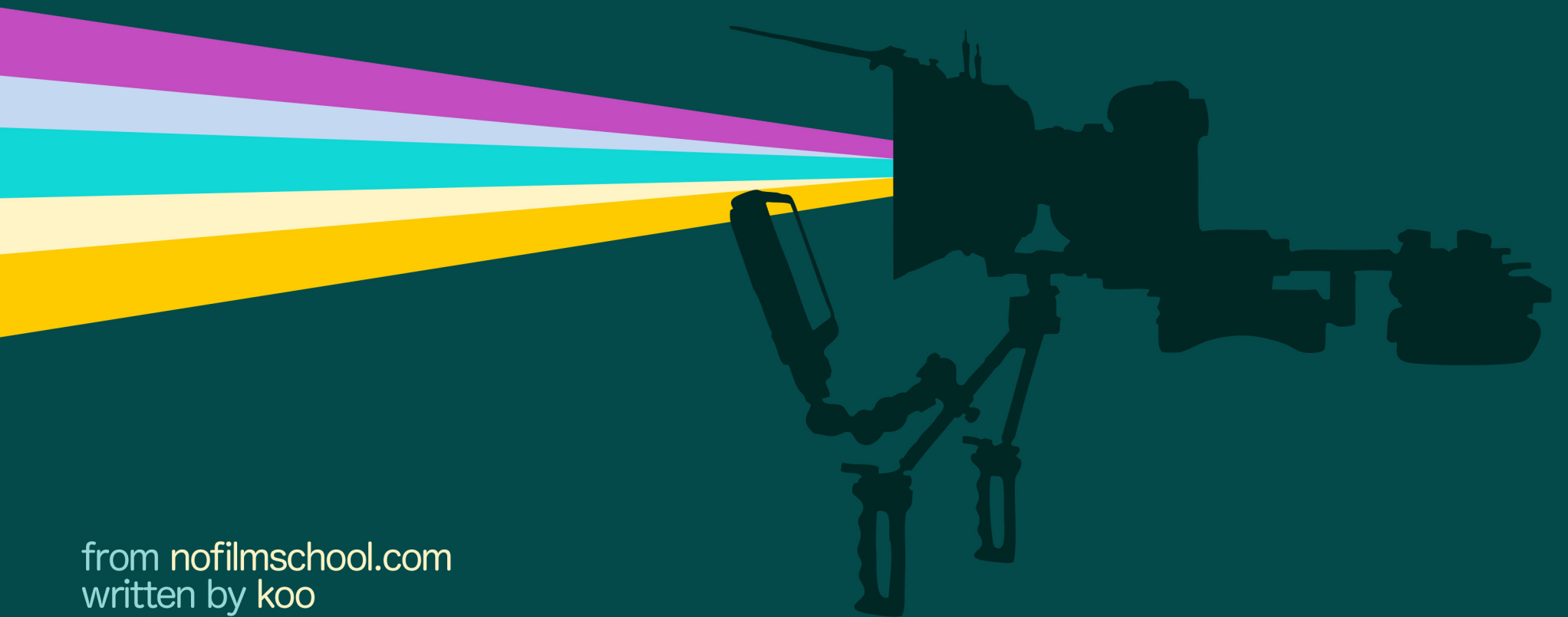


The DSLR Cinematography Guide



from nofilmschool.com
written by koo

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For those of you who have donated in the past, thank you so much for your support — now, onto the guide!

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INTRODUCTION

Why are DSLRs so important?



That “movie mode” hidden in the menu system of your new DSLR? It’s not just a novelty feature. Together with the emergence of large CMOS imagers, HDSLRs are nothing short of a revolutionary, democratizing, disruptive moviemaking technology, as important as the invention of color film, 16mm, or HDTV. Not convinced? I’ve written more about how the DSLR is affecting the future of [not only cinematography but also photography](#), as well as how their low-light sensitivity [enables a whole new generation of international filmmakers to tell their story](#). However, the proof is in the pudding, so here are [ten examples of stunning DSLR cinematography](#). [Zacuto’s Great Camera Shootout 2010](#) is another great demonstration of what DSLRs are capable of when compared to (much more expensive) 35mm film cameras.

As for my own DSLR qualifications, I recently shot two episodes of the WBP Labs/ Babelgum show [RADAR](#) on a Nikon D90; [several behind-the-scenes videos](#) for Focus Features on a [Canon 5d Mark II](#); some other DSLR footage I can't yet talk about publicly; and I've lensed plenty of pre-DSLR projects (e.g. [The West Side](#), or [a music video I shot when I was 19](#)).

Digital cinematography is changing so rapidly these days that a printed book on the subject will likely be outdated by the time it reaches store shelves; this is especially true when it comes to the rapid release cycle of DSLRs. Up-to-date information can be found on online forums, but forums lack the organizing principles of a book, and as a result it

can take a ludicrously long time to piece together reliable information (I spent months forum-surfing to assemble my own camera package). Thus, this guide: I hope it saves readers money they would've otherwise spent on an out-of-date book, and I hope it saves forums from so many newbie — sorry, “n00b” — questions.

DSLRs (often called HDSLRs or VDSLRs now) are a great enabler on the “no film school” front, as they are priced to own and allow aspiring filmmakers to follow the “buy a



DSLRs are a great enabler on the “no film school” front.

camera and learn” lesson plan. But as with any creative tool, a DSLR is only as good as the person using it — because, while these cameras offer a world of advantages, they also come with a considerable set of drawbacks. However, these drawbacks are worth dealing with in order to get the kind of amazing images possible with an imaging sensor that has **twenty to thirty times more surface area** than that of a similarly priced, dedicated video camera. To emphasize: **these cameras are not designed to shoot movies**. Their primary function remains to shoot still photos, but **it just so happens that they shoot amazing video very inexpensively**, and for that they are worth tinkering with, hacking, and jumping through a number of hoops to use. And make no mistake: to modify these still cameras to behave like “real” movie cameras, there are a *lot* of hoops to jump through (thus the length of this guide), but you will be rewarded by using a camera that many of us could only dream of a few years ago, for cheaper than any of us imagined.



As with any creative tool, a DSLR is only as good as the person using it.

This guide assumes some basic knowledge of moving images, such as **exposure**, **shutter speed**, **focal length**, and **frame rate**. It focuses on the technical challenges unique to DSLR cinematography — it won’t teach you how to light scenes, stage camera movements, or cook a full English breakfast. It will, however, give you a huge jump start in figuring out how to make beautiful, inexpensive movies using a DSLR.

I can only take credit for a small percentage of the knowledge here. The vast majority of it comes from terrific user forums like **DV Info**, **Cinema5d**, **DVXuser**, **REDuser**, and **Creative COW**; news sites like **FreshDV** and **Pro Video Coalition**; and noted DSLR users like **Philip Bloom**, **Dan Chung**, **Vincent LaForet**, Jon Fairhurst, **Stu Maschwitz**, and **Shane Hurlbut** (not to mention firmware luminary **Tramm Hudson**). I’ve tried to credit and

link to others wherever possible, but ultimately **this is one person's opinion**. I've taken a lot of findings from the forums and aforementioned users, combined them with my own experiences, and distilled everything down into one time-saving guide. Plenty of people will disagree with some of what I say here, so please make the forums your first stop after reading this guide. Let me repeat: **if you have questions, take them to the forums** — you'll get a faster response and benefit from the wisdom of the crowd. Finally, take into account the crucial fact that **this guide is free!** It's saving a lot of people a lot of time, and it costs nothing, so with that in mind, please keep your comments and suggestions constructive.

