppose, they could have just gotten it wrong.

significantly (it's okay to take this shot using **JPEG fine**, by the way—it's one way I identify my color check file, since all the other files have NEF versions). If I want to use **White balance preset** white balance, then I set it using the gray card.

Of course, you don't *always* want to correct for color temperature! One reason why sunrise and sunset scenes look red (or orange) to us is that the color temperature is extremely warm, approximately 3100-3600K depending upon the exact timing of the shot and atmospheric conditions. We perceive it as warm because the change occurs so rapidly (prior to sunrise the color temperature may be 7000K or higher) and the blue wavelengths are generally filtered out by the extra atmosphere the light has to get through. In such cases, you'd want to set the camera's white balance to **Direct sunlight** and shoot normally, lest you lose the very aspects of the light that intrigued you in the first place.

But probably the most difficult white balance situation to deal with is mixed sources that include frequency-based lights (fluorescent, mercury vapor, carbon arc, etc.). As I noted earlier, you need to set your shutter speed to match frequency-based lights (e.g. 1/60 for fluorescent lights in the US), lest you introduce color errors due to phosphor decay. But that may not be enough. Ask yourself these questions:

- *Which lighting type dominates?* In mixed source situations, try turning the sources on one at a time and taking a meter reading. One source is likely to dominate, and that should usually be the one you use as your base white balance setting.
- *Can you overpower the lighting?* A strong flash comes in handy in mixed lighting situations, as you can often make your flash the primary light source (at least if your subject is less than 20 feet (~6m) away. In this case, make flash your white balance setting. Your subject will look correct, but the background may now look very wrong because it's lit by another light source (incandescent would

produce orange backgrounds, fluorescent an obnoxious blue green). That's one reason why most location photographers use multiple light setups. They either turn off the background lighting or they overpower it. With multi-flash TTL now possible, I tend towards turning off the source lighting and using my own, if possible. Three SB-800's and the internal flash can light a pretty large area plus subject.

- *Will a filter balance errant color?* If the problem is a mix of flash and fluorescent, or even incandescent and fluorescent, the primary problem is the fluorescent light. Try using an FLD filter (or a 30M), as the primary problem with most fluorescents is going to show up as too much magenta. With mercury vapor in the mix, you want to cut out red, so a 30R should be tried. (Anything more than 30 units of filtration starts to become a major problem with the other light sources; indeed, I'd probably try 10M or 10R first.) Many professional photographers carry filter gels for their flash—essentially they try to filter the flash that they *add* color to the scene to match that of the existing light so that a **Preset manual** white balance works better.

If you've got an SB-600, SB-800, or SB-900, you can get a mini filter set for the flash that helps. In this case, you set white balance for the ambient lighting and then pick an appropriate filter for the flash head so that it (nearly) matches the ambient (the amber filter for incandescent, the green filter for fluorescent).

- *Are the lighting sources lighting distinctly different areas of the scene?* If you are using flash to light the subject and fluorescent is lighting the background, you can sometimes use Photoshop's layering to select the background and color correct it after the fact. In short: set up the shot so that you have distinct areas that can be selected and color corrected.

Shooting Video with Your D90

Let's get the bad news out of the way real quick: the D90 isn't an exceptional video camera. I'm going to have to qualify that statement and explain it, but the bottom line is that in almost every aspect that's important to achieve high quality video, Nikon has made a compromise that will get in your way. Some of them you can work around, some will cause you grief.

A better way to think about the D-Movie mode of the D90 is this: you can record the Live View capture in a format that plays like a movie. Yep. That's harsh, but it's the truth.

Live View is a little different than you might first guess, and this difference is important to understand when it comes to movies. While the D90's sensor is 4288 x 2848, the D90's video is 1280 x 720 maximum, and the D90's color LCD is basically a 640 x 480 monitor. Getting the impression that something might be lost in the translation(s)?

You betcha. Quite a bit as it turns out. I'll cut to the bottom line now and get to some details later: the D90 uses the sensor differently in Live View (and thus D-Movie) mode than it does for stills. For stills, the shutter is mechanical and all pixels are utilized. For Live View and D-Movie, the shutter is electronic (part of the sensor) and not all pixels are utilized. This has all kinds of quality implications that we'll have to work through.

First, though, we need to talk about video.

The D90 is touted as an HD video camera. If you've shopped for an HD television, you probably already realize that we need a lot more definition than "HD" to specify what the D90 is doing.

Here in the US, most television networks and stations have mostly standardized on one of two of the many possible HD

definitions. In particular, you'll see references to 720P and 1080i. The numbers in those nomenclatures tell you the vertical resolution, the letters tell you how that vertical resolution is achieved:

- P** *Progressive*: all vertical information is provided for every frame
- i** *Interpolated*: half the vertical information is provided with each alternating frame (two alternating "fields" make a frame)

So, while 1080 is a larger number than 720 and indicates a higher vertical resolution, P indicates a better *temporal* resolution, as your brain gets all the information for a frame at once rather than in two interlocking pieces. Indeed, US TV networks that have a heavy sports content tended all to pick 720P as their HD standard so that motion effects work more consistently with the way our brain does, while networks that were more drama oriented tended to pick 1080i as their HD standard. In theory, 1080P would be a better choice than either (and it's what you might get with, say, a Blu-ray disc and the proper television), but the amount of data transmitted per second of video is higher with 1080P than it is for 1080i or 720P. Bandwidth costs networks real money, so they've compromised on lower-than-possible standards.

By way of comparison, the old NTSC standard used in the US for television is 648x486, and it does this with interpolated frames (two 648x243 fields), so it has less temporal resolution, too.

I've already noted that the D90's video resolution is 1280 x 720, so you've probably already guessed that the D90 is a 720P device. You'd be correct. While the D90 doesn't do the highest possible linear resolution possible for HD video, it does a very high temporal resolution. I personally wouldn't characterize 720P or 1080i being "better" than the other. For some things one is better than the other, for other things it isn't. Here's the comparison in table form:

<i>Resolution</i>	<i>NTSC</i>	<i>720P</i>	<i>1080i</i>
Horizontal	648	1280	1920
Vertical	486	720	1080
Temporal	Interlaced	Progressive	Interlaced
<i>For those of you in areas where PAL is used, it is 720 x 486 interlaced.</i>			

That's the good news. One bit of bad news is that it appears that the D90's vertical and horizontal resolution is compromised somewhat by the way in which it is produced. Diagonals on a very slight angle tend to produce "gaps", for example. It appears that the video mode (Live View) is sub-sampling the sensor. Instead of looking at all photosites to produce the final image, it is looking at every n th photosite. Actually, to get the RGB data, it's more accurate to say that the D90 is looking at a block of photosites spaced every n photosites apart.

Thus, while the D90 does produce HD video, it isn't perfectly crisp HD video. Very fine detail can be compromised.

Another aspect of the D90's video is the frame rate. Here in the US we use 59.94 scans per second for our televisions, which for interlaced video results in an effective 29.97 frames per second (often rounded to 30 fps). The D90 produces 24 frames per second. Persistence of vision—the phenomena that produces our brain's interpretation of continuous motion in a stream of frames—requires something on the order of 18 frames a second to trigger fully, so the D90 certainly produces image streams that we'll perceive as continuous.

But higher frame rates are generally perceived differently by our brains than lower frame rates. Feature films are recorded at 24 frames per second and have one "look," video is presented to us as 30 fps and has a different look, and some high end systems—such as IMAX—use even higher frame rates and trigger entirely different perceptions.

One of the things that was jumped on by aspiring filmmakers when the D90 was announced was that 24 fps frame rate. Coupled with the high resolution nature of the individual frames, it was hoped that the D90 would become the “poor man’s filmmaking camera.” Indeed, the 24 fps output of the D90 does have that classic feature film look to its motion. But it may not have as much resolution as those filmmakers wanted.

Moreover, the 24 fps poses a bit of an issue for anything other than direct playback on a computer. If you wanted to *broadcast* the D90’s output or put into a regular DVD, the frame rate has to be converted. As with feature films, the normal method of doing this would be what’s called a “3:2 pulldown”¹⁴³, which introduces a bit of unevenness to the motion. Anyone trained in filmmaking can easily spot film-to-video conversions versus regular video because of this.

The actual “video” that the D90 records is called Motion-JPEG. Motion-JPEG consists of a stream of JPEG images. In the case of the D90, it places this stream into an **.AVI** file container along with the audio stream recorded from the camera’s built-in microphone (there were other options here, such as Quicktime [**.MOV**]).

The good news about Motion-JPEG is that almost any software that edits videos recognizes this format and the container that Nikon chose to put it in. Thus, on a Mac, even iMovie can edit a D90 movie file. The bad news is that Motion-JPEG files tend to be larger than the other common HD formats, such as AVCHD or MPEG-4. On a D90 set to record 720P, the video

¹⁴³ Basically you need to put 24 progressive frames into 60 interlaced frames. The method by which this is done is to place progressive frame 1 into interlaced fields 1 and 2 (the first interlaced frame), progressive frame 2 into interlaced fields 3, 4, and 5, progressive frame 3 into interlaced fields 6 and 7, and so on. This 2:3 relationship continues until all 24 original frames comprise 60 final fields (30 interlaced frames). The “pulldown” nomenclature comes from the original method of how this was done: special film projectors pulled down a frame from a film reel into the projection area and held it for two video fields, then did the same for the next frame of film for three video fields, and so on.

will chew up about 100MB of card space a minute. Put another way, a 2GB card will hold about 20 minutes of video.

The D90 will record up to five minutes of 720P video at a time. The five-minute limit appears to be due to tariffs applied in Europe to “video cameras”—the time limit keeps the D90 from being considered a video camera. Also, because recording video tends to generate unwanted heat, the D90 will shut down if you exceed its heat tolerance. While the Live View mode has a specification of 60 minutes of continuous use, what I find in practice is that you can get about half that amount of video recorded before the camera does its shutdown thing. When it does, you’ll need to give the D90 about fifteen minutes rest to recover.

Believe it or not, we’re not even close to done with describing limitations and the not-so-great things about the D90’s video abilities.

Next on our list is the “rolling shutter.” I spoke of “frames” earlier, and that the D90 records 24 of them a second in D-Movie mode. You probably imagined them like 24 still pictures strung together, as that’s what the file format essentially is. But a “frame” is not recorded all at once on a D90 (or on any other CMOS consumer camcorder, either). Instead, the frame is recorded in pieces, from top to bottom. First we grab the top line of the “frame,” then we grab the second line, then the third line, and so on until we’ve completed grabbing the full frame. Then, and only then do we put it all together into the frame that is stored in the **.AVI** file.

But what happens if something moves while we’re recording that “frame”? Well, then the top part of it will be recorded with the subject in one position, the bottom might record the subject in a different position! The shutter is called a rolling shutter because the part that’s exposed “rolls” from one portion of the frame to another to another.

Here’s what that looks like:



Indeed, the rolling shutter on the D90 explains two of the artifacts that occur in your videos: skew and wobble.

Skew happens when you pan with a moving object. Depending upon the speed and motion of the objects in the frame, they'll skew (tilt) one way or the other from their normal position:



Not skewed



Skewed

The amount of the skew depends upon the speed of the pan or object. Basically, skew means vertical objects lean. How much they lean is based upon speed. Thus, you can avoid objectionable skew by not panning quickly or by not recording very fast moving objects.

Wobble is a little more troublesome. Wobble usually happens when the *camera* is moving quickly and/or erratically, as it might when you handhold it. It's possible for the motion of the camera to outrace the rolling shutter, causing stretching of an object. The "wobble" part comes when one recorded

frame has a stretched version of the object and the next doesn't. It's difficult to capture this impact in a still, but you can get individual frames that have artifacts in them (look at the arms):



Wobble also has a relative called “jello.” This is where you move back and forth across an object quickly and the object seems to wobble back and forth so much that it looks like the object is made of Jell-O and gyrating in ways that solid objects don't.

Wobble can be reduced quite a bit by putting the camera on a tripod and by avoiding back and forth pans. But if the tripod gets bumped or you're in high winds, a tripod isn't going to stop the wobbles. VR also usually helps reduce wobble.

Even small amounts of skew or wobble can be problematic if you're trying to imitate George Lucas and go all Star Wars with your videos. If you need to do special effects—say combine a moving object in front of a green screen with some computer generated effects that replace that green screen in the final frame—a rolling shutter is going to make your life miserable.

A final problem with rolling shutters is “partial exposure.” Let's assume that you're contentedly using your D90 to shoot video at your friend's wedding reception when the wedding photographer comes in and snaps a shot using his flash. Since it's unlikely that the photographer's flash is synced with your video frames, what happens is a portion of your frame is recorded without the flash and a portion with:



Note how the exposure changed half way down the shirt.

Fortunately, only one frame is usually impacted by this problem when a sudden flash of light occurs during your recording, but it is visually jarring nonetheless. In the old jargon of filmmaking, we call these “hot frames.” Hot frames intrude on our brain’s method of tricking us into thinking we’re seeing reality on the screen.

Before moving on, let me summarize some of the things you can do to minimize the problems the rolling shutter can add to your videos:

- Try to avoid shooting movies where flash or strobes are being used.
- Keep the D90 on a stable tripod.
- Avoid fast pans.
- Avoid shooting fast moving subjects.
- Use lenses that have VR and make it active when handholding the camera.
- Never pan back and forth quickly.
- Use subjects with little motion if you are going to combine the video with special effects.

While that list seems a little daunting at first, it’s an attempt to *completely* avoid rolling shutter artifacts. As I noted earlier, consumer camcorders use such shutters, too, so it’s not as if the D90 is alone in having these problems¹⁴⁴. But the notion that the D90 is a *professional* video camera is a little over the top because of this (and more, we’re not done!).

¹⁴⁴ Though I should note that there is a variability in the way rolling shutters are designed. I’d place the D90 more towards the highly problematic rolling shutter cameras than the less problematic ones.

The D90 has a built in microphone on the front of the camera (just above and to the left of the D90 nameplate as you look at the camera from the front). It lives behind three small holes, and actually is reasonably good in terms of picking up nearby sound. But note that the D90 is monaural, not stereo, and that the microphone is also good at picking up camera handling sounds. The actual format is 16-bit monaural, recorded at 11Khz sampling rate. This is a rather low quality level (audio CDs are sampled at 44Khz), but an okay choice for the spoken voice. Just don't think that the D90 is going to be recording high quality audio of that band you're filming.

Moreover, you probably will be handling the camera. For one, when recording video, the D90 does not autofocus. You'll need to manually focus the camera while recording video (though you can get an initial focus point using Live View prior to starting recording). Remember that microphone? It's awful close to the lens and where you hand is likely to be when focusing. You'll have to be careful not to do things that the microphone will pick up.

Another thing that doesn't happen during making a movie is that the aperture doesn't vary, and the shutter speed varies in a narrow range. Exposure during video recording is done by what is essentially the Auto ISO function: the camera varies its sensitivity (and sometimes shutter speed a bit) when the exposure in the scene needs to change. This has the impact of making for choppy exposure changes, as the ISO is not varied continuously, but in those third-stop increments that Auto ISO uses.

The list of compromises is starting to get pretty long, isn't it? I don't consider the D90 a serious video camera. I consider it a still camera that just happens to be able to do some modest video work. If you can live within the limitations the D90 imposes on video, you'll be happy. It actually is capable of producing some impressive looking video when handled properly and used within the limits of what it can do. But if you think that it is a full replacement for your camcorder,

you're probably wrong. Your camcorder has abilities and features that make it more convenient than the D90.

Still want to take some video? Great. It's easy:

1. Press the **LV** button to enter Live View.
2. Press the **OK** button to start recording video.
3. Press the **OK** button again to stop recording video.

Okay, that's the simplistic instruction set. Let's expand on that so that we minimize as many of the D90 video issues as possible:

1. Before we start trying to record video, let's set Custom Setting #F4 to **AE lock (hold)**. We do this because most of the time we don't want the D90 jerking exposure around. Even a minor exposure change in the scene can trigger a choppy-looking one-third stop ISO adjustment.
2. Set Custom Setting #C2 to a very long value (consider 30 minutes). We do this because if we actually use the **AE-L/AF-L** button to hold exposure, we don't want to lose that lock because the meter times out while we're twiddling with things between scenes (the single button press "lock" only lasts until the meter times out).
3. Set the aperture you wish to use (apertures and beginning ISO values must be set prior to entering Live View).
4. Press the **LV** button to enter Live View.
5. Set your white balance, if you haven't already. (Live View allows you to see the impact of the white balance setting, so in tough light conditions it sometimes is easier to just visually adjust white balance.)
6. Use the Direction pad to move the focus box to the area you want focus to be initiated at. (You can hold down the **AF** button and rotate the Rear Command dial to change the type of focus being done.)

7. Press the shutter release partway down to initiate focus.
8. Press the **AE-L/AF-L** button to lock exposure. (If you really want the camera to try to compensate for exposure during the scene, you can skip this step, but remember, the camera will make choppy adjustments.)
9. Press the **OK** button to start recording video. The camera will start a countdown indicator on the color LCD to tell you how much of the five minutes of video you can record are left.
10. If the subject moves while recording, manually follow focus.
11. Press the **OK** button again to stop recording video.

Even this isn't good enough for the really serious video shooters. Remember, exposure adjustment is normally done for video by changing the ISO, and the serious video shooters want to force the camera to use the lowest possible ISO value and stay there. To do that, they need to use a fast lens that has an aperture ring:

1. Set Custom Setting #F4 to **AE lock (hold)**.
2. Set Custom Setting #C2 to a very long value (consider 30 minutes).
3. Put a lens with an aperture ring on the camera. Set the ring on the lens to the smallest aperture for the time being.
4. Set Aperture-priority exposure mode.
5. Set the ISO to your desired value.
6. Set a mid-range aperture, such as f/8 or so.
7. Point the camera at a very well lit bright white wall or object and:
 - a. Press the shutter release partway to establish exposure.
 - b. Press the **AE-L/AF-L** button to lock that exposure.

8. Press the **LV** button to enter Live View.
9. Point the camera at your scene.
10. Set your exposure visually by using the aperture ring on the lens! Ignore the **FEE** error on the top LCD (curiously, so will the camera while recording video).
11. Set your white balance, if you haven't already.
12. Focus.
13. Press the **OK** button to start recording video. The camera will start a countdown indicator on the color LCD to tell you how much of the five minutes of video you can record are left.
14. While recording, if the subject moves, manually follow focus.
15. Press the **OK** button again to stop recording video.

As you can tell, we're having to jump through a lot of hoops to get much control over what the camera does. We use a bright source in Step 7 to keep force a low ISO, mid-range aperture exposure, then we manually override the aperture part in Step 10 while the camera should be keeping the low ISO steady due to the exposure lock.

Realistically, the D90 needs a number of refinements to be what we need it to be for the highest possible quality video.

One thing I haven't covered is Picture Controls. Yes, they are active when recording video on the D90. That means you can choose to do a black and white (monochrome movie) or one with vivid colors and everything else that you can do with Picture Controls. Just remember to set your Picture Controls prior to entering Live View.

Tip: Don't use much sharpening. High levels of sharpening produces ghosts and black edges on moving subjects in the D-Movie mode. Indeed, I think the most "film-like" movies on the D90 are produced using no sharpening, which makes for a softish frame but mimics old-school Hollywood

films (because they tended to use fast lenses at maximum aperture due to the fact that quality film stocks weren't available in high ISO speeds).

I've been assuming that you want to record the best possible movie with your D90, but it is possible to set lower quality levels:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the SHOOTING menu (green camera icon).
3. Use the Direction pad to navigate to **Movie settings** and press the **▶** key on the Direction pad or the **OK** button to select it.



4. Use the Direction pad to navigate to **Quality** and press the **▶** key on the Direction pad or the **OK** button to select it.

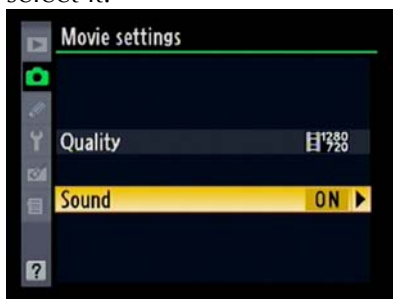


5. Use the Direction pad to select the quality you wish to record and press the **▶** key on the Direction pad or the

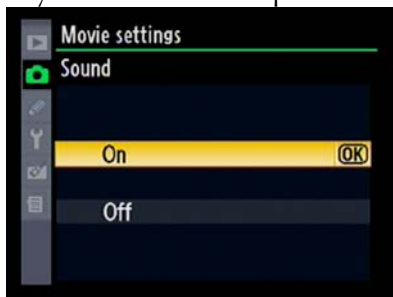
OK button to select it.



6. Use the Direction pad to navigate to **Sound** and press the **▶** key on the Direction pad or the **OK** button to select it.



7. Use the Direction pad to navigate to **Off** if you don't want to record sound with your movie and press the **▶** key on the Direction pad or the **OK** button to select it.



	1280x720	640x424	320x216
Type	720P HD	~VGA	~Half VGA
Aspect ratio	16:9	3:2	3:2
Storage	~100MB/min	~30MB/min	~15MB/min
Limits	5 minutes per clip	20 minutes per clip	20 minutes per clip
<i>Note that there is a 2GB size limit to any video clip.</i>			

After You've Taken Pictures or Video with Your D90

In this section I'll present an overview of some of your post-shooting options that involve the camera. That includes in-camera corrections, connecting to a computer, printing images, and using television hookups to see your images.

Post-processing done on a computer has been broken out to the new Introduction to Nikon Software eBook that came with this Complete Guide.

Things You Do After the Shot or Video is Taken

You've followed my advice so far and now have a Secure Digital card full of images and videos you've shot. What's next?

The primary things you do with your images and videos boil down to:

- *Transfer them to your computer.* Because your images and videos are digital, they fit right into the computer world, at least once you get them there. On your computer, you can modify, annotate, email, and print your images and videos, amongst other things. Your computer in essence

becomes your scrapbook and your desktop darkroom and movie editor. See “Transferring Your Images and Video to Your Computer” on page <721> and read *Introduction to Nikon Software* (on this eBook’s CD).

- *Print them.* That’s what you used to do with your film images, and you can do the same with your digital images. You don’t need a computer to print your images, by the way—plenty of other methods exist, including direct from camera to printer (PictBridge). See “Printing Your Images” on page <724>.
- *Show them.* The D90 has the ability to present a slide show of images, and it further has the ability to present this slide show on a television monitor. See “Slide Shows” on page <742>. Or, for HD movies, you can hook the D90 to an HDMI connector on your television and view them. See “Television Playback” on page <739>.
- *Modify them.* The D90 has a number of in-camera features that allow you to modify images you’ve already taken. See “The Retouch Menu” on page <684>.

We’ll tackle each of these things individually in this section of the book.

The Retouch Menu

Nikon includes the RETOUCH menu on the D90, but they’ve added a number of new items to it from previous cameras. The RETOUCH menu allows you to make a number of changes to your images, *after you’ve taken them*. Normally, you’d use a computer and a photo editing program—such as Lightroom or Photoshop—to make changes to your images, but the D90 brings a set of basic editing tools to the camera.

Before I get to describing each of these tools, let me give you a word of advice: for the ones that change color, I’d tend to avoid them. The primary reason is that the color LCD on the camera is just too small and inaccurate to make critical image post processing decisions. The good news is that the camera always creates a new image while making changes, leaving your original intact, but if you still have to end up using that

original to make fine-tuned changes, well, I don't see that you've gained anything by doing a "quick-and-dirty" edit in the camera.

You might wonder about what happens to EXIF data when you create these new images from existing ones. Simple: the camera copies the EXIF data from the image being used (in the case of **Image overlay**, from the first image). It also adds another EXIF data point indicating the type of retouching done and a new field with that data on the final image review page:



Also note that the filename changes from the form of **DSC_####.JPG** (or NEF) to **CSC_####.JPG** (that's how the original and modified version can coexist yet still be recognizably linked: the number stays the same, but the prefix changes).

Okay, you've decided that you want to explore the camera's image manipulation capabilities anyway, so let's look at the options one by one.

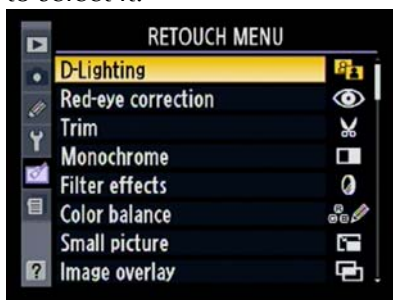
D-lighting

Nikon uses the trademarked term "D-lighting" to describe a process whereby the tonality in the shadow areas of an image are changed to show more detail. It's similar in action to Photoshop's **Shadow/Highlight** function, though the camera's built-in version only impacts the shadow areas (highlights are maintained as is).

D-lighting is also a function in Nikon Capture NX2. Capture NX2 has additional options and setting flexibility that the camera does not (another reason for not performing this function in the camera).

To use D-lighting, you must first take a picture. That picture needs to be color (i.e., you can't apply this to black and white images shot with the D90), and can be NEF or JPEG. D-lighting's effects will be more obvious with underexposed images or images with large darker areas of exposure.

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the **RETOUCH** menu (purple paintbrush icon).
3. Use the Direction pad to navigate to **D-lighting** and press the **▶** key on the Direction pad or the **OK** button to select it.



4. You'll be presented with thumbnails of twelve images at a time. Images with a yellow  icon cannot be retouched (this includes videos).

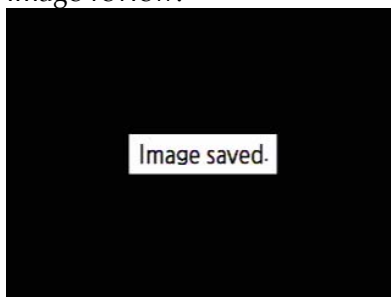


- a. Use the Direction pad keys (or Rear Command dial) to navigate to the image you wish to work with.
 - b. Use the Zoom In button (⌕) to see the currently selected image in full screen size.
 - c. Press the **OK** button to select the image you wish to change.
5. The camera now shows two examples of the image. On the left you'll see the original, while on the right you'll see how the modified image appears.