The guide is organized in order of basic-to-advanced, meaning you can read it from start to finish if you're new to DSLR cinematography, or jump around using the table of contents if you're a seasoned vet. Without further ado, let's get started!

BASIC CINEMATOGRAPHY CONCEPTS

What should I know about
(digital) cinematography?

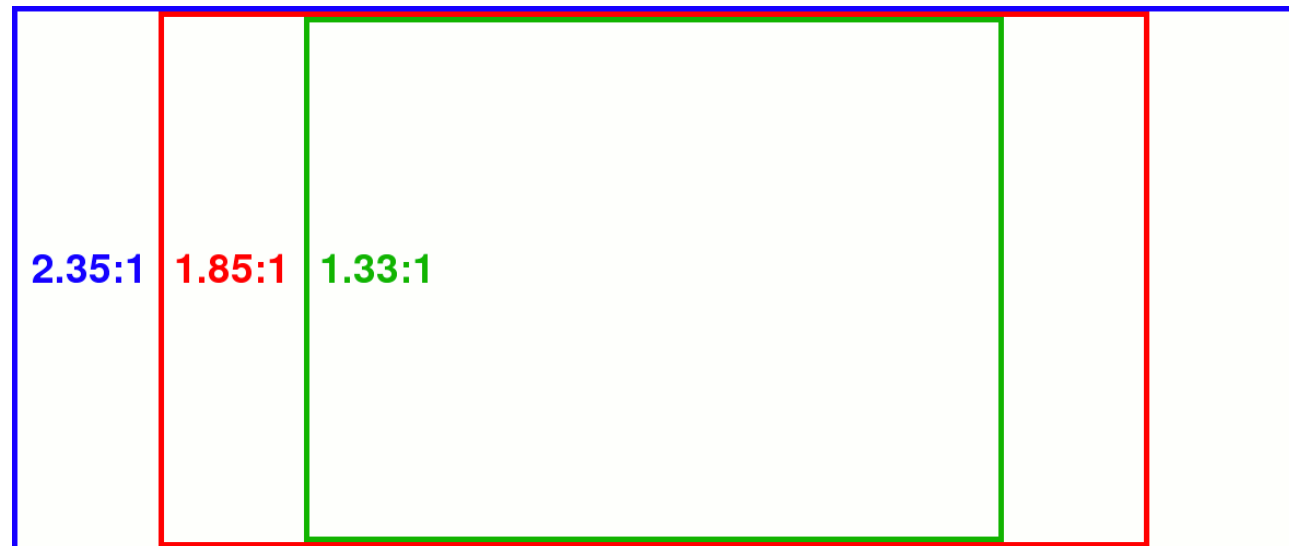


From reader emails, I realized that a basic introduction to some of the concepts referenced later in the guide might be helpful. Many of you are already familiar with these terms, so feel free to skip this chapter! However, if your background is in still photography or if you're new to digital imaging in general, this bonus chapter should help clarify some basic cinematography concepts that we'll be working with going forward. By no means is this an exhaustive glossary, but it is a good starting point. I'm going to explain things from a practical, crash-course standpoint rather than a scientific, 100% semantically-correct perspective, because I think it's handier to know *how* something works in practice than it is to know all of the details of *why* it works — if you're looking for knowledge of the latter, there are of course

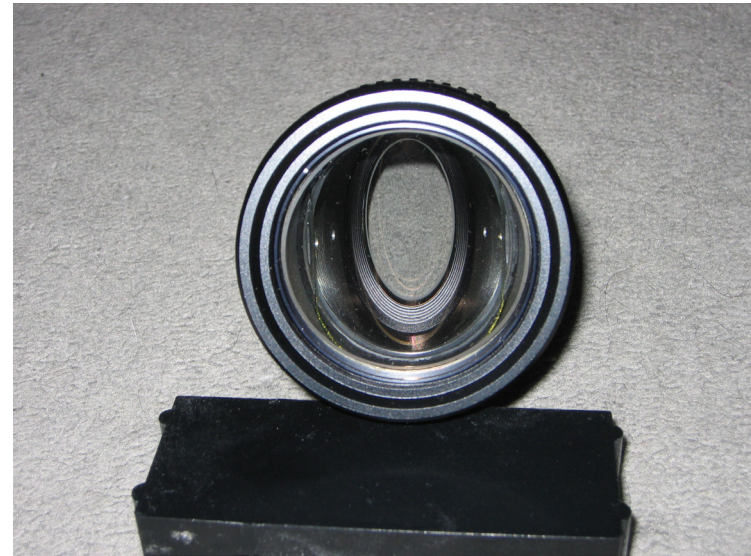
thousands of good resources on the internet to bolster your knowledge. In alphabetical order, then, here are ten basic concepts you should be familiar with:

1. Aspect Ratios & Anamorphic Lenses

Aspect Ratio used to be a more prominent issue for digital cinematographers than it is today: before the advent of high-definition cameras, the standard 4:3 aspect ratio of standard-definition TV was generally seen as undesirable for anyone looking for a “cinematic” look, because 4:3 (or 1.33:1) content was associated with broadcast TV, while widescreen compositions were what people expected to see in the theater. When we say “4:3,” we mean the image is four units wide and three units high. When we say “1.33:1,” we mean... well, you get it — the same thing. Many times the “:1” is removed because it is implied — shooters will simply say “1.85” instead of “1.85:1.”



HDTV today is widescreen by default, with a 16:9 aspect ratio that works out to be 1.78:1 — very similar to the traditional 1.85:1 aspect ratio of many feature films. Other than these two virtually-indistinguishable aspect ratios, the most common widescreen aspect is the CinemaScope ratio of 2.35:1, which appears most often in the multiplex in big-budget films.



2.35:1 films are typically shot with anamorphic cine lenses. **Anamorphic lenses** are not spherical in the sense that they squeeze an image to fill the negative or sensor, with an additional step necessary during projection to re-stretch the image to the intended size. The odd-looking image here of a lens with an oval aperture demonstrates the non-spherical nature of an anamorphic lens (the aperture is perfectly round, but the lens is distorting our view of it). While it is possible to attach an anamorphic lens to a DSLR, most of us will simply shoot at the native widescreen aspect ratio of 16:9.

2. Bokeh

Bokeh (pronounced like “bo” from “boat” and “ke” from “Kentucky”) is one of the chief reasons many shooters have switched to DSLRs. Bokeh is a term derived from

the Japanese word “bokeh” which, roughly translated, means “blur quality.” Bokeh refers to the portions of an image that are defocused or blurry. In the filmmaker’s toolkit, bokeh is not only an aesthetically pleasing quality, but it also allows the filmmaker to focus the viewer’s eye on an object or area of interest in the frame. Bokeh is a function of shallow depth-of-field (see below).



Lossy codecs are the reason we can record hours of footage to inexpensive flash memory devices like CF and SD cards.