- a. Use the ▲ and ▼ keys on the Direction pad (or Rear Command dial) to change the level of D-lighting you wish applied: **Low**, **Normal**, **High**.
 - b. Use the Zoom In button (⌕) to see the modified image in full screen size.
 - c. Press the □ button to cancel the process and *not* create a modified image.
 - d. Press the **OK** button to start the creation of the modified image.
6. After pressing the **OK** button in Step 5, the camera will display an hourglass icon for a moment to indicate that it is creating a modified image according to your instructions. After a few moments, you'll see an **Image saved** message and be returned to normal

image review.



The modified version of your image will appear with a special icon (paintbrush):



Red-eye correction

A better method than using the red-eye reduction function on the flash (see “Setting Flash Options” on page <556>) is to remove red-eye after the fact. Red-eye correction is also a function in Capture NX2, so you don’t need to perform this function in camera.

To use **Red-eye correction**, you must first take a picture *using flash*. That picture also needs to be color (i.e., you can’t apply this to black and white images shot with the D90, nor can you apply it to images that weren’t taken with flash), and can be NEF or JPEG.

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the RETOUCH menu (purple paintbrush icon).

3. Use the Direction pad to navigate to **Red-eye correction** and press the **►** key on the Direction pad or the **OK** button to select it.



4. You'll be presented with thumbnails of twelve images at a time. Images with a yellow  icon cannot be retouched (this includes videos and stills that were taken without flash).



- a. Use the Direction pad keys (or Rear Command dial) to navigate to the image you wish to work with.
 - b. Use the Zoom In button () to see the currently selected image in full screen size.
 - c. Press the **OK** button to select the image you wish to change.
5. The camera looks at the image and tries to detect red-eye. If it does not, it will report **No red-eye detected** and you'll be returned to Step 4.

Otherwise, the camera will display an hourglass icon for a moment to indicate that it is creating a modified

image according to your instructions. After a few moments, you'll see the new image and be offered to review and/or save it.

Review:



Zoomed:



The modified version of your image will appear with a special icon (paintbrush):



Trim

Sometimes you'll take a picture that covers more area than you want in the final image (for example, you couldn't get closer to your subject or didn't have a long enough telephoto lens). Eventually, you'll want to crop that image to get rid of the extraneous parts. The D90 allows you to do that in

camera (though with some size constraints that might not match what you want to do).

To use **Trim**, you must first take a picture. That picture can be NEF or JPEG, black and white or color.

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the RETOUCH menu (purple paintbrush icon).
3. Use the Direction pad to navigate to **Trim** press the **▶** key on the Direction pad or the **OK** button to select it.



4. You'll be presented with thumbnails of twelve images at a time. Images with a yellow  icon cannot be retouched (this includes videos).



- a. Use the Direction pad keys (or Rear Command dial) to navigate to the image you wish to work with.
- b. Use the Zoom In button () to see the currently selected image in full screen size.

- c. Press the **OK** button to select the image you wish to change.
5. The camera now shows two examples of the image. The full screen is the “cropped” version, while the smaller yellow framed area shows you how your crop is made from the larger, original image (i.e., the yellow outline shows the current trim position).



- a. Use the Zoom In (⌂) and Zoom Out (⌂) keys to change the amount of trim you wish applied. Note that Nikon has a backwards notion of what “zoom in” and “zoom out” are: to zoom in the trim area you have to press the Zoom Out button! For a full-sized image you have the options of: **3424x2568**, **2560x1920**, **1920x1440**, **1280x960**, **960x720**, and **640x480** at the 3:2 aspect ratio, **3424x2280**, **2560x1704**, **1920x1280**, **1280x856**, **960x640**, and **640x424** at the 3:2 aspect ratio, and **3216x2568**, **2400x1920**, **1808x1440**, **1200x960**, **896x720**, and **608x480** at the 5:4 aspect ratio.
- b. Use the Direction pad keys to move the area being trimmed.
- c. Press the  button to cancel the process and *not* create a modified image.
- d. Press the **OK** button to complete the trimming process.

6. After pressing the **OK** button in Step 5, the camera will display an hourglass icon for a moment to indicate that it is creating a modified image according to your instructions. After a few moments, you'll see an **Image saved** message and be returned to normal image review.

The modified version of your image will appear with a special icon (paintbrush):



Monochrome

While the D90 has the ability to shoot black and white images directly (see “Picture Controls” on page <330>), you can also create them after the fact using this function.

To use **Monochrome**, you must first take a picture. That picture needs to be color (i.e., you can't apply this to black and white images shot or created after the fact with the D90), and can be NEF or JPEG.

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the RETOUCH menu (purple paintbrush icon).
3. Use the Direction pad to navigate to **Monochrome** and press the **►** key on the Direction pad or the **OK**

button to select it.



4. Use the Direction pad to navigate to one of the three types of black and white images that can be created and press the **►** key on the Direction pad or the **OK** button to select it. **Black-and-white** is a straight conversion, **Sepia** is a warm-toned conversion, and **Cyanotype** is a cool-toned conversion.



5. You'll be presented with thumbnails of twelve images at a time. Images with a yellow  icon cannot be retouched (this includes videos).



- a. Use the Direction pad keys (or Rear Command dial) to navigate to the image you wish to work with.

- b. Use the Zoom In button (Q) to see the currently selected image in full screen size.
 - c. Press the **OK** button to select the image you wish to change.
6. The camera now shows an example of the converted image.



Press the **OK** button to begin the change process.

7. After pressing the **OK** button in Step 6, the camera will display an hourglass icon for a moment to indicate that it is creating a modified image according to your instructions. After a few moments, you'll see an **Image saved** message and be returned to normal image review.

The modified version of your image will appear with a special icon (paintbrush):



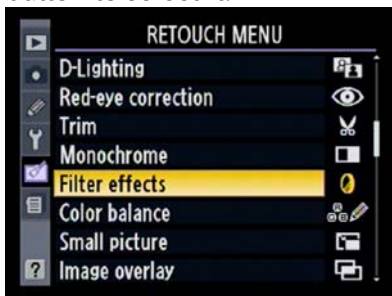
Filter Effects

A very interesting retouching tool is the Filter Effects option. This allows you to change the color balances or add starbursts in the image using one of several techniques:

- **Skylight filter**—this option places a slight “cool” color cast on the image, with an emphasis on the *slight*.
- **Warm filter**—this option places a slight “warm” color cast on the image, again with an emphasis on the *slight*.
- **Red intensifier, Green intensifier, Blue intensifier**—Allows you to add saturation to specific colors.
- **Cross screen**—adds a starburst effect to the highlights.

To use **Filter effects**, you must first take a picture. That picture needs to be color (i.e., you can’t apply this to black and white images shot with the D90), and can be NEF or JPEG.

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the **RETOUCH** menu (purple paintbrush icon).
3. Use the Direction pad to navigate to **Filter effects** and press the **►** key on the Direction pad or the **OK** button to select it.



4. Use the Direction pad to navigate to one of the filter options and press the **►** key on the Direction pad or

the **OK** button to select it.



5. You'll be presented with thumbnails of twelve images at a time. Images with a yellow  icon cannot be retouched (this includes videos).



- a. Use the Direction pad keys (or Rear Command dial) to navigate to the image you wish to work with.
 - b. Use the Zoom In button () to see the currently selected image in full screen size.
 - c. Press the **OK** button to select the image you wish to change.
6. The camera now shows an example of the image, as modified. For **Skylight filter** and **Warm filter** your only choices are to cancel or save the change (Steps 6c and 6d, below).



Intensifiers:

Use the Direction pad keys to increase or decrease the intensity, then press the **OK** button to complete the action.



Cross screen:

Navigate to each of the submenus on the right side to your options, then navigate to **Confirm** and press the **OK** button to apply them. Navigate to **Save** and press the **OK** button to complete the action.



Filters:

Press the **OK** button to complete the action.

7. After pressing the **OK** button in Step 6, the camera will display an hourglass icon for a moment to indicate that it is creating a modified image according

to your instructions. After a few moments, you'll see an **Image saved** message and be returned to normal image review.

The modified version of your image will appear with a special icon (paintbrush):



Color Balance

One of the most interesting of the RETOUCH menu options, **Color balance** allows you to use the CIE two-dimensional color space to change the colors in your image. The range of change is very high here and fully under your control. If you know what you're doing with two-dimensional color representations, you can change colors in your image to match just about any style you'd like.

Note: On some earlier Nikon DSLRs, including the D80, this function lived in the **Filter effects** menu.

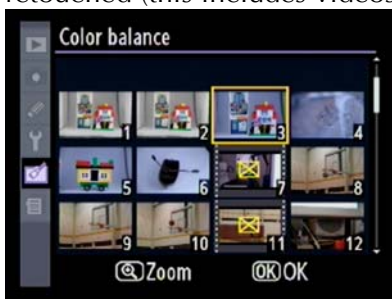
To use **Color balance**, you must first take a picture. That picture needs to be color (i.e. you can't apply this to black and white images shot with the D90), and can be NEF or JPEG.

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the RETOUCH menu (paintbrush icon tab).

3. Use the Direction pad to navigate to **Color Balance** and press the **▶** key on the Direction pad to select it.



4. You'll be presented with thumbnails of twelve images at a time. Images with a yellow  icon cannot be retouched (this includes videos).



- a. Use the Direction pad keys (or Rear Command dial) to navigate to the image you wish to work with.
 - b. Use the Zoom In button () to see the currently selected image in full screen size.
 - c. Press the **OK** button to select the image you wish to change.
5. The camera now shows an example of the image, along with the two-dimensional color space. Use the Direction pad keys to move the black square that marks the color shift you wish (here taken into the greens), then press the **OK** button to complete the

action.



- After pressing the **OK** button in Step 5, the camera will display an hourglass icon for a moment to indicate that it is creating a modified image according to your instructions. After a few moments, you'll see an **Image saved** message and be returned to normal image review.

The modified version of your image will appear with a special icon (paintbrush):



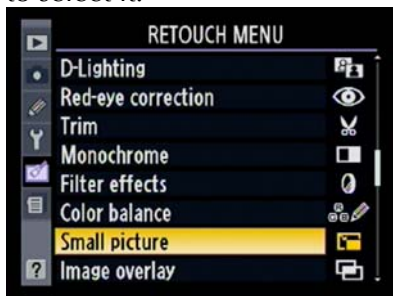
Small Picture

At first, you may think that this option is like **Trim**. It isn't. The difference is that **Trim** *crops* and image while **Small picture** just creates a smaller version of the *full* image.

To use **Small picture**, you must first take a picture. That picture can be NEF or JPEG, black and white or color.

- Press the **MENU** button to show the menu system.
- Use the Direction pad to navigate to the RETOUCH menu (purple paintbrush icon).

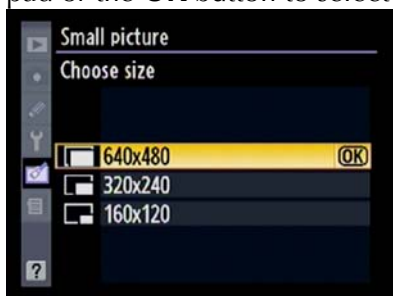
3. Use the Direction pad to navigate to **Small picture** press the ► key on the Direction pad or the **OK** button to select it.



4. Use the Direction pad to navigate to **Choose size** and press the ► key on the Direction pad or the **OK** button to select it.



5. Use the Direction pad to choose the size image you wish to create and press the ► key on the Direction pad or the **OK** button to select it.



6. Use the Direction pad to navigate to **Select picture** and press the ► key on the Direction pad or the **OK** button to select it. *Note: despite the name, you*

actually get to select *pictures*, not a single picture!



- a. You'll be presented with thumbnails of twelve images at a time. Images with a yellow  icon cannot be retouched (this includes videos).



- i. Use the Direction pad keys (or Rear Command dial) to navigate to an image you wish to create a smaller version of.
- ii. Use the Zoom In button () to see the currently selected image in full screen size.
- iii. Use the Thumbnail/Zoom Out button () to select or deselect images you wish to create smaller versions of. A "smaller picture" icon is placed on each image you select.
- iv. Press the **OK** button to complete selection of the images you wish to change.

7. The camera now shows the following display:



- a. Use the Direction pad to navigate to **Yes**.
 - b. Press the **OK** button to complete the new image creation process.
8. After pressing the **OK** button in Step 7, the camera will display an hourglass icon for a moment to indicate that it is creating a modified image according to your instructions. After a few moments, you'll see an **Image saved** message and be returned to normal image review.

The modified version of your image will appear with a special paintbrush icon. All images created with this option also appear with a gray border around them on the color LCD to indicate that they're a smaller size than the picture took.



Image Overlays

The D90 has an in-camera facility for creating composite images. Things to note about this function:

<i>Number of shots:</i>	2 only
<i>Image Format:</i>	Pre-shot NEFs are used to create a finished JPEG or NEF
<i>Auto Gain:</i>	No; you can adjust the gain and preview the final effect of the overlay
<i>Image Quality settings:</i>	Are applied from current settings
<i>EXIF Data:</i>	Is applied from first image to the final “overlaid” image

Here’s how to use image overlays:

1. Shoot two images you’d like to combine. Make sure that these are in NEF format.
2. Press the **MENU** button to show the menu system.
3. Use the Direction pad to navigate to the RETOUCH menu (purple paintbrush icon).
4. Use the Direction pad to navigate to **Image overlay** and press the **▶** key on the Direction pad to select it.