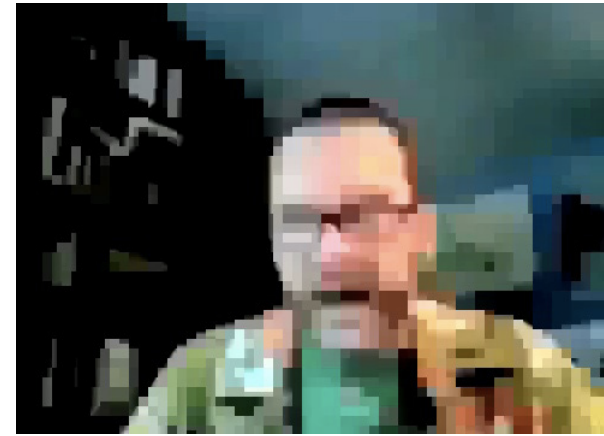
3. Compression & Bit Rate

Compression refers to a method for reducing the amount of data a DSLR produces; in the case of video-shooting DSLRs, all cameras currently employ some method of compression. If you’re used to shooting photos in **JPEG** format, you’re used to capturing compressed images; while RAW can also employ compression, it is generally thought of as “uncompressed.” This is because, as far as shooters are concerned, when we’re talking about compression we’re talking about lossy compression — meaning, a codec (compression algorithm) that throws out data in order to reduce file size. As you can imagine, tossing portions of an image has negative side effects, and while many codecs



DSLRs exploded in popularity almost singlehandedly because of their ability to render images with a shallow depth of field.

deal with images perceptually in order to minimize their perceived impact, the difference is there. For example, if you upload a video to YouTube, the service re-compresses your video in order to optimize it for internet delivery; you might not notice this compression, but check out this [video that's been recompressed a thousand times](#) and you can see that every compression step throws out data along the way. On the positive side, however, lossy codecs are also the reason we can record hours of footage to inexpensive flash memory devices like CF and SD cards.



The most common compression formats in DSLRs are [h.264](#) and [MJPEG](#), and while both are lossy, h.264 is generally much more efficient (it introduces less artifacts at the same bit rate as MJPEG). **Bit rate** is the amount of data per time that a given codec adheres to; higher bit rates are almost always better because they use less compression. At press time there are no DSLRs that shoot uncompressed video.

4. Depth of Field

The amount to which objects in the foreground, mid-ground and background are all in focus at once is a function of **depth of field**. A shallow depth of field would mean that only one plane was in focus; a wide (or deep) depth of field would mean that all planes are in focus at once. Depth of field is determined by the focal distance and

aperture size (see below for more on Aperture). DSLRs exploded in popularity almost singlehandedly because of their ability to render images with a shallow depth of field. This is chiefly due to their massive sensor sizes (see the next chapter, “Choosing a DSLR,” for an examination of sensor sizes), which are exponentially larger than previous video cameras. On a basic level, shallow depth of field (DOF) allows filmmakers to blur out areas of the image they deem to be unimportant or undesired.



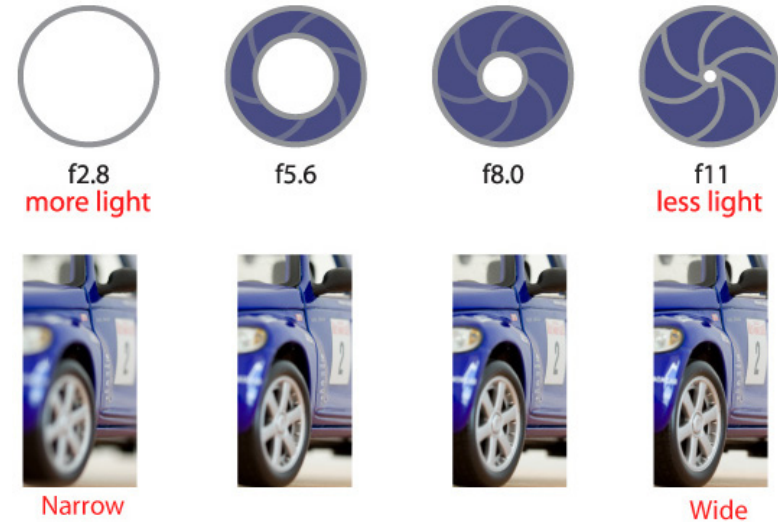
5. Exposure & Aperture

Exposure refers to the amount of light allowed to enter the DSLR sensor (or any imaging surface). When shooting stills, DSLRs use a mechanical shutter to regulate exposure by opening for the desired amount of time (1/60th or 1/1000th of a second, for example) and then closing. DSLRs are generally rated to last for hundreds of thousands of shutter cycles, but at 24 frames per second, couldn't your DSLR reach that limit very quickly? No, because in video mode, DSLRs use an electronic shutter — the sensor basically turns on and off to regulate exposure, instead of relying on a physical barrier (i.e., the mechanical shutter) to regulate light. **Aperture** refers to the adjustable opening near the rear of

In video mode, DSLRs use an electronic shutter.

the lens that lets light through — the amount of light it transmits is generally referred to as the **F-stop** (T-stop is very similar, except it's *measured* instead of *calculated*).

We'll go more into depth on aperture in the "Lenses" section of the guide, but keep in mind that the size of the aperture does not only affect the *amount* of light, but also the angle of light rays hitting the sensor — a narrow aperture creates an image with a wide depth of field, whereas a large aperture creates an image with a shallower depth of field.



A narrow aperture creates an image with a wide depth of field, whereas a large aperture creates an image with a shallower depth of field.

6. Focal Length

Technically, **focal length** refers to the distance over which collimated rays are brought into focus. An easier way to think of it: focal length refers to image magnification. A longer focal length, e.g. 100mm, makes distant objects appear larger, whereas those same objects will appear smaller with a shorter focal length, e.g. 35mm. Focal length also refers to angle of view; longer focal lengths have a narrower angle of view, whereas shorter focal lengths have a broader angle of view. When it comes to focal length, a picture is worth a thousand words, so here are images taken with the camera in the same place, but with lenses of different focal lengths attached:



28mm



50mm



70mm



210mm



Being able to shoot in 24p is essential if you're planning on shooting narrative material.

7. Frame Rate


Frame rate is the frequency with which your DSLR captures consecutive images. This typically corresponds to the number right before a "P" in the case of progressive images,

so that 24p is 24 frames per second, 30p is 30 frames per second, and 60p is 6,000,000 frames per second. Just kidding. Different frame rates have very different motion rendering characteristics, which, combined with different shutter speeds, produce images that behave very differently. Motion pictures have had a standard frame rate of 24 frames per second since the 1920s, and audiences have come to associate this frame rate with cinematic content, so being able to shoot in 24p is essential if you're planning on shooting narrative material. However, you don't always have to shoot at the same frame rate at which you're planning on distributing your material. For example, if your DSLR can shoot 60p, this is a very effective way of acquiring slow-motion footage — anything shot at 60p can be played back at 40% speed in a 24p timeline for a flawless slow-motion effect, and can generally be slowed down further in your editing system.

8. ISO & Noise

ISO is actually the International Organization for Standardization, which is why you see it used in lots of places beyond photography — many businesses are certified [ISO:9001](#), for example. As cinematographers we're concerned with just one "standardization," however — the one that pertains to *measurement of noise in photography*. ISO as it relates to digital photography is based on analog standards of film speed — while we won't be shooting a frame of actual film with our DSLRs, our cameras are calibrated so that an ISO of 400 on our camera is somewhat equivalent to a film SLR's ISO 400. ISO is a logarithmic measurement, so ISO 400 is twice as sensitive to light as ISO 200, ISO 200 is twice as sensitive as ISO 100, and so on and so forth.

The relationships between sensitivity and **noise** is basically linear, however, so the



ISO is a logarithmic measurement, so ISO 800 is twice as sensitive to light as ISO 400, ISO 400 is twice as sensitive as ISO 200, and so on and so forth.

higher the ISO, the brighter the image — and the more noise contained in the image. However, thanks to sophisticated noise reduction and other processing tricks, DSLRs have managed to dramatically reduce noise at higher ISOs, and can often blow film stock out of the water (this depends on which camera you're shooting with, which we'll cover in the next chapter).

9. Progressive vs. Interlaced

Interlacing was a workaround invented for older-tech CRT monitors in the 1930s that has lived far too long. In the early days, video bandwidth was more limited than today, and so engineers found a way to divide a frame into two images and display it using alternating fields. As you can see in this image of a tire wheel, interlacing can cause motion artifacts (as well as a host of other problems). We're lucky to live in a predominantly progressive society today — in



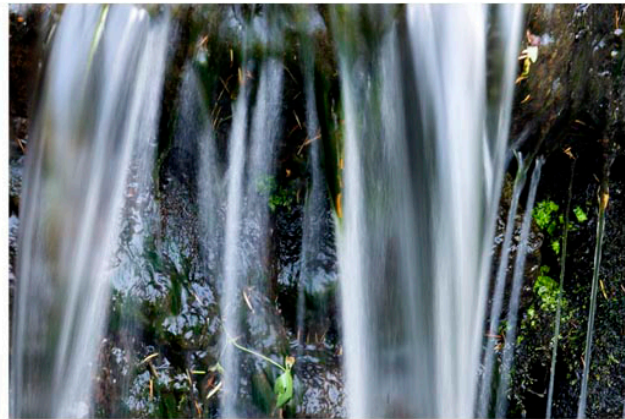
the imaging sense if not the political. **Progressive scanning** is a method that captures and displays the lines of an image in sequence, which is akin to motion picture film with regards to motion rendering. Compared to interlaced images, progressive images have a higher vertical resolution, lower incidence of artifacts, and scale better (both spatially and temporally). Friends don't let friends shoot interlaced! Luckily, while there are plenty of video cameras that shoot interlaced footage, every DSLR I can think of shoots progressive footage.

Interlacing can cause motion artifacts as well as a host of other problems.

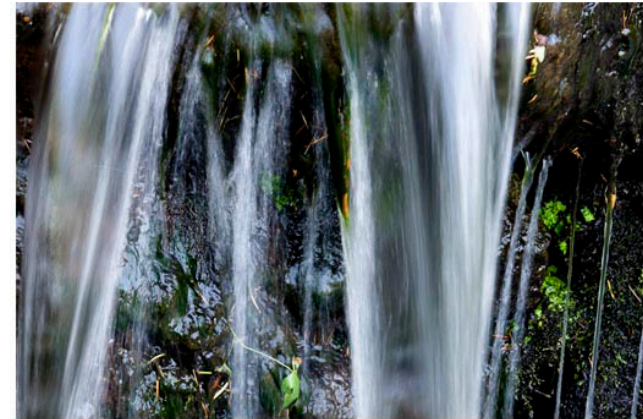
10. Shutter Speed

Shutter speed refers to the length of time an image is exposed. For film SLRs, this would be measured by the amount of time the camera's mechanical shutter is open, but for shooting video on DSLRs, this is simulated electronically. Shutter speed affects the amount of light that reaches the camera and also affects the motion rendering of the moving

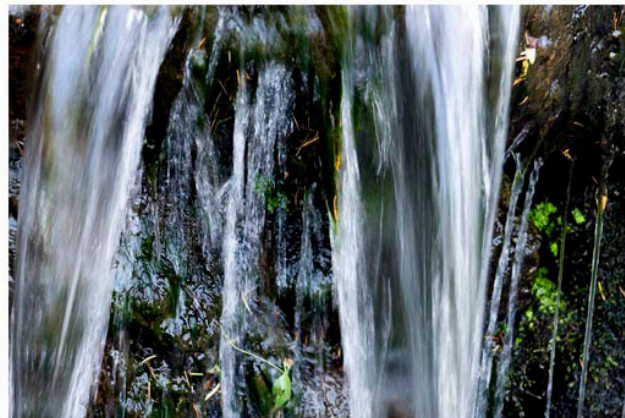
Shutter speed affects the amount of light that reaches the camera and also affects the motion rendering of the moving image.



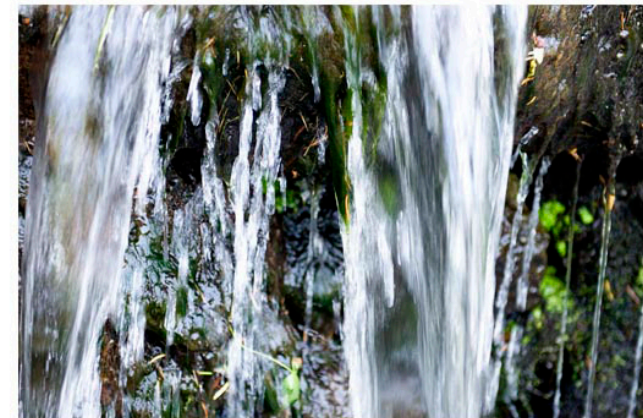
1/2



1/5



1/20



1/60

image. Lower shutter speeds yield a brighter and smoother image (up to and including water and light blurring tricks), whereas higher shutter speeds result in a darker and more stroboscopic image.

Motion picture film cameras typically shoot with a 180-degree shutter, which means that the shutter is open 50% of the time (180 out of 360 degrees). This means the amount of time your shutter is open is half of the shooting frame rate; thus, at 24 frames per second, a 180-degree shutter is best emulated on a DSLR by choosing a shutter speed of 1/48. This may not be possible depending on your DSLR, so the closest reading will do — 1/50 or 1/60, for example. This gives the most “filmic” rendering of motion, but can be varied greatly depending on your intention. Higher shutter speeds create “jerkier” images, as most famously seen in action films like [Saving Private Ryan](#) and [Gladiator](#). Conversely, lower shutter speeds create “smoother” images due to increased motion blur. There is no hard and fast rule when it comes to shutter speed, but if you’re not sure of what shutter speed to select, go with the setting that’s closest to half that of your current frame rate.

Okay! That was much longer chapter than I anticipated, despite blitzing through these concepts as quickly as possible. If you don’t understand something, don’t worry – you’ll figure it out as you go. Now let’s get started with DSLRs by checking out some cameras.

CHOOSING A DSLR

Which camera is right for me?