5. You'll see an overlay preview screen. The first image area (**Image 1**) should be highlighted:

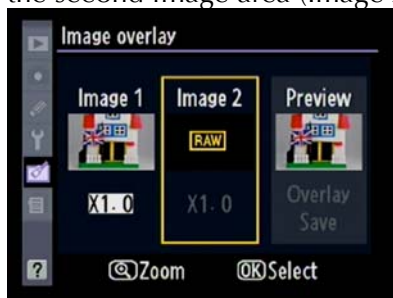


- a. Press the **OK** button to show the NEF images on your card.



- b. Navigate to the image you want to use as your base image.
- c. Press the **OK** button to use that image as **Image 1**.
- d. Use the ▼ and ▲ keys on the Direction pad (or Rear Command dial) to adjust the “gain” for **Image 1**. A value of 1.0 means use the exposure as is. A value of 0.5 would mean to use half the normal exposure, a value of 2.0 uses twice the exposure. You can set values between 0.1 and 2.0 for each image.

- e. Press the **▶** key on the Direction pad to select the second image area (Image 2).



- f. Once again press the **OK** button to show the NEF images on your card. Navigate to the image you want to use as your second image (**Image 2**).



- g. Press the **OK** button to use that image as **Image 2**.
 - h. Use the **▼** and **▲** keys on the Direction pad (or Rear Command dial) to adjust the “gain” for **Image 2**.
6. You may use the Direction pad to navigate back and forth between the two images to adjust the gain for the two images. At any time you can press the Zoom In button (**⌂**) to get a full screen version of the currently selected image.
 7. When you’re satisfied with the images selected and the gains assigned them, use the **▶** key on the Direction pad to navigate to the Preview image (right-

hand image):



- a. Navigate to **Overlay** and press the **OK** button to see a full screen preview of the effect prior to saving.
 - b. Or navigate to **Save** and press the **OK** button to complete the effect.
8. It'll take a few seconds to combine the images, and during that time an hourglass appears over the screen to indicate that the camera is working at combining the images. When complete, it'll be as if you shot an image with the camera (e.g. if you have Image review **On**, you'll see the image on the color LCD as if it had just been taken by the camera; image data for the EXIF fields is taken from the first image).



Note: If you try to combine a vertical and horizontal image, the camera will ignore the difference in rotation when combining the two images. However, as you can see from the above example, the camera will pick up the rotation of the first image and use that for the final image (that's because rotation is in the EXIF data!).

The question you're probably asking yourself is this: is there a reason to use the overlay function? Maybe. It seems to me that the strongest use of this function would be for the classic moon + landscape sandwich. This allows you to use a wider lens for the landscape and a more telephoto lens for the moon (to make it a bigger object in the sky). This would work best if the sky were truly black so that you aren't adding sky exposure into the moon (and the moon's sky exposure into the landscape).

Another possibility is to shoot a person against a black background and have them talk to themselves (e.g. one pose on one side of the image and a second one on the other side). Instant twins!

But the function is interesting enough to provoke play on my part. Usually you'll want detail in one picture where there is only a plain area in the other (and vice versa), but that's not universally true, so experiment. One thing this function is great for is creating Halloween ghost pictures. Try it next Halloween when you take pictures of your kids in costume!

(What makes me think some wedding photographer is going to pull all of the above on some unsuspecting bride? 😊)¹⁴⁵

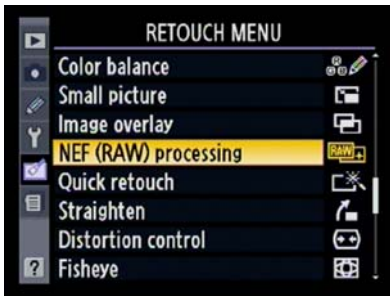
Processing NEFs

The D90 has the ability to process NEF images in the camera. This might be helpful if you're shooting NEFs in the field and someone asks you for a JPEG copy: you can create that on the fly in the camera:

1. Remember, you need to have shot an image in the NEF format for this process to work.
2. Press the **MENU** button to show the menu system.

¹⁴⁵ Okay, they will, guaranteed. At one of my workshops in the ghost town of Bodie, we ran into a wedding there (turns out you can rent the church for such occasions for US\$500, in case you're interested). I won't describe all the crazy shots the photographer was taking, but let's just say that she was way *beyond* creative.

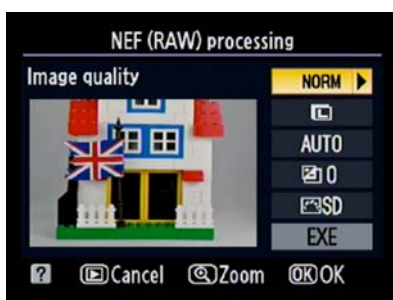
3. Use the Direction pad to navigate to the RETOUCH menu (purple paintbrush icon).
4. Use the Direction pad to navigate to **NEF (RAW) processing** and press the **►** key on the Direction pad to select it.



5. You'll see the D90's standard pick-an-image screen. Use the Direction pad keys or Rear Command dial to navigate to the image you wish to process.



6. You're taken to the processing screen. On the left is your image as it will appear with the processing. On the right are five sub-menus from which you can choose from. From top to bottom, they represent: JPEG quality, JPEG size, white balance, exposure compensation, and Picture Control.



For each of these options, use the ▲ and ▼ keys on the Direction pad to navigate to one you wish to change, then the ► key to enter the sub-menu for it. Press the **OK** button to set an option and return to the screen shown above.

7. When you've completed all your changes, navigate to **EXE** (short for "execute") and press the **OK** button.



The modified version of your image will appear with a special paintbrush icon.

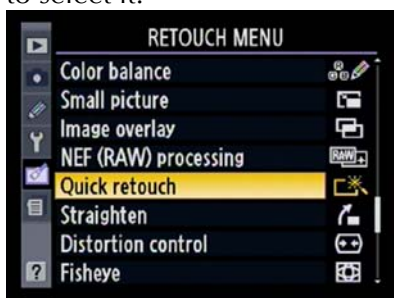


Quick Retouch

You can change your mind after the fact for color saturation with your images. The **Quick retouch** option allows to create a variant with more or less color saturation.

To use **Quick retouch**, you must first take a picture. That picture can be NEF or JPEG, but it must be in color.

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the RETOUCH menu (purple paintbrush icon).
3. Use the Direction pad to navigate to **Quick retouch** press the **▶** key on the Direction pad or the **OK** button to select it.



4. You'll be presented with thumbnails of twelve images at a time. Images with a yellow  icon cannot be retouched (this includes videos).



- a. Use the Direction pad keys (or Rear Command dial) to navigate to the image you wish to work with.

- b. Use the Zoom In button (⌕) to see the currently selected image in full screen size.
 - c. Press the **OK** button to select the image you wish to change.
5. The camera now shows two examples of the image. The left one is the original version, while the right one shows the retouched version. At the bottom of the right image is a sub-menu that is controlled by the ▲ and ▼ keys on the Direction pad and which controls the range of the saturation change.



Press the **OK** button to complete the retouching process.

6. After pressing the **OK** button in Step 5, the camera will display an hourglass icon for a moment to indicate that it is creating a modified image according to your instructions. After a few moments, you'll see an **Image saved** message and be returned to normal image review.

The modified version of your image will appear with a special icon (paintbrush):



Straighten

Sometimes you'll notice that after the shot you didn't quite get the camera straight. You can fix that after the fact (up to a point, as you'll soon see).

To use **straighten**, you must first take a picture. That picture can be NEF or JPEG.

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the RETOUCH menu (purple paintbrush icon).
3. Use the Direction pad to navigate to **Straighten** press the **▶** key on the Direction pad or the **OK** button to select it.



4. You'll be presented with thumbnails of twelve images at a time. Images with a yellow  icon cannot be retouched (this includes videos).



- a. Use the Direction pad keys (or Rear Command dial) to navigate to the image you wish to work with.

- b. Use the Zoom In button (Q) to see the currently selected image in full screen size.
 - c. Press the **OK** button to select the image you wish to change.
5. The camera now shows the image, along with some crop lines to help you assess if the image is straight. At the bottom of the image is a straightening control that is controlled by the ◀ and ▶ keys on the Direction pad. Note the yellow indicator on this indicator bar (in the example below, it is all the way to the right but we still haven't quite straightened the image: you can only change the image by about 5°, in quarter degree increments).



Press the **OK** button to complete the straightening process.

6. After pressing the **OK** button in Step 5, the camera will display an hourglass icon for a moment to indicate that it is creating a modified image according to your instructions. After a few moments, you'll see an **Image saved** message and be returned to normal image review.

The modified version of your image will appear with a special icon (paintbrush):



Still leaning tower or Thom

Distortion control

Many lenses have some form of linear distortion, and this gets recorded into your pictures as slightly curved lines that should be straight. The **Distortion control** option allows to fix this¹⁴⁶.

To use **Distortion control**, you must first take a picture. That picture can be NEF or JPEG, but it must be in color.

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the RETOUCH menu (purple paintbrush icon).
3. Use the Direction pad to navigate to **Distortion control** press the ► key on the Direction pad or the

¹⁴⁶ I don't understand why **Auto** isn't a shooting option. If the camera has the internal processing to be able to manage that correction, it ought to be doing it while shooting.

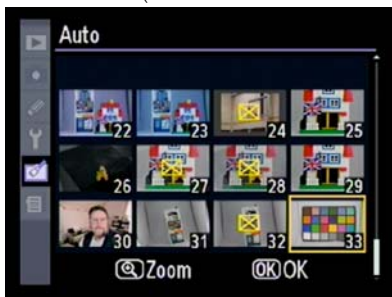
OK button to select it.



4. Navigate to the **Auto** option and select it if you're using a Nikkor D- or G-type lens, navigate to the **Manual** option and select it if you're using anything else.

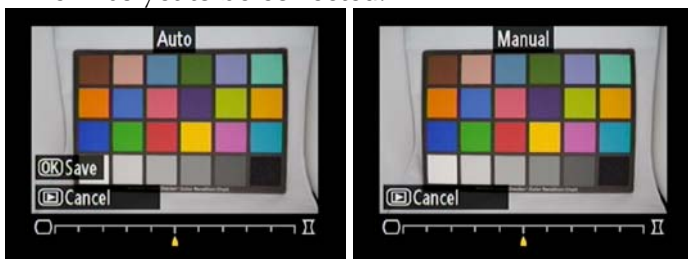


5. You'll be presented with thumbnails of twelve images at a time. Images with a yellow  icon cannot be retouched (this includes videos).



- a. Use the Direction pad keys (or Rear Command dial) to navigate to the image you wish to work with.

- b. Use the Zoom In button (Q) to see the currently selected image in full screen size.
 - c. Press the **OK** button to select the image you wish to change.
6. The camera now shows the corrected image. You can adjust the correction by using the ◀ and ▶ keys on the Direction pad. Here's the same image as it appears with the two types of processing first applied. Note the slightly bowed character of the one on the right, which has yet to be corrected.



Press the **OK** button to complete the trimming process.

7. After pressing the **OK** button in Step 6, the camera will display an hourglass icon for a moment to indicate that it is creating a modified image according to your instructions. After a few moments, you'll see an **Image saved** message and be returned to normal image review.

The modified version of your image will appear with a special icon (paintbrush):



Fisheye

The D90 has a function that allows you to add barrel distortion to your image to “simulate” what happens when you use a fisheye lens. I put the simulate in quotes because this function really is more like those mirrors in a carnival fun-house: we’re really just distorting the image.

To use **Fisheye**, you must first take a picture. That picture can be NEF or JPEG, but it must be in color.

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the **RETOUCH** menu (purple paintbrush icon).
3. Use the Direction pad to navigate to **Fisheye** press the **▶** key on the Direction pad or the **OK** button to select it.



4. You’ll be presented with thumbnails of twelve images at a time. Images with a yellow  icon cannot be retouched (this includes videos).



- a. Use the Direction pad keys (or Rear Command dial) to navigate to the image you wish to work with.
 - b. Use the Zoom In button (⌕) to see the currently selected image in full screen size.
 - c. Press the **OK** button to select the image you wish to change.
5. The camera now shows the processed image. Use the ◀ and ▶ keys on the Direction pad to increase or decrease the effect.



Press the **OK** button to complete the trimming process.

6. After pressing the **OK** button in Step 5, the camera will display an hourglass icon for a moment to indicate that it is creating a modified image according to your instructions. After a few moments, you'll see an **Image saved** message and be returned to normal image review.

The modified version of your image will appear with a special icon (paintbrush):



To all men reading this: I am not responsible for the reaction of your girlfriend, significant other, fiancé, or spouse should you decide to use this retouching option on an image of your loved one. Take responsibility for your own actions! Should your loved one send me email complaining, I'll rat you out...

Transferring Your Images and Videos to Your Computer

Images are stored in your D90 on a Secure Digital card. You can get those images and videos off the card into your computer in three basic ways:

1. Connect the camera to a computer via cable.
2. Remove the card from the camera and put it into a card reader slot or attached device to your computer.
3. Remove the card from the camera, put it into a portable storage device such as the Epson P-5000 and transfer the images (not all such devices may recognize videos, however). Later, connect the portable storage device to your computer and transfer the images from it to one of your hard drives.