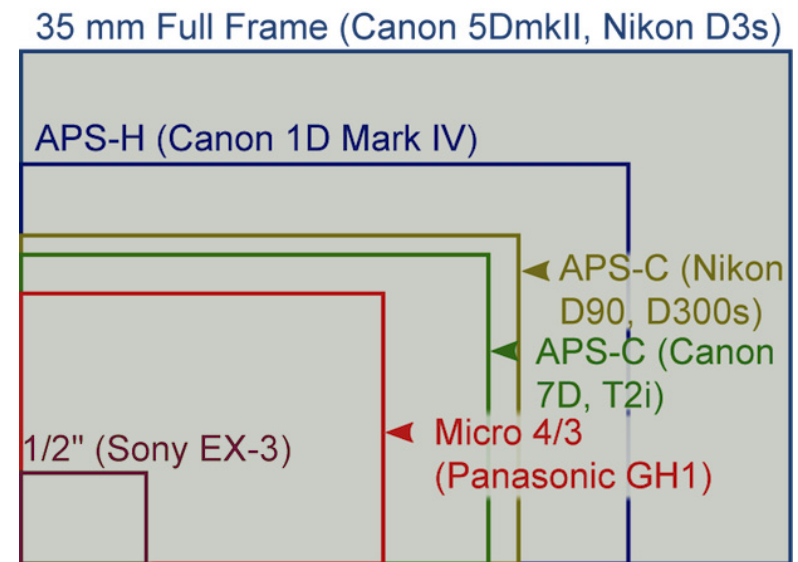


This guide focuses on Canon's EOS series of DSLRs ([1D Mark IV](#), [5D Mark II](#), [7D](#), [60D](#), [Rebel T1i](#), [Rebel T2i](#)), but also pertains to Nikon's cameras ([D3100](#), [D90](#), [D300s](#), [D3s](#)), as well as other video-capable DSLRs like the [Panasonic Lumix GH1](#), [Pentax K-7 HD](#), and Sony's [A55](#), [A33](#), and [NEX series](#). Given new cameras are always hitting the market, you might want to check out the [top-selling DSLRs](#) list to find out what's current. If you're wondering why some DSLRs shoot video and others don't — or why none of them did a couple years ago — check out [Gizmodo's article](#). At this point in time I believe the Canon DSLRs offer the best quality and flexibility for filmmakers, due in part to their superior [h.264](#)-based codec (which is of higher quality than the [MJPEG](#) codecs of Nikon and the lower-bitrate [AVCHD](#) codec of Panasonic's offering). However there are several top DSLRs contending for your hard-earned dollars (not

all Canons); each camera has its particular strengths and weaknesses, which should help you decide which DSLR is right for your particular needs.

The main thing to understand while reading the following comparison is how DSLR sensor size affects the images the camera produces. Larger sensors aren't *always* better, but for our purposes it's easiest to think of larger sensors as capturing images that have a shallower **depth of field**, greater **dynamic range**, and better **low-light sensitivity**. Here is a chart of DSLR sensor size: ¹

As you can see in the chart, Canon and Nikon's implementation of APS-C is *slightly* different, but not enough to make a practical difference. For comparison's sake, I've included the \$9,000 **Sony EX-3** professional video camera in the chart — you can see how much larger all of these DSLR sensors are, which is the chief reason why DSLRs are such a disruptive technology. With this in mind, let's take a look at the top DSLRs for filmmaking:



¹ Sensor size illustration modified from a Wikipedia image by Moxfyre and Autopilot.

Canon 5D Mark II



Strengths: In my opinion, thanks to its full frame sensor the 5D produces the smoothest, most beautiful images of them all (this should be written out four times because this factor far outweighs the others...) Also due to the sensor size, the 5D is the friendliest of the Canon DSLRs for using old SLR lenses (you don't have to deal with crop factors). Thanks to a firmware update, shoots at 1080p/24p as well as 30p. Also has manual 48KHz audio. Good build quality. Shoots terrific stills.



One important issue regarding your DSLR choice that you won't find in a manual or spec sheet is the camera's hackability.

Weaknesses: HDMI output drops to 480p the moment you hit record; this is terrible for using [field monitors](#) (not so much an issue if you're planning on using a LCD viewfinder). Footage starts to get noisy from heat without the camera telling you it's overheating. Full frame sensor can be an issue if you want to adapt cine lenses, which don't cover the almost [VistaVision](#)-sized sensor. No 50p or 60p which means you can't get great slow-motion footage from the camera. Full frame sensor means your depth of field is so shallow that it can be difficult to pull focus.

Canon T2i (a.k.a 550D)

Strengths: A great deal — it's basically the same camera as the 7D (see below) for less



than half the price. Cinema-sized APS-C sensor size with lots of recording options: at 1080p, 24p/25p/30p; at 720p, 50p/60p (great for slow-mo work). Terrific LCD screen. Did I mention the T2i is a great deal? IMO it can't be beat as a "first DSLR."

Weaknesses: Not much weather coating, and not as good at shooting stills as some of the others (slower continuous shooting speed, no top LCD). HDMI-out drops to 480p during recording. Overheats easily. No manual audio control and no manual white balancing.

Canon 7D



Strengths: Offers some advantages over its cheaper cousin T2i, chiefly that its HDMI-out stays at 1080i during recording. If you're planning on using a field monitor, this is huge. The 7D is also crazily weatherproofed — video camera users will not be used to being able to leave a camera recording in rain and snow, but the 7D can handle adverse conditions with aplomb; something to keep in mind if you're shooting in extreme conditions. Same sensor size and flexible video recording options as the T2i.

Weaknesses: More expensive than the [T2i](#) without offering a ton of upgraded features – it’s still priced very aggressively, and its price wouldn’t be considered a “weakness” if it weren’t for the cheapness of the T2i. Overheats easily. No manual audio control.

Canon 1D Mark IV



Strengths: Canon engineers applied some magic to the sensor and got some extra low-light performance out of the sensor (most famously demonstrated by [Nocturne](#)). APS-H sensor size splits the difference between Full Frame and APS-C, which can offer some interesting advantages (zoom lenses get a bit more reach and your lens kit effectively doubles if you’re pairing the [1D](#) with a different camera because primes attain a different focal length on the 1D). Beefier batteries, beefier build quality.

Weaknesses: APS-H sensor splits the difference between Full Frame and APS-C, which can offer some interesting disadvantages (good luck finding good wide-angle lenses). No manual audio. More than twice as expensive as the [5D Mark II](#), yet has a smaller sensor.

Nikon D3s

Strengths: Full frame sensor just like the [5DmkII](#); the best low-light performer of them



all thanks to A) the size of the sensor, B) larger pixels on the same size sensor (the D3s is 12MP instead of 21MP), and C) better noise reduction. If you've got a lot of Nikon lenses, you don't need to mess with adapters. Probably the best camera in this roundup for taking still photos.

Weaknesses: Maxes out at 720p! Crappy recording codec. 5-minute clip limit (Canons max out at 12 minute takes). Nikon engineers are still significantly behind Canon engineers when it comes to video and so the \$5k Nikon DSLR trails the \$800 Canon when it comes to resolution, codec, and frame rate options. No manual audio control.

Panasonic GH1




Strengths: Inexpensive. Offers 1080p at 24p and 720p at 60p (for North America; 25p and 50p for PAL countries). Articulating LCD screen and actually viable auto focus give shooters greater flexibility than the other DSLRs here. The GH1 also doesn't line-skip like the Canons do which reduces or eliminates **aliasing** problems. I didn't consider the GH1 to be a particularly viable camera for filmmaking because of its codec, until it was significantly upgraded thanks to a brilliant **hacked firmware** that allows the codec bitrate to be raised from 17Mbit

to 50Mbit. For more on this firmware, see the chapter “GH1 Firmware.” At such a high datarate the efficiency of the codec is much less of an issue; this singlehandedly transforms the GH1 into a viable moviemaking tool. DVXUser has some [GH1/5D comparisons](#), from which users seem to favor the GH1’s image.

Weaknesses: Low-bitrate codec is crippling if you’re not into the idea of installing unsupported hacked firmware on your \$1k equipment. Not great in low light no matter what you do to the firmware. [Micro 4/3 sensor](#) won’t give you as shallow a DOF as the rest of the cameras here. No manual audio options.

To summarize, I still like the [Canon 5D Mark II](#) as an all-around great DSLR (for both movies and stills) despite its quirks; once Canon added 24p and manual 48KHz audio via firmware update, the 5D became a much more viable tool for shooting, say, feature films. On the lower end the [T2i](#) is so much camera for the money that I can’t see a downside to owning one (even as a B cam to, say, a [5D](#)). As the [GH1](#)’s hacked firmware matures, it will be interesting to see if it catches up to the Canons.

One could write an entire guide on choosing a DSLR, but that is a never-ending and ever-changing debate that I can’t resolve for anyone; each shooter’s DSLR choice comes down to availability, price point, and their own particular needs. Take into account the strengths and weaknesses mentioned above and also check out the forums for further info! Also, when budgeting for a camera package, assume the camera itself is going to make up a third (or less) of your overall expenses. This is just a rough rule of thumb, but if you have \$8k to spend, don’t target a camera that costs \$5k; consider a \$2-3k camera body and then budget for lenses, tripod, audio equipment, etc. and see where you end



When budgeting for a camera package, assume the camera itself is going to make up a third (or less) of your overall expenses.

up. While DSLRs are capable of capturing great moving images, they are by no means optimal for movie making in terms of features or ergonomics; thus a plethora of add-ons are necessary to make a DSLR behave like a “legitimate” movie camera. Unfortunately, much of the add-on market is targeted at accessorizing cameras that cost several times as much as a DSLR; when your camera costs \$300k, it makes sense to spend \$5k on a matte box; when your camera itself cost \$3k, it’s a bit harder to justify. This guide focuses on finding quality equipment on a reasonable budget.

SAVING MONEY

How can I get the best deal on a DSLR?



Buying a gray market camera means you're ineligible for warranty coverage in the US.

Once you've decided on a model, buy it from an authorized dealer. If you're in the US, confirm on the manufacturer's website that the dealer is authorized (here are the dealer search pages for each manufacturer: [Canon](#), [Nikon](#), [Panasonic](#)). I recommend [B&H Photo](#), for two reasons: 1) I believe they have the best combination of price, selection, and service; and 2) I am a B&H partner, which means any items purchased through B&H links help support NoFilmSchool. It doesn't cost you anything to do so — B&H simply gives me a small percentage of their sale. Feel free to shop around, but digital cameras in particular are notorious for being sold through unauthorized channels, and while you'll see a number of seemingly great deals, many of these are [gray market](#) — they are new, sealed, genuine

products, but they're being imported directly from Taiwan or Hong Kong and are therefore bypassing the US division of the camera manufacturer. This is a sizable investment on your part and though the listing for "HUGE KIT!!! Camera, 7 lenses, 3 tripods, 48 batteries, and maid service" may be appealing — it's probably cheaper than the camera alone from an authorized dealer — buying a gray market camera means you're ineligible for warranty coverage in the US, which is not something to skip, especially if you plan on putting your camera to professional use.



If you know exactly what you want, however, you can often find the best deals by keeping an eye on eBay.

However, if you want to search [eBay](#) for deals on DSLRs, I've got a great way of doing so for USA-based shooters. To ensure we find reputable sellers, I've set up advanced eBay searches using Boolean logic in an attempt to eliminate gray market sellers. These links should only display USA-based authorized dealers (see below for a way to double-check). I've also eliminated used cameras and bid-only auctions, since authorized dealers generally sell new cameras as "Buy it Now." Here are the DSLRs for which I've set up customized searches, use whichever link corresponds to the camera you're interested in:

- [Canon EOS 5D Mark II](#)
- [Canon Rebel T2i](#)
- [Canon EOS 7D](#)

- [Canon EOS 1D Mark IV](#)
- [Nikon D3s](#)
- [Panasonic GH1](#)

I've arranged the search results by price (lowest to highest), but you'll want to scan the different listings to find the best deal (some will come with lenses, some will be body-only, and others will come in larger packages with multiple bundled items). Also make sure to note the shipping fee — some are non-existent and some are exorbitant. Once you've found your item, be sure to search the item's listing page for "USA Warranty," "Authorized Dealer," or something similar that affirms the seller is authorized to sell the particular brand of DSLR you're buying. I tried to customize the search as much as possible, but it's by no means infallible, so make sure they state somewhere in their listing that they're authorized.

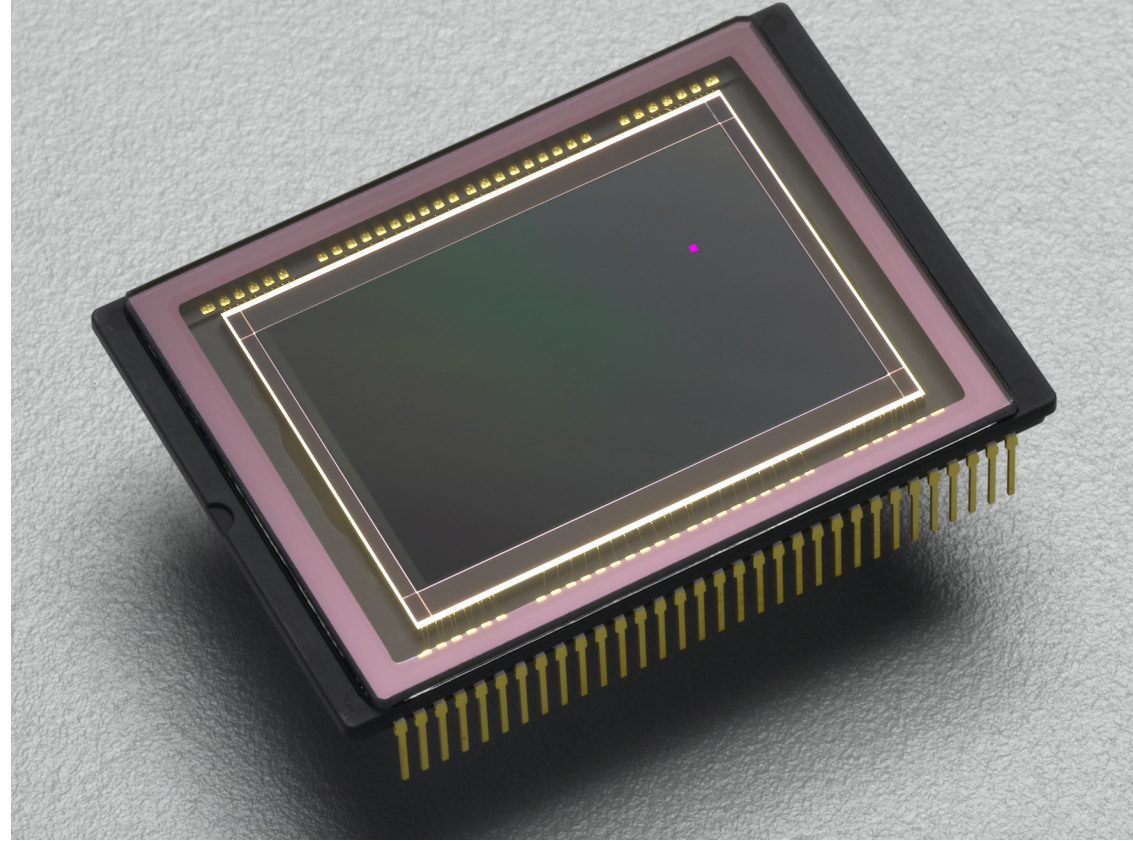


Good used equipment is always better than cheap new equipment.

Finally, by buying used accessories on eBay, you can save hundreds; the end result is either significant money saved or more equipment purchased. A final tip: if you think you might freelance and charge an equipment fee, keep in mind your producer won't know if you bought your equipment used; good used equipment is always better than cheap new equipment.

STUCK PIXELS

What are these tiny, persistent dots on my image?



You will almost certainly get a camera that ships with a few hot pixels.