Methods #1 and #2 are the most commonly used transfer mechanisms. I usually recommend #2 over #1. First, if you're shooting a lot of images or videos, you probably have multiple cards you want to transfer. Second, I worry a bit more about wearing out or damaging the rubber gasket and USB connector on the D90 than I do the card slot. Also, batteries get consumed quickly when you use the camera for direct transfers, and batteries have a finite number of recharges they'll sustain. Finally, I think that the less you have to handle the camera, the longer that it'll last (think of having your camera sitting on your desk connected to the computer—will *you* spill drinks on it or accidentally knock it off onto the floor?).

Method #3 is the one that I sometimes use. It's my preferred method when I'm away from the office for long stretches of time, as the portable storage device acts as a temporary home for my images. This frees up my cards for more use and puts

all of my images from a trip in one place, which makes it easier to transfer them all when I get home. However, note that some of these portable storage devices will not recognize the **.AVI** files created by the D90's D-movie function.

Still, you'll want a card slot or card reader on your computer just in case you ever need to resurrect accidentally "deleted" images or if you need to reformat the card for some reason.

Both of the first two methods require either specialized software or manual copying. (The third method requires special hardware, as well.)

Note that the D90 doesn't support setting the mode in which the USB connector communicates with the computer, as did many previous Nikon DSLRs. Essentially, the USB connector is always in what is known as MTP/PTP mode on the D90. This means that older operating systems no longer correctly "mount" the D90 (which requires the old Mass Storage mode). Thus, computer connections are only fully supported with Windows XP SP2 or later, Windows Vista SP1 or later, and Macintosh OS-X version 10.3.9 or later.

Automated copying works better, in my opinion, because it gives you renaming options, if nothing else. Photoshop Elements, Apple iPhoto, Nikon Transfer, Nikon ViewNX, and a host of other programs install automated copying processes that pop up when you connect your camera or insert your camera's card into a slot or reader on your computer. I deal with Nikon's software in *Introduction to Nikon Software*.

Connecting to a Computer



The USB connector is the small, shiny connector situated in the middle on the left side of the camera, under the rubber door.

The D90 includes a USB (2.0 compatible) interface for connecting the camera to computers. This connection type is available on most computers made in the past few years. Your computer must have the appropriate USB interface available and be configured correctly.

The D90 comes with a UC-E4 USB cable, though it's relatively short. If you choose to replace Nikon's cable with one from a third party, note that ~15 feet (5m) is the maximum distance at which the D90 can reliably communicate with the computer through USB¹⁴⁷.

 Connect your D90 to the PC as follows (assumes the computer is already configured and ON, and Nikon Transfer has been installed):

1. Turn the camera OFF.
2. Plug one end of the USB cable into the connector on the lower left of the camera (it's under the bottom rubber door). The other end plugs into the appropriate connector on your computer. (You can't get the connections backwards; only one end fits the camera, only one end fits your computer.)
3. Turn the camera ON.

¹⁴⁷ Nikon warns that the use of a hub makes it so that high-speed USB transfers don't work. Put another way, Nikon disclaims support beyond the usual 15 feet (5m) when the camera is directly connected to a computer USB port.

4. The computer should recognize the camera and start up a transfer operation if you have everything connected correctly. I deal with the remaining steps in the section on Nikon Transfer in *Introduction to Nikon Software*.

*Note: If you've got a Macintosh, iPhoto may recognize the **DCIM** folder on the camera and attempt to start up, as well. To fix this in OS-X, make sure no cameras or card readers with **DCIM** folders on them are connected to the Macintosh. Open **Image Capture** (in the **Applications** folder). Choose **Preferences** from the **Image Capture** menu, then choose **No application** in the pop-up.*

5. When you're done with the connection, turn the camera OFF before removing the cable. But make sure that all transfers have completed before turning the camera OFF otherwise data may be lost.

Nikon designed the D90 so that it would continue to operate normally while connected to a computer. That means that you can take pictures while the camera is connected to the computer. You can also control the camera from the computer with Nikon Camera Control Pro 2, something that is useful in studio situations (see *Introduction to Nikon Software*).

Printing Your Images

You have three primary ways to print images you take with your D90:

1. Remove the Secure Digital card from the camera and take it somewhere that makes prints (in the US: Walmart, Costco, most camera stores, most drugstores; I'll call those "labs").
2. Connect the camera to a PictBridge-enabled printer and print directly. See "PictBridge Printing" on page <729>.

3. Remove the Secure Digital card from the camera and insert it into a printer that has the appropriate slot and printing support, and print directly from the card.
4. Transfer your images to your computer and print using the printer connected to your computer.

I've listed these basically in increasing order of cost per print and inconvenience. Having someone else make your prints is convenient and many places charge much less per print than you can achieve with an inkjet printer connected to your computer. PictBridge printing, especially with the small 4x6 printers that are becoming ubiquitous, is a little more expensive, but still very convenient. Transferring images to your computer and printing from there is usually the most time consuming and often the most costly per print.

If printing your photos is your primary goal, we have a few things we need to get out of the way:

- *Make sure the image is ready to print.* Most labs and all PictBridge printers require your image to be in JPEG format and using the sRGB Color Space. You'll note that my recommendations for most folk ("Which Type of Photographer are You?" on page <633>) were to shoot JPEG and use the sRGB Color Space, so there's no real need to change anything if you're following those guidelines. However, if you shoot NEF files or use the AdobeRGB Color Space *you must transfer your images to a computer and process them correctly before sending the image out to print.*
- *Select the images to print.* The D90 has a feature—**Print set (DPOF)**—that allows you to automate this process in the camera. If you take your images to a lab to be printed, you'll want to look into using this. See "Selecting Images to Print" on page <726>.
- *Get the images to the printer.* In the case of using a lab the simplest method is to simply take the Secure Digital card out of the camera and give it to the clerk at the lab. (But make sure you've used JPEG, sRGB, and have selected

images to print first!) With PictBridge, it's as simple as plugging the camera into the printer and following the instructions in "PictBridge Printing" on page <729>. If you're going the computer-to-printer route, the combinations and permutations of things you might want or need to do is more complex and involved than I can present quickly in this eBook. Basically, you transfer the images to your computer, edit them using software on your computer (e.g. Photoshop Elements), then use that software to send the images to your printer. Just be warned that there are all kinds of variables you'll need to be aware of, from using the right printer profiles for the paper and ink you're using to getting the resolution aligned correctly (see "Printing Resolution" on page <734>).

Selecting Images to Print

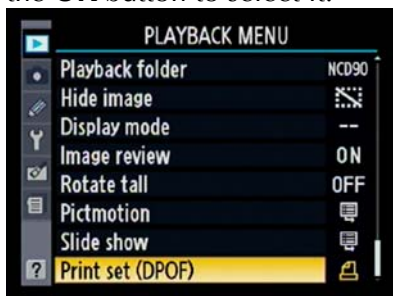
The D90 supports the DPOF specification (Digital Print Order Format), which allows you to insert your Secure Digital card into a DPOF enabled printer and automatically get prints of images pre-marked for printing (called the "print set"). Most inkjet printers that allow you to insert a Secure Digital card support DPOF (e.g., the Epson 875), as do most print labs that accept Secure Digital cards for printing.

Pre-selecting your images for printing before you get home to your printer or before take your card into a lab can save you time, as it means that you don't have to scroll through them individually after the fact. In other words, you could add to your print set as you shoot in the field, then be ready just to print your chosen images immediately when you get home or to the lab.

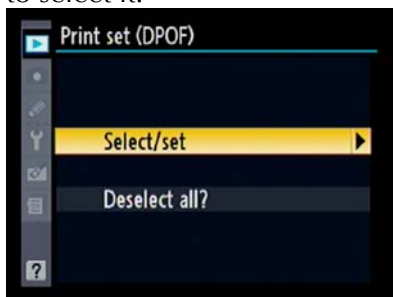
 To pre-select images to be printed:

1. Press the **MENU** button to show the menus on the color LCD.
2. Use the Direction pad to navigate to the PLAYBACK menu (blue play icon).

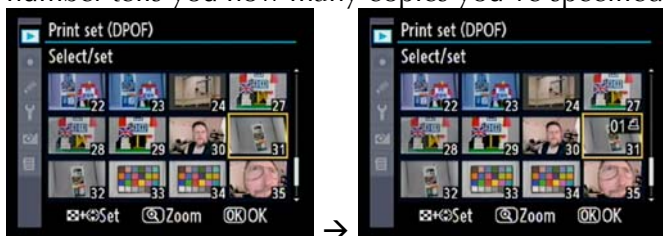
- Use the Direction pad to navigate to **Print set (DPOF)** and press the **►** key on the Direction pad or the **OK** button to select it.



- Use the Direction pad to navigate to **Select / set** and press the **►** key on the Direction pad or the **OK** button to select it.

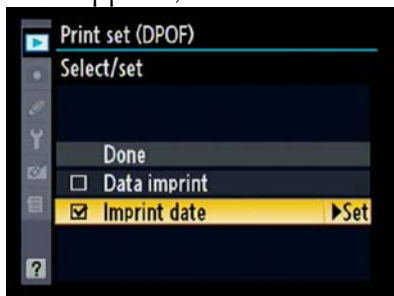


- The camera displays a thumbnail view of the images, twelve at a time. Navigate through them exactly as you would in thumbnail view (**◀** and **▶** key or Rear Command dial), pressing the **▲** key on the direction pad to increase the number of copies you want to print of an image or the **▼** key on the direction pad to decrease the number of copies. A small 1/1 icon indicates that the image will be printed and the number tells you how many copies you've specified.

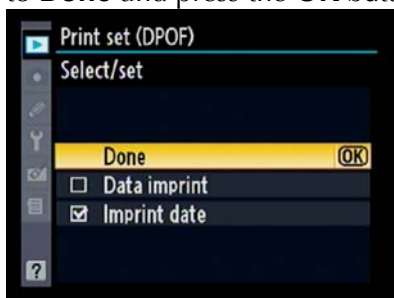


NEF files cannot be chosen for the print set; you'll see the message **This file can not be selected** when you press the keys on the Direction pad to select NEF images.

6. You'll be given the option to set both data and date imprints. Use the Direction pad to navigate to the ones you want, and press the **►** key to set it (a check mark appears).



7. When you're done selecting printing options, navigate to **Done** and press the **OK** button.



Note: DPOF printers expect images using the sRGB color space. If you plan to use the **Print set** option, you should set the Color Space of your D90 to **sRGB**. See “Color Profiles and Color Spaces” on page <636>.

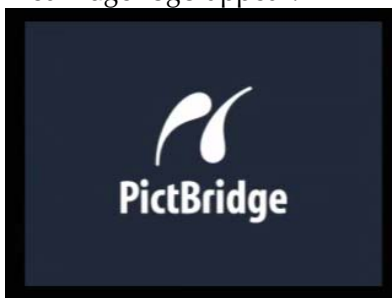
So what have you done here? Essentially you've put data into the EXIF fields for the image that most digital camera aware printers will pick up on (e.g. printers that have the DPOF logo). When a group of such images is presented to the printer—usually by putting your Secure Digital card into a slot on the printer—the printer sees the fields (print, number of

copies, imprint data request) and uses them to automatically create your prints, as requested.

PictBridge Printing

The steps for printing using PictBridge to print are also simple (I'll use a Sony DPP-FP30 in my example, but any PictBridge printer should work similarly):

1. Ready the printer (insert media and cartridges and turn the printer ON).
2. First connect the UC-E4 USB cable that came with the camera to the printer's PictBridge port.
3. Next connect the UC-E4 cable to the camera's USB port. After a few seconds you should see the PictBridge logo appear:



This takes you directly to a "browsing mode," where you can directly print pictures. You'll be shown the current image on your card with a PictBridge overlay at the top:



4. You may simply scroll through the images pressing the **OK** button on each image you want a print of; you'll

be prompted to **Start printing**. Press the **►** key and then you'll see something like the following screen while your print is made (the card access light on the back of the D90 illuminates—usually blinks—while the printer and camera are transferring image data):



or you can press the **MENU** button on the camera to bring up the PictBridge Print Menu:



5. If you've identified photos to print using DPOF, use the Direction pad to navigate to **Print (DPOF)** and press the **►** key on the Direction pad to select it.



- a. You're taken to a page that displays your available images (no raw or video files will

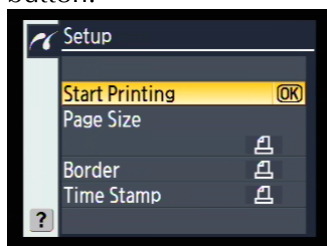
show).



- b. If you want to add images to the print set, you navigate to each image you wish to print and press the **▲** and **▼** keys on the Direction pad to increment or decrement the number of copies.

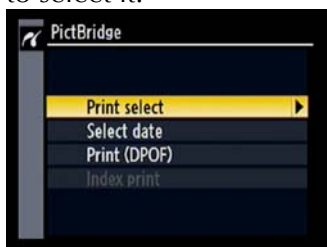


- c. When you're ready to print, press the **OK** button, navigate to **Start printing**, and press the **▶** key on the Direction pad or the **OK** button.



6. Assuming that you didn't use DPOF, you can alternatively navigate to **Print Select** from the main PictBridge menu and press the **▶** key or the **OK** button

to select it.



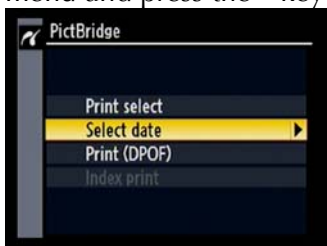
- a. The camera shows twelve photos at a time.



- b. Use the Direction pad to navigate to the photo(s) you wish to print and then
1. Press the ▲ and ▼ keys on the Direction pad to increment or decrement the number of copies you want.
 2. When you've selected all the images you wish to print, press the **OK** button
 3. You're taken to the Setup screen, where you may be able to choose options for print size, border, and time stamp (depends upon your printer¹⁴⁸).

¹⁴⁸ I originally thought to show each of these options, but found with just a few PictBridge printers the combinations and permutations were piling up in a way that would have added many pages to this work. Fortunately, the D90 will only show you the options that are available for the printer you're connected to (all others will either not appear or be disabled), so it should be relatively obvious what you can and can't do by what appears in this menu.

4. Press the **▶** key on the Direction pad or the **OK** button to start printing.
7. You can also select by date the picture was taken. Navigate to **Select date** from the main PictBridge menu and press the **▶** key or the **OK** button to select it.



- a. The camera shows six dates at a time, along with a small preview of the first shot taken on that date.



- b. Use the Direction pad to navigate to the date(s) you wish to print and then
 1. Press the **▶** key on the Direction pad to set the check mark for that date.
 2. When you've selected all the dates you wish to print, press the **OK** button
 3. You're taken to the Setup screen, where you may be able to choose options for print size,

border, and time stamp
(depends upon your printer¹⁴⁹).

8. Press the ► key on the Direction pad or the **OK** button to start printing. When you're done printing, turn the camera Off, then unplug the cable.

Note: DPOF and PictBridge printers expect images using the sRGB color space. If you plan to use either to print, you should set the Color Space of your D90 to **sRGB**. See "Color Profiles and Color Spaces" on page <636>.

Note: The D90 stays powered and active the entire time that it is connected to a PictBridge printer. Batteries can get exhausted rapidly: in printing a dozen images, for example, the battery in my D90 lost about half its charge. Generally, I'd recommend that you use the EH-5 AC Adapter to power the camera when printing directly from the camera.

Printing Resolution

Okay, if you're reading this section you've opted to print images from your computer to your printer instead of using a direct PictBridge connection to the camera. While this might seem easy enough, you're left on your own devices by most camera and printer companies (and even most software companies). The one area that usually stops first timers dead is resolution.

Resolution is a word that's often used casually in the digital world. The camera has 4288 x 2848 pixels of resolution. Your printer might claim 1440 dpi (dots per inch) resolution. Your computer monitor might have 1280 x 1024 pixels of resolution. Or it might be specified as 90 dpi. Photoshop might report your JPEG images as having 72 dpi. Are you confused yet?

¹⁴⁹ I originally thought to show each of these options, but found with just a few PictBridge printers the combinations and permutations were piling up in a way that would have added many pages to this work. Fortunately, the D90 will only show you the options that are available for the printer you're connected to (all others will either not appear or be disabled), so it should be relatively obvious what you can and can't do by what appears in this menu.

Don't be. Most of the numbers you encounter in the resolution world are arbitrary. Let's make them work for us. Your D90 can capture 4288 pieces of information across the (usually) horizontal axis. That's an *absolute*. There really are 4288 pieces of data to deal with in that axis (assumes **Image size** is set to **Large**). What happens as that image moves to other devices is where things get murky for some.

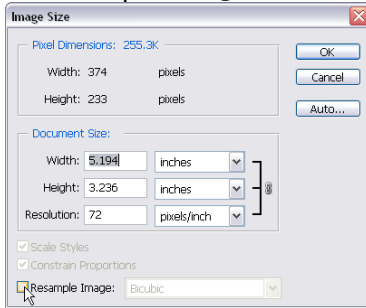
On your computer monitor, for example, you might specify to view your 4288 x 2848 pixel image via your software's **Fit in Window** command. If the maximum size of that window is 640 x 480, obviously the software has to *scale* the original data in some way. Normally, it does this by creating a temporary, interpolated *copy* of your data. Nothing changed in your original data. But you're also no longer looking at your original data! That's why you'll find that most tutorials on post processing ask you to look at the effects of destructive tools like sharpening at **100% View**. That way you see the exact effect on (a portion of) your original data, not a simulation of it. *Bottom line*: viewing at different scales or sizes on your computer monitor does not change the actual "resolution" of your image.

Another place where we see resolution numbers is in the software we use. For example, if you use Photoshop or Photoshop Elements **Image Size** command, you'll see a entry called **Resolution** that's specified in **pixels/inch** (or **pixels/cm**). For D90 JPEG images this value will normally be **72**. This is an *arbitrary* assignment by the software program and sometimes controlled by a value in the EXIF data. Above this value you'll often see values for the width and height for the image if it is printed *at that dpi*. Read it this way: *IF you print at that pixels/inch value your photo will be X" high and Y" wide*. That's a big IF. Usually we want to print at a specific pixels/inch value that will maximize the output of our printer.

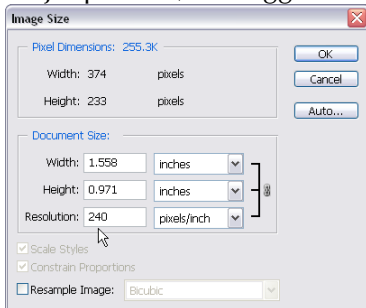
The D90 places a 72 dpi marker in JPEG files and a 300 dpi marker in NEF files (actually, it's usually the software converter that sets that for NEF files; some have the ability for

you to set a preference to change that). If we have to change the dpi value (but *not* change the original pixels), we do this in Photoshop¹⁵⁰ by:

1. Unchecking the **Resample Image** box in Photoshop's **Image Size** dialog.



2. Entering a new value in the **Resolution** box in the **Image Size** dialog. (For an Epson and most other inkjet printers, I'd suggest 288 pixels/inch.)



If you then need to *resize* the image, set your dpi value as just described, then

3. *Recheck* the **Resample Image** box.
4. Enter new dimensions in the **Width** and/or **Height** boxes. However, if you perform this step, you'll no longer be dealing with the actual pixels you captured

¹⁵⁰ Other software programs will have similar, but not identical steps and dialog boxes.

while shooting, but Photoshop's interpolation of them at the new size.

Why do we specify the “resolution” as 288 dpi for printing? Because typically that's the most pixels per inch you need to send to an inkjet printer to get a very high perceived quality. Anything over that makes changes that are very difficult to see, if they can be seen at all. The printer driver of your printer “invents” in-between pixels, if necessary, to maximize its output quality, but those invented pixels are usually good enough that we don't have to supply them in the first place.

Note: If you've been following that discussion and set your D90 images to 288 dpi for printing on your inkjet printer that means that a D90 image will print as a ~10 x 15" image after Steps 1 and 2 are completed. To create a printed image larger than that, you'd need to change Steps 3 and 4, above.

Output on Commercial Printers

While it's a little bit out of the scope of this book, enough D90 users have asked me about professional printing options that it makes sense to give a brief set of tips here, especially since color issues are usually the biggest complaint.

As I write this, the Fuji Frontier is probably the most ubiquitous automated printer you'll run into at labs (and Wal-Mart and Costco in the US)¹⁵¹. Thus, I'll present the overall workflow for it (other printers should be similar—but work with your lab to verify each step I present). The following example assumes you use Photoshop or Photoshop Elements (other software products should be similar, but may use different file extensions or command names):

1. Crop, size, adjust, and sharpen your image as usual.

¹⁵¹ The popular Noritsu and a few other commercial printers are similar. Try following the directions given here for them—you'll probably find that it works for them, too.

2. Instead of 288 dpi (see “Printing Resolution” on page <734>), use 300 dpi.
3. If you’re working in Photoshop, save your edited copy as a **.PSD** file in case you need to revisit your changes. (If you’re working in another editor, save in its native file format.)
4. Flatten all layers, if any.
5. If the image isn’t already in 8-bit RGB mode, convert the image to 8-bit RGB color (16-bit RGB color and Lab Color aren’t usually supported by commercial printers). In Photoshop, this is done on the **Image** menu on the **Mode** sub-menu.
6. Use the **Canvas Size** menu item to make sure that your final image size is one that the Frontier supports (e.g., 8x10” in the US). In other words, if the final crop of your image was 7x9.5” you would use **Canvas Size** to center that on an 8x10” canvas. (If you don’t perform this step, the Frontier—and most other automated printers—resizes your image, causing all kinds of ugly artifacts.)
7. Use Photoshop (or the photo editor you’re using) to *convert* the Color Space you were working in, if necessary (e.g. AdobeRGB), to the one the Frontier uses (sRGB). (If you give a Frontier an image in a Color Space it doesn’t support, guess what, you get wrong colors!)
8. Save the image as a TIFF or JPEG file. *Do not* embed the Color Space (usually a checkbox in the **Save** dialog; it’s ignored by the printer, anyway).
9. Save all your images on a CD-R and take them to the printer.

Viewing Your Images

The D90 can be connected to a television so that what would normally appear on its color LCD appears instead on the TV.

It can also present a “slide show” of all the images on the Secure Digital card inside your camera.

Television Playback



*The video connection (bottom connector under top rubber door, and labeled **Video Out** on the door) is on the left side of the camera (and interferes with holding the camera when connected to a television). Nikon supplies a short video cable with the camera. I've plugged my cable into the connector here.*

Before connecting the D90 to a television, you must tell the camera what kind of video standard to use:

NTSC The video standard in the US, Canada, and Japan.

PAL The standard in the UK and many European countries.

 To set the camera's video standard and connect it to a television:

1. Press the **MENU** button to display the menus.
2. Use the Direction pad to navigate to the SETUP menu (yellow wrench icon).
3. Use the Direction pad to navigate to **Video mode**, and then the **▶** key on the Direction pad or the **OK** button to select it.



4. Use the Direction pad to navigate to either **NTSC** or **PAL**, and then the **▶** key on the direction pad or the **OK** button to select it.



5. Turn the camera OFF.
6. Plug one end of the EG-D2 video cable into **Video Out** jack on the left side of the camera, the other ends into the **Video In** and **Audio In** jacks on your television. Your TV must be set to its **Aux** or similar composite video input setting.
7. Turn the camera ON. Operate the camera as you would normally while reviewing images.
8. When you're done, turn the camera OFF before unplugging the video cable.

You may also plug the D90 into a VCR's **Video In** and **Audio In** connections. Depending upon your VCR and television, to see the image from the D90 you will either have to have the VCR feed the TV's **Aux** (composite video) input or tune the television attached to the VCR to a specific channel (usually 3 or 4) after pressing a button on the VCR (usually **Aux** or **Line**).

*Note: If the camera is connected to a PAL compatible television (and **Video Output** is set to **PAL**), output resolution is reduced somewhat, as the camera has to alter the number of bits in the thumbnail to adapt the image to the screen resolution.*

📺 If you're going to connect the D90 to a modern HD television or monitor that supports input via the correct HDMI

cable, you'll need a mini-pin HDMI cable. Note that this cable is different from the one needed for the D3. The D90 uses mini-pin HDMI to full-pin HDMI, while the D3 uses full-pin HDMI to full-pin HDMI.

1. Press the **MENU** button to display the menu system.
2. Use the Direction pad to navigate to the SETUP menu (yellow wrench icon).
3. Use the Direction pad to navigate to **HDMI**, and then the **►** key on the Direction pad to select it.



4. Use the Direction pad to navigate to the proper high definition (HD) setting for your television or monitor and then the **►** key on the direction pad to select it.



*In theory, you should be able to leave this on **AUTO** and most HD devices should negotiate with the D90 as to what format to display. But if you're having problems, try the individual settings. In the US, **720p** and **1080i** are the most commonly encountered devices.*

5. Turn the camera off.

6. Plug the mini-pin end of the proper HDMI video cable into the mini-HDMI jack on the left side of the camera, the other end into your HD device. You may have to set the HD device's **Input** or similar setting if the device supports multiple inputs.
7. Turn the camera on. Operate the camera as you would normally while reviewing images.

When you're done, turn the camera off before unplugging the video cable.

HDMI or regular video? Easy answer: HDMI if your television or monitor supports it, you'll get a much better picture from the camera.

One thing that surprises some D90 users is that the camera still functions normally when connected to a television. Yes, that means that you can take pictures with the camera hooked up to a TV. Anything that would normally be displayed on the color LCD appears instead on the television. This facility is useful in studio shooting.

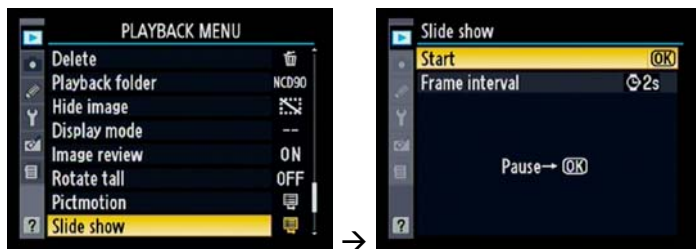
Note: You should note that battery consumption for the camera is considerably higher as long as it driving an external display device. The D90 continues to show images on a television for up to 10 minutes, after which this connection is turned OFF, regardless of the color LCD's status or the camera's timeout settings.