Another reason to buy your camera from an authorized dealer is the all-too-common issue of [stuck pixels](#) (also known as “hot” or “dead” pixels; see the purple dot on the next page for an example). With the extremely high pixel-count CMOS sensors (and massive sensor sizes) of current DSLRs, you will almost certainly get a camera that ships with a few hot pixels; video camera users accustomed to [CCD](#)-based imagers may not be ready for this. For pro DSLRs that ship with 20 million pixels, several stuck pixels are well within a manufacturer’s tolerated specs, and pro photo applications like [Lightroom](#) or [Aperture](#) often detect and fix stuck pixels automatically when you import still photos. However, there is no such fix for video, and while one stuck pixel out of 20 million unmoving pixels isn’t very noticeable on a still photo, one

stuck pixel out of two million moving pixels is often *very* noticeable (DSLRs record video in a reduced-resolution mode; 1080p is just shy of 2 million pixels). It's not entirely necessary to test for stuck pixels in still mode with your new camera — you'll drive yourself crazy thinking about your "defective" camera (if you really want to geek out, though, they have [programs](#) you can use to run tests).



The hot pixel issue alone is a good reason to buy from an authorized dealer with a decent return policy.

However, you *should* absolutely enter a low-light setting, crank up the ISO, and pan across a plain wall in movie mode to see if you have any persistent dots. My first 5D had 16 stuck pixels in still mode and 1 on video, so I exchanged it (my second fared better, with 7 stuck/hot pixels in still mode, but again a sole offender in video mode, for which I'm planning on having it serviced). The hot pixel issue alone is a good reason to buy from an authorized dealer with a decent return policy, as every DSLR is like a box of chocolates. Except these days a box of chocolates is not, in fact, like a box of chocolates: there are pictures on the outside of the box and you usually know exactly what you're going to get.

If you don't detect a dead pixel until you've already shot your footage, all is not lost. I wrote a post on the very subject of removing dead pixels using Final Cut, After Effects, or Vegas: [How to remove stuck pixels from video footage](#).

ALIASING AND MOIRÉ

Why do jagged horizontal lines sometimes show up?



Another issue to be aware of before diving headfirst into the DSLR world is the problem of aliasing (moire is an offshoot of the same problem). Aliasing is a problem with DSLRs because the cameras were designed primarily to shoot still photos at much higher resolution than their video mode allows. So, in order to drop from 5616 x 3744 in still mode to 1920 x 1080 in video mode, the camera skips lines. Ideally the camera would sample all of the pixels and average them out, giving you a smooth image (think about resizing an image in Photoshop and choosing Bilinear or Bicubic); instead, because DSLRs lack the processing power required to do this in real time, they just toss every other line or so (think about resizing an image in Photoshop and choosing “Nearest Neighbor”). What you’re left with are unseemly jaggies.



The first thing you should do when switching your DSLR from still to movie mode is to make sure the Sharpness setting is turned all the way down.

The end result is most commonly seen on thin lines and patterns, and ranges from overt to invisible. For an example, watch the gray rooftop here:



This video can be watched on the online version of this chapter, at: <http://nofilmschool.com/dslr/aliasing-and-moire/>

The first thing you should do when switching your DSLR from still to movie mode is to **make sure the Sharpness setting is turned all the way down**. This won't come close to eliminating aliasing under all conditions but it should reduce your camera's problems. As the chips inside these cameras get more powerful, we might see a HDSLR that does some in-camera image sampling; but to eliminate aliasing problems, the best solution might be to actually lower the camera's resolution (this is one of the advantages of a 5-megapixel RED camera over a 21-megapixel DSLR).

For more on the technical reasons behind aliasing and moire, see [Barry Green's post at DVXuser](#) and [Stu Maschwitz's follow-up](#) (I commented on both as well).

ROLLING SHUTTER

Why does the image appear unstable?



Rolling shutter, known informally as jello cam, is another drawback inherent to large CMOS sensors. Yes, CMOS technology allows you to put a big 'ole chip inside a relatively cheap camera (compared with a **3CCD** approach), but with the good (Shallow depth-of-field! Low-light sensitivity!) comes the bad (Stuck pixels! **Bayer filtering!**) and the ugly (Jello cam!). Because large CMOS sensors scan top-to-bottom instead of all at once like CCDs, fast movements and pans can cause the image to appear to wobble. I can show you better than I can tell you:



Don't expect to do any whip-pans with your DSLR, and don't expect to shoot Blair Witch-style.



This video can be watched on the online version of this chapter, at: <http://nofilmschool.com/dslr/rolling-shutter/>

Dealing with jellocam (same with aliasing) is all about knowing the enemy, and using the right tactics to avoid it. **Don't expect to do any whip-pans with your DSLR, and don't expect to shoot Blair Witch-style.** Treat your VDSLR like a larger motion picture camera — better yet, attach some accessories and a third point of contact (more on this later) to make you treat it like a larger motion picture camera — and do planned, slow camera movements. This instruction alone, more than any technical nugget contained in this guide, will help your productions tremendously! Also be aware of strobe lights, flash photography, or lightning — such rapid changes of illumination can cause partial exposures, where half of the frame is bright and half of it is dark.

OVERHEATING

Why did the camera suddenly turn off?



Overheating is an unfortunate side effect of getting a whole lot of camera for very little money.

DSLRs weren't designed to shoot video in a bona fide video production environment, so no matter which DSLR you buy, you're likely to have overheating problems. This is when the DSLR's operating temperature rises to the point where the camera either shuts down automatically, or the image becomes noisier due to the excess heat. This generally happens after several minutes of continuous shooting; in the case of the Nikon D90, the camera will just shut down and you'll be unable to enter Live View mode until it has sufficiently cooled; in the case of the 5D the camera will allow you to shoot as it overheats but your image will become noisier due to interference from the heat. Overheating is an unfortunate side effect of getting a whole lot of camera for very little money, and the best solution is actually to get two camera bodies so you can shoot with one while the other cools. Or, if you're on a

major production, get [13 bodies](#). Other than that, there's not a whole lot you can do to prevent it, except to take the camera out of Live View whenever possible, keep the shooting environment as cool as possible, and plan your production's breaks accordingly. On staged productions where it's a standard operating procedure to cut often, DSLR overheating is not a deal-breaker; however, **if you're considering a DSLR to shoot interviews this is a major consideration as your camera will inevitably run into issues in the middle of an interviewee's spiel.**

Here is a timelapse video of a [7D](#) in Live View; when the red flashing temperature icon appears, the camera will shut down.



*This video can be watched on the online version of this chapter, at:
<http://nofilmschool.com/dslr/overheating/>*

Okay, enough about the drawbacks of shooting movies with HDSLRs! Remember you're getting a camera that has a shallower depth of field and is more sensitive to light than anything else south of \$20k! You've now been warned of the drawbacks, but as I said earlier: the hoops are worth jumping through.

LENSES: USING PRIMES, CHOOSING A BRAND

Which lenses should I use?



One of the beauties of DSLR moviemaking is being able to change lenses. Up until this point in history, every video camera below \$5k has had one fixed lens that you shot everything through. ² No longer!

But wait, what's the advantage of having interchangeable lenses, you ask? After all, many people buy their first DSLR and only use the all-purpose lens that came with it (sort of defeating the purpose of having a SLR in the first place). Well, there is no such thing as an

There is no such thing as an "all-purpose lens."

² There might be exceptions to this rule, but it's *basically* true.