Slide shows

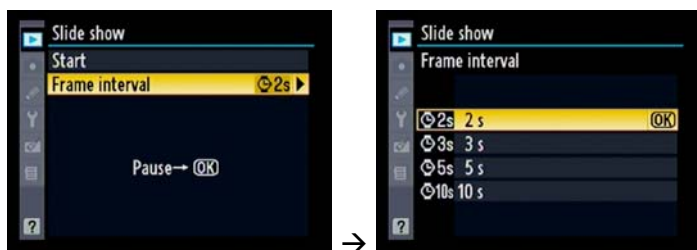
The D90 has two slide show functions built into it, allowing you to show one or more folders of D90 images in sequence, with a specific delay between each image (two to ten seconds) or to add one of five preset music tracks and transition effects to the slide show. Since the D90 can be connected to a television (see "Television Playback" on page <739>), this allows you to shoot images and then show them to a group of people as a completed presentation.

Let's start with the basic slide show function.

📷 You can make the camera display all the images in the current folder in sequence by selecting the **Slide show** option from the PLAYBACK menu. When you do so, you'll see an additional menu (above) that allows you to **Start** the show, or set the **Frame Interval** (time each image is displayed). Intervals of 2, 3, 5, and 10 seconds are supported.



Note that you have one option that can be set: the interval between images:



Controls length of time each image is on the screen

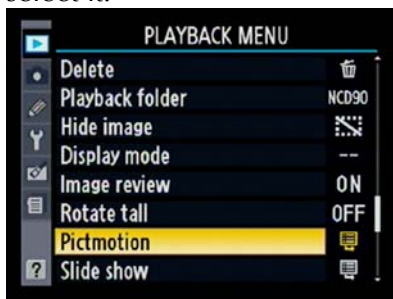
Slide shows can be paused by pressing the **OK** button (then select **Restart** and press the **▶** key on the Direction pad to continue), or terminated early by pressing the **MENU** button (actually, just about any button). At the end of a slide show, the pause display is shown, allowing you to restart the show

from the beginning if desired:



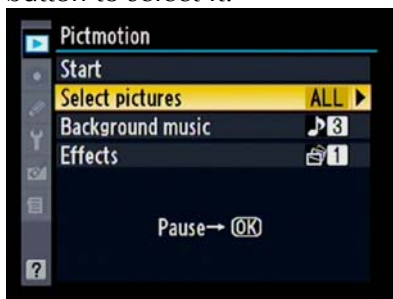
The D90 has a second form of slide show, called Pictmotion, that is more sophisticated:

1. Press the **MENU** button to show the menu system.
2. Use the Direction pad to navigate to the **PLAYBACK** menu (blue play icon).
3. Use the Direction pad to navigate to **Pictmotion** press the ► key on the Direction pad or the **OK** button to select it.

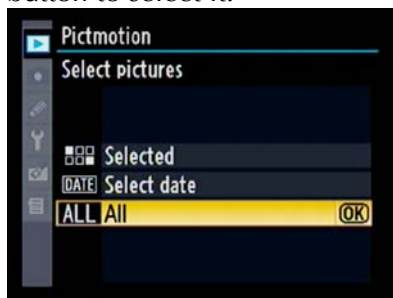


4. Use the Direction pad to navigate to **Select pictures** and press the ► key on the Direction pad or the **OK**

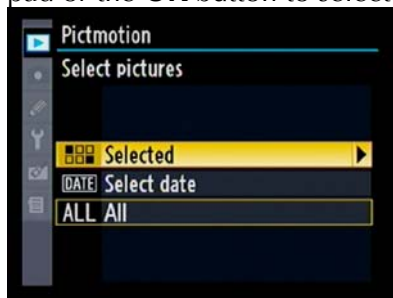
button to select it.



- a. If you wish to use all the non-hidden pictures on the Secure Digital card in the camera, use the Direction pad to navigate to **All** and press the ► key on the Direction pad or the **OK** button to select it.



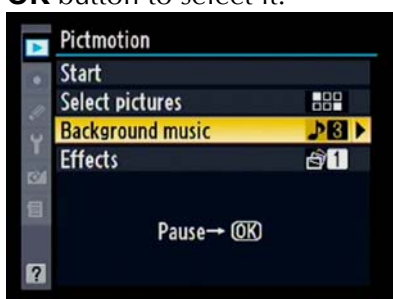
- b. Alternatively, if you wish to use only selected pictures, use the Direction pad to navigate to **Selected** and press the ► key on the Direction pad or the **OK** button to select it.



- i. You'll be presented with thumbnails of six images at a time.

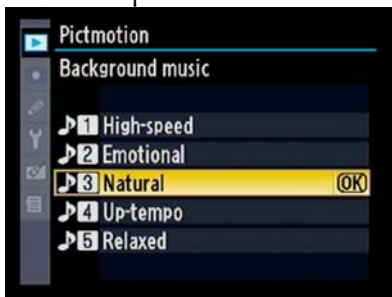


- ii. Use the Direction pad keys (or Rear Command dial) to navigate to an image you wish to create a smaller version of.
 - iii. Use the Zoom In button (⌕) to see the currently selected image in full screen size.
 - iv. Use the Thumbnail/Zoom Out button (⌕) to select or deselect images you wish to see in the slide show. A ✓ icon is placed on each image you select
 - v. Press the **OK** button to complete selection of the images you wish to change.
5. Use the Direction pad to navigate to **Background music** and press the ► key on the Direction pad or the **OK** button to select it.



6. Use the Direction pad to navigate to the music selection you wish to use press the ► key on the

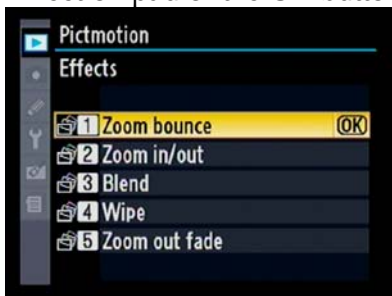
Direction pad or the **OK** button to select it.



7. Use the Direction pad to navigate to **Effects** and press the **▶** key on the Direction pad or the **OK** button to select it.



8. Use the Direction pad to navigate to the transition effect you want to use and press the **▶** key on the Direction pad or the **OK** button to select it.



9. Use the Direction pad to navigate to **Start** and press the **▶** key on the Direction pad or the **OK** button to begin your slide show.



At any time you can press the **OK** button to pause the slide show. When you pause the slide show or it ends, you'll be presented with the following simple screen of two options. Navigate to the one you wish to use and press the **OK** button again.



Obviously, if you're using the slide show option you probably are displaying images to others, perhaps in a review session. The D90 supports television display of the images for this very situation (see "Television Playback" on page <739>). Timeouts are handled a little differently in slide show mode, though. The D90 does not power OFF when displaying a slide show unless 10 minutes have passed since you pressed a button on the camera.

D90 Accessories

Nikon and many third parties all make accessories that work with the D90. Indeed, the list seems to grow each day. Before presenting Nikon's available options, I'm going to cut to the chase and give you a list of what you might want to consider and what you don't need.

Consider:

- *Extra batteries.* Nikon's EN-EL3e are the preferred choice, despite the extra cost. As a lot of people have discovered, some of the third-party imitations of this battery don't work with all Nikon bodies (most notably the D300). Thus, I suggest you stick to the official Nikon battery. You probably only need one extra battery anyway.
- *Remotes.* Get either the wireless ML-L3 or the wired MC-DC2 remote release. I have a slight preference for the wired remote due to the cumbersomeness of setting the wireless remote option and the battery drain it creates.
- *LCD protection.* Nikon supplies a simple protector, but many people like the Delkin pop-up shade protectors. They're a little cumbersome in that you have to pop the hood up and down while shooting and reviewing and the edge is very close to the Direction pad, but they offer superb protection and make it easier to see the LCD in bright light. (Remember, this is the *consider* list, not the *absolutely buy* list).
- *An additional wireless flash.* Because the D90 can control off-camera flash wirelessly as well as its internal flash, you get some lighting flexibility by purchasing an SB-600 or SB-900.
- *The GP-1 GPS accessory.* If you're interested in geotagging, the GP-1 is probably the most practical way to do that with a D90.

Don't really need:

- *Armor.* Those rubber armor options offered by some don't really offer much additional protection and make the camera more cumbersome to use, in my opinion.
- *Grips.* Nikon and others offer optional power grips for the D90. They add bulk and weight, but not a lot of additional capability. I don't find them particularly sturdy, either; they introduce a bit of flex that can be problematical if you're trying to get absolutely sharp images off a tripod.

With that out of the way, here's what Nikon offers in the way of D90-specific accessories:

EN-EL3e Rechargeable Li-ion Battery. This lithium-ion battery pack is a custom enclosure with a proprietary connector, and provides 7.4 volts at 1500mAh. The EN-EL3e battery can power the D50, D70, D70s, D80, D90, D100, D200, D300, or D700 body. One EN-EL3e battery is supplied with the D90.

EH-5a AC Adapter. Designed to power the D50, D70 series, D80, D90, D300, or D700, this adapter can be used with voltage sources of 100-240V, with AC cycles of 50 or 60 Hz. Draws 1.2 amps. Provides 9v volts at 4500mA. Separate power cables are available for North America, the UK, Europe, Australia, and Japan, although you can use plug adapters in a pinch. The cable from the AC adapter to the camera is not removable or extendable. Note that when the camera is plugged into an EH-5a, the monitor timeouts (10 minute default) still apply!

MH-18a Quick Charger. Designed specifically for the EN-EL3 type battery packs, the MH-18a can charge a fully depleted battery in about two hours. This is the charger that is supplied with the camera, and is designed for the EN-EL3, EN-EL3a, and EN-EL3e batteries. The AC power cable is removable, and the charger can be used with voltage sources of 100-240V, with AC cycles of 50 or 60 Hz. (Third party EN-EL3 chargers exist and work fine; the third pin that causes some third-party batteries to be rejected by the camera does not come into play with the chargers, as that pin is not used during charging.)

DK-21 Eyepiece Cup. This small device slides into the viewfinder rails and has a rubber rim to shield the viewfinder from receiving light. If you take pictures without looking through the viewfinder and your camera isn't in Manual exposure mode, you *must* block light coming in through the viewfinder using your hands or the supplied DK-5 eyepiece shutter, which goes into the viewfinder rails in place of the DK-21. One DK-21 is supplied with the D90.

DG-2 Magnifier (requires, and usually comes with, DK-7 Eyepiece Adapter, which slides into the viewfinder rails). An optional viewfinder extension that magnifies the scene in the viewfinder and provides additional precision in determining focus in macro and telephoto work.

DR-6 Right Angle Viewer. An optional viewfinder extension that slides into the viewfinder rails in place of the DK-21 and allows you to see the scene in the viewfinder at a right-angle. Useful for low-angle, macro, and copy stand work.

DK-21M Magnifying Eyepiece Cup. This small replacement eyepiece slides into the viewfinder rails and has a rubber rim to shield the viewfinder from receiving light. Unlike the regular DK-21, this eyepiece provides a mild magnification that some find useful. However, you may not be able to see the entire image area and viewfinder display information simultaneously using it.

BM-9 LCD Monitor Cover. The clear plastic cover that protects the color LCD from smudges and damage. One is supplied with the D90.

ML-L3 Wireless Remote Control. A battery powered infrared remote control for the D40 series, D50, D60, D70 series, D80, and D90. Also works with some Coolpix models.

MC-DC2 Remote Control. A simple wired remote for the D90. Has a lock position for continuous shooting or Bulb exposures. Plugs into a connector currently only available on

the D90 (left side of the body, bottom rubber door on the D90). Note this is *not* the same cable as the MC-DC1 that was used with the D70s and D80.

Specifications

<u>Feature</u>	<u>Specification</u>
Operating temperature	32-104°F (0-40°C)
Operating Humidity	<85%
Sensor Size	.93 x .62" (23.6 x 15.8mm)
Final Image Size	4288x2848, 3216x2136, or 2144x1424 pixels
Sensor Bit Capture	12 bits
ISO Sensitivity	200-3200 in 1/3 stop increments, 100, 125, 160, 4000, 5000 and 6400 equivalents
File Formats	JPEG (8-bit) and compressed NEF (12-bit)
JPEG Compression	1:4 at Fine, 1:8 at Normal, 1:16 at Basic
Storage Media	Secure Digital (SD) or SDHC
Motor Drive	4.5 fps, 25 frame buffer (7 with NEF, 100 with most JPEG sizes)
Self Timer	2, 5, 10, 20 seconds
White Balance	Auto, 6 manual modes, 6-step modification, Manual, from picture
Autofocus Detection Range	TTL phase detection using eleven sensors (single area, dynamic, or auto)
Autofocus Range	-1 to 19 EV (at ISO 100)
Autofocus Module	Nikon CAM-1000
Autofocus Features	AE/AF lock button, AF lock on partial shutter release, auto area option, viewfinder focus confirmation, wide area or normal central area

Metering Modes	420-pixel matrix, center-weighted (75/25, circle alterable), spot (2%)
Metering Range	0-20 EV (matrix and center-weighted, ISO 100), 2-20 EV (spot metering, ISO 100)
Exposure Compensation	-5 to +5 stops in 1/3 or 1/2 stop increments
Exposure Bracketing	2 or 3 images at increments of 1/3, 1/2, 2/3, 1, or 2 stops
Metering Features	User selectable center-weighted area, eleven spot metering areas, spot metering follows focus, AE/AF lock button
Shutter	Mechanical, 50,000 cycle tested
Shutter Speeds	30 seconds to 1/4,000 second, in 1/3-or 1/2-stop intervals, Bulb
Maximum Flash Sync	1/200 second (1/4000 with FP)
Flash contacts	ISO-type hot shoe
Flash Output	GN 56 feet (17m) in TTL
Flash Modes	Balanced Fill Flash (i-TTL) at ISO 200; Standard TTL; Commander Mode; Repeating Flash, Manual;
Flash Options	Red-Eye Reduction; Slow Sync; Rear Curtain Sync
LCD Monitor	3" 920k TFT
Playback Functions	Single frame, thumbnail playback (9 images), date, slide show, histogram (including channel histograms), highlight display, thumbnail playback, magnification of playback image

Viewfinder Coverage	96%
Viewfinder Eyepoint	19.5mm (at -1.0 diopter); 0.94 magnification
Viewfinder Adjustment	-2 to +1 diopters (accessories extend range)
Focus Screen	B-type BriteView clear matte with on-demand E-type grid
LCD Coverage	100% coverage, both dimensions
LCD Protection	nearly transparent BM-9
Video Output	NTSC or PAL (user selectable), HDMI
Computer Interface	USB 2
Size	5.2" wide x 4.1" tall x 3" deep (132mm wide x 103mm tall x 77mm deep)
Weight	1 pound 6 ounces (620g) (w/o battery or card)

Getting Service

Assuming that you bought an officially imported camera and not a gray market one, getting service for the D90 should be relatively straightforward. In practice, both Nikon and users make it more difficult than it should be.

I won't go into the gray market problem here (see <http://www.bythom.com/warranty.htm>), as it's an entirely different issue and varies considerably in how it's handled around the world.

The real problem is that users and Nikon both make assumptions that sometimes are contradictory. Here are the major problems I keep hearing from Nikon users who have troubles with NikonUSA and a few of the other subsidiaries:

- *Not under warranty.* Unless NikonUSA receives a copy of the warranty card *and* a copy of a dated sales receipt showing the purchase of the item in question, they typically assume that product is *out* of warranty. (Tip: *always* get the store to put the serial number on the invoice). Registering your product on Nikon's Web site or sending in the Product Registration card is not enough. Unfortunately, there isn't a clear "warranty card" that comes with the D90 in the US. Thus, that dated sales receipt is even more important, as it's the only official document that Nikon accepts.
- *Second-hand purchase.* Nikon warranties aren't transferable. Again, that purchase receipt is important.
- *Impact damage.* Don't try to fool Nikon and claim your camera doesn't focus and that it should be repaired under warranty after you dropped it and bent the lens mount. Some problems simply occur only because of poor user handling (bent aperture arm and lens mount being two obvious ones). But don't allow multiple problems to be grouped automatically by Nikon under impact damage. If your camera had a persistent card writing problem before you dropped it and damaged the lens mount, make sure

that Nikon knows that and that you expect them to fix *that* problem under warranty.

- *Slow service.* With new products, service usually slows for all but NPS members (professional photographers). Even NPS pros sometimes encounter parts shortages that delay repairs. But a more frequent problem is that Nikon didn't get all your information and/or is waiting for something from you (repair authorization, proof of purchase, shipping address, etc.). We'll deal with that further down in this section.
- *Problem not repaired.* A frequent complaint goes something like this: the user sends Nikon a camera body with the complaint that focus isn't accurate; Nikon puts the camera on their test station and finds it is within tolerance, Nikon sends the camera back to the user without changing anything, so the user complains that the camera wasn't repaired. You won't like hearing this, but that's your fault if it happens to you (I'll tell you how to avoid it in a moment).
- *Small part = expensive repair.* Most repairs require tear down of at least part of the camera and quite a bit of testing time. Beyond that, most parts are replaced modularly (e.g. you get an entire new shutter, not just one piece of it, or, heaven forbid, you often get an entirely new sensor and filter assembly if you break the filter).
- *Where'd it go?* NikonUSA ships to street addresses only. Sometimes people wait for return of their product while Nikon waits for a street address instead of a PO Box.
- *Diagnosis overload.* Once Nikon opens up a camera to be repaired, they diagnose all problems that would need to be fixed to return the camera to factory specifications. Thus, you might send the camera in to be fixed under warranty for a shutter problem and discover you're going to be billed for impact damage on a bent lens mount. You probably want that fixed, but since you weren't expecting to have to approve an estimate for repair costs, you never followed up with Nikon in a timely fashion and your camera sits waiting for authorization.

Okay, now that I've scared you, how do you get quick and complete service out of Nikon? Here's my list, compiled after talking and corresponding with dozens of users who've had troubles with NikonUSA service:

- *Document.* Take the time to write a clear, complete, and if appropriate, illustrated letter that describes *exactly* the problem you've encountered. If the problem intersects image quality, send a printout of an image that clearly shows the problem. In extreme cases, I'd send a file on CD, as well. What kinds of things am I talking about? Dead pixels, excessive hot pixel problems, other image artifacts, side-to-side focus problems, blank or incorrectly written images, and so on. Don't write a novel; make your note concise and to the point. If you have an expectation, state it. If you included anything other than the item you want repaired, list those things in your note, along with all serial numbers.
- *Provide.* Find the original warranty form if the product came with one, make a copy of the purchase invoice for the product, and staple them to the note you wrote.
Provide these items even if the product is out of warranty! Make sure the serial number is visible on all of these things and matches the item you're sending in! If the item has been repaired within the last three months, let Nikon know and provide a copy of anything you received back with that previous repair. Nikon has an on-line repair form at <http://form.nikonimagesvcapprove.com/>.
- *Include.* If the problem is exhibited with a particular accessory, you need to send the accessory! Got external flash problems with your D90? Send the camera *and* your flash. Got focus problems? Send the camera, a lens that triggers the problem, *and* a photo that shows the resulting out-of-focus image problem. Note that if you send an accessory like this, you need to provide the warranty form and purchase invoice for it, too! (And don't send third-

party flash units and lenses to Nikon; obviously, they don't warranty those.)

- *Strip.* Don't send the battery (unless you're having power problems), don't send your storage card (unless you're having trouble writing to it and it's one of Nikon's tested ones), and don't send your neckstrap. I actually get a bit overboard here: I take off the eyecup and color LCD protector. On the flip side: *do* put the body cap on.
- *Be accessible.* Nikon's NPS repair request form has places for home phone, work phone, fax, and email address. Seems like a good idea to provide them, but I go even further: I tape a business card to the camera. Also, PO Boxes are no-no with Nikon: give them a street address to ship back to.
- *Follow up.* In the US, that usually means phoning or checking the Web site that Nikon will point you to once they receive and log your item into service. Be sure you have any number Nikon provides you, along with the serial numbers of the items you sent.
- *Authorize.* If your repair is going to cost you something (as in the case of impact damage), you're at some point going to need authorize payment. Usually you should wait for Nikon to ask for it. But if you want to expedite the process, write a note that says "I hereby authorize Nikon to make any repair of up to US\$xxx and charge this to my Mastercard/Visa ##### expiration x/xx." (Note that I put a spot for that on my form.) ***You must sign this authorization.*** (Nikon will also ship COD, though this is always sent UPS Second Day delivery in the US.)

By now you're probably wondering about how you get in touch with Nikon service. After all, the phone number is conspicuously missing from the materials provided with the camera. In the US, call 1-800-NIKON-SV (that's 1-800-645-6678 if you've still got a rotary phone that doesn't have the letters on it). Foreign readers will have to consult the Web site for their local distributor. I once tried to put every number worldwide into one of my books, but some of them changed so rapidly, it became a chore to stay up to date.

In the US, your equipment will need to be sent to:

Nikon Inc.
Attn: Service Dept.
1300 Walt Whitman Road
Melville, NY 11747-3064

Or

Nikon Inc.
Attn: Service Dept.
841 Apollo St. Suite 100
El Segundo CA 90245

The Nikon service Web site for NikonUSA is at:
http://www.nikonusa.com/template.php?goingto=inc_service.

Questions and Answers

Q: Are there different models of D90 in different parts of the world?

A: No. A D90 camera sold in the United States is the same as the camera sold in Japan and Europe. The serial numbering method does seem to vary between regions, however (which is one way that Nikon can tell whether you've got an official import or gray market camera, by the way). Servicing and warranty policies tend to vary between countries and regions. Note that some gray market importers "strip" items out of the box Nikon provides in order to offer a "lower price." It's always a bad sign if the retailer asks you if you want a battery, body cap, charger, eyepiece, or any other normally supplied accessory. NikonUSA *will not* repair a gray market camera, and such "add-on scams" are your first sign that you're getting one.

Finally, note that Nikon produces different D90 "kits" that consist of the camera and one or more lenses.

Q: How can I tell if I'm getting an officially imported D90?

A: There's no simple way, unfortunately. In the US, the serial number (at least until they run out of numbers), should be in the form 30####. That's not a perfect method of determining origin, though.

Q: Can I have older manual focus lenses modified to work better with a D90?

A: With a few minor caveats, yes. First, if the lens is pre-AI, you should have the lens converted to AI (see <http://www.aiconversions.com>). Once the lens is AI-compatible, you can mount and use it on the D90. To get the lens to meter you must add what Nikon calls a "CPU chip" to the lens. I used to point out a service that installed CPUs into lenses, but I've received just enough complaints about that vendor that I no longer can recommend them. If you know what you're doing, it's relatively easy to order a CPU from Nikon and install it in the mount yourself. But remember, you

can always shoot in Manual exposure mode and refine your exposure by looking at the histogram.

Q: What's the CPU that Nikon keeps referring to in lenses? Do Nikon lenses really have a computer in them?

A: No, there's not really a computer in Nikon lenses. There is a small chip that provides two or three pieces of information to the camera: the maximum aperture, the focal length, and (on D-type and later lenses) a broad indication of the focus distance currently set. (The focus distance is not exact, but rather one chosen from a small set of possible distances.) Is it really important to use D-type lenses on a D90? If you use flash at close-in distances, yes. With a lens of less than 100mm in focal length and at focus distances of 15 feet (5m) or less, you'll see small, but usually visible differences in flash exposures between non-D and D-type lenses in TTL flash modes. With longer focal length lenses and longer focus distances, flash exposures don't vary much, if at all. In non-flash exposures, you won't see any dramatic differences in exposures between non-D and D-type lenses at the same focal length and focus distance, despite Nikon's claims for improved "3D matrix metering." I have seen some small differences, though, especially with really wide angle lenses focused at close distances. What *does* make a difference for both flash and non-flash use is the maximum aperture information, which is required for the D90 to provide Program and shutter-preferred exposure modes, as well as matrix metering.

Q: Is it safe to let the D90 and Secure Digital cards go through airport X-ray machines?

A: Yes, though the camera should normally be turned OFF before doing so. The danger is not the X-ray itself (as it is with film), but that these devices tend to have strong magnetic fields associated with them. But the brief exposure in any X-ray machine, especially the relatively low-powered ones used in the United States, shouldn't have any impact on the camera or the Secure Digital media. Likewise, your computer

equipment shouldn't have problems with X-ray machines, either.

Q: Are there any underwater housings for the D90?

A: Not specifically as I write this, though the fact that the D90 is the same size and essentially the same layout as the D80 means you might be able to use one of the D80 ones: Sea&Sea DX-D80, Nimar NI303D, Zillion ZAP-D80, Ikelite 6808.1, Nexus D80, Fantasea FD-80, Patima PDCH-D80, Aquatica AD-80, and Hugyfot HFN-D80. Note that these are all more expensive than the D90 itself.

Q: Can I attach a bellows unit to the D90?

A: Yes. The Nikon PB-6 bellows can be attached by using a compatible extension ring (PK-11a, PK-12, PK-13, or PN-11) between the bellows and the camera. Nikon also warns that you may need the PB-6D bellows spacer for some situations. Note that all of these devices are AI compatible, but that means that metering is turned off on the D90. If you use an MB-D80, you may need to increase the extension between body and bellows to clear the front grip of the MB-D80.

Q: Can the D90's software be upgraded?

A: Yes. As I write this, there have been no updates.

Q: Can the D90's sensor be upgraded later?

A: Not likely. Such a change would require a pretty drastic disassembly, removal and realignment procedure, and the supplemental electronics might need to be replaced, too. The likelihood of that being done at a reasonable cost is low, so it's more likely that a replacement camera model would appear instead. Nikon has been on about eighteen month cycles with their consumer models. Any D90 replacement wouldn't appear until 2010 based upon current Nikon cycles.

Q: Is there a software development kit (SDK) available to deal with communication to and from the camera and the NEF file format?

A: Yes. You can apply to Nikon for access to some key header files and other information, including DLLs that operate as “black boxes” between your software and the camera or NEF images. Some developers find it easy to get, others difficult (and it varies between Europe, the US, and Asia). You’ll also need to sign a license agreement to get the SDK. Nikon also produces a “mini-SDK” that allows access to the encrypted white balance for NEF files.