“all-purpose lens.” It’d be like wearing an all-season outfit — you need winter clothes for when it’s cold out, summer clothes for when it’s hot out, and no clothes for when it’s nudist out.

With DSLR moviemaking, if you want your films to look like everyone else’s, use the stock lens. Fine. But the stock lens is not suited for narrative filmmaking. It’s cool for documentary, but for a shallow **depth of field** and better low-light sensitivity, you’re going to want **Prime lenses**. Wait, let me stress this a bit more:




Primes!

Yes, for narrative filmmaking, primes are your BFF. Documentarians will probably want more zoom lenses in their kit for flexibility, but primes (meaning, lenses with a fixed focal length) are generally faster (in terms of light, I mean, not “how many shots you can get in an hour”) and less expensive. They also make you reposition the camera and put some thought into getting a shot rather than automatically reaching for the zoom, the latter of which is the hallmark of home movies.

Primes are less expensive than more mechanically complex zoom lenses, and because

For narrative filmmaking, primes are your BFF.



If you're on a tight budget and are mostly interested in shooting movies, you can skip the bundled lens, buy the body-only version, and spend the savings on used lenses.

they've been around for years, **“buy used” has seldom been more true than when it comes to DSLR lenses.** New DSLRs come with autofocus lenses, which work great for still images, but in video mode they're stuck using a contrast-detection method which is too slow to be viable; no one should be using autofocus on narrative films anyway. If you buy the camera with a bundled lens, you'll get a solid all-around lens for taking still photos; however, if you're on a tight budget and are mostly interested in shooting movies, you can skip the bundled lens, buy the body-only version, and spend the savings on used lenses. Here's where the great advantage of “obsolete” technology comes in: there are thousands of manual focus-only lenses out there with a deflated value because of their relative uselessness on modern DSLRs — except when it comes to video mode, where they're suddenly useful again.

While you can't beat good cine lenses, at this price point it's a blessing to have so many interchangeable lenses available at bargain prices. Many of these older manual lenses may not be up to the task of resolving 21 megapixels with aplomb, but they don't need to; in video mode, 1080p amounts to just shy of 2 megapixels, and any old halfway-decent SLR lens outstrips this resolution. For the web almost any SLR lens will be sharp enough, but if you're planning on going to the big screen (theatrical, a festival run, etc.) then you'll want to make sure you're getting a **sharp enough piece of glass.**

When it comes to assembling a kit of lenses, most filmmakers like to choose a brand and stick with it, so the visual characteristics of the lenses match up from shot-to-shot; with the same brand lenses in your kit, the lenses will also handle similarly (some have dampened focus rings and true aperture rings, whereas others rely on the camera for aperture selection electronically and have looser focus rings designed for autofocus).

Matching a lens brand to your camera — a common practice in the still world, and often a necessary one given the differences in lens mount electronics between manufacturers — is not nearly as important for video. ³ And thanks to the widespread availability of quality, low-cost lens adapters (pictured right) that allow one manufacturer's lenses to work with another's camera, you don't have to put Canon lenses on a Canon — you can generally interchange manual lenses at will with the right adapters. More on adapters in a bit, but first, let's take a look at the particular characteristics of each lens brand, for which I'll defer to DP [Shane Hurlbut](#) (*Into the Blue, Terminator Salvation*), who summarized them nicely on his [blog](#):



- **Canon lenses** “produce wonderful skin tones, have medium contrast and give you a wonderful gradation into the blacks.” The problem is, any recent Canon lens relies on the camera's electronics to control the aperture (not a good thing; most camera

³ The newest version of the Magic Lantern firmware includes auto rack-focusing as a feature of software; it remains to be seen how practically important it is, but it does offer a compelling reason to stick with Canon autofocus lenses, if you like the idea of automated focus pulls. Personally, I'm not interested, but there may be some follow focus devices coming down the pipeline that use the Canon internal electronics.

operators, myself included, would rather have instant, tactile access to exposure controls), and older manual Canons are generally thought of as being slightly optically inferior to their Nikon counterparts. However, if you're buying a Canon EOS and going the hybrid route — you plan on shooting a lot of stills in addition to video — you will definitely want some quality, modern Canon glass.

- **Zeiss lenses** *“produce a colder, contrasty feel. They are incredibly sharp... Be sure to use more fill light when using these lenses and also control your highlights.”* Shane's absolutely right; one of the disadvantages to a DSLR movie when compared to, say, 35mm film is the DSLR has less **dynamic range** (and, to date, lacks some of the gamma knee options of a sophisticated video camera to control highlights). A very saturated, contrasty lens like the Zeiss would often be an advantage, and I do appreciate their aesthetic (I own a Zeiss set myself), but you have to be even more careful with **Zeiss** lenses to protect your highlights from blowing out harshly. Zeiss lenses are famous for having very large, all-metal focus rings with a lot of fluid drag, which many DPs like (I actually find the action a tad too heavy for handheld work), and they share many rendering qualities with Zeiss cine lenses, which is to say: they're beautiful.
- **Nikon lenses** *“are sharp with a little softer contrast than the **Zeiss** lenses.”* In my own experience, Nikon lenses are generally the most widely available and least expensive. They have manual apertures and a light touch to their focus rings (which I happen to like, but some don't), but they have one main problem: their focus rings turn in the opposite direction of every other lens (which can be confusing for operators or focus pullers). This means instead of turning the focus ring clockwise to focus nearer,

you turn Nikon lenses counterclockwise. I can't explain how infuriating this can be if you're used to the "standard" configuration; there are reversing gears for use on a follow focus, but it's a consideration regardless.

- **Panavisions**, of course, *"are the ultimate lenses."* But you can't afford them (in fact, you can't even buy them). If your production has a sizable budget and you're planning on renting equipment (and are shooting on a DSLR for some reason), by all means check them out, but know you'll need special adapters as well.
- **Leica lenses** *"delivered beautiful contrast and color throughout. They felt the closest to the Panavision Primo primes and had more of a cinema focus throw, even more than the Zeiss ZE primes. These lenses resolve so well on the big screen."* I haven't used Leica lenses myself, but shooters love them; there's some more on Leica lenses in the next section.

Finally, Zeiss has released a complete set of **Compact Prime CP.2 lenses** tailored for DSLR filmmaking. These





Of all of the gear covered in this guide, lenses just might be the best investment, because good optics will never be obsolete.

lenses are no joke, and as you can see, neither is their price. But compared to, say, their [complete set of DigiPrimes](#), the Compact Prime 2s are a bargain! Especially considering they are Zeiss's first set of cine lenses to offer full-frame coverage (this means you, [5D Mark II](#) owners, as well as future RED full-framers). So, what are some of the advantages of these Compact Primes? Geared focus *and* iris rings, smooth aperture adjustment (no mechanical stops), 14 aperture blades (which equals a smoother [bokeh](#) than their 9-bladed counterparts), and an interchangeable EOS/PL lens mount — it's enough to get a filmmaker like myself, who (present guide otherwise excepted) often wants to scream “enough about the minutiae of the technology, how good was the writing?!? And what does it *mean*?” excited about spending money I don't have. Here's the thing to keep in mind with lenses in general: of all of the gear covered in this guide, lenses just might be the best investment, because **good optics will never be obsolete**. So say you mortgage the house and drop \$20k on these Compact Primes? They'll work on your DSLR, a full-frame [RED](#), a 35mm film camera, and basically any cinema camera going forward (and they hold their value well if you one day decide to, or need to, sell). Just something to keep in mind as you budget for the various components listed here.