

## Pixel Aspect Ratio, Part 1 Fitting rectangular pixels into square holes.

by Chris & Trish Meyer, CyberMotion

One of the more annoying idiosyncrasies of digital video is that images often look distorted on a computer monitor: they're either too wide or too skinny, especially when working with widescreen footage. This can lead to a crisis in confidence – often late at night, usually on deadline – as to whether you can trust your eyes, or if you are doing the right thing. In this article, we will help explain the tricky subject of pixel aspect ratio or “PAR” for short, including PARs for common video formats. In our next article, we will discuss strategies for mixing non-video assets such as photographs and scans with your digital video, including how not to make a client's logo – or the clients themselves – look too fat or too thin.

### Pixels, Fat and Thin

Computers are, for the most part, logical devices. As part of this, the picture elements or “pixels” on their displays are usually square: as wide as they are tall. Thanks to this, when you draw a circle that is supposed to be, say, 200 pixels tall and 200 pixels wide, it looks like a perfect circle.

(That's in theory. You can always adjust a monitor wrong, or feed it a screen resolution that doesn't line up with its actual size. But we're going to pretend for a moment that everything's right in the world...)

By contrast, video isn't nearly as logical. A normal, non-widescreen television picture is supposed to have a 4:3 image aspect ratio, meaning it is 1.333 (4÷3) times as wide as it is tall. You would think these numbers would carry over to how many pixels are used to depict a video screen. They don't – at least, not directly.

The specification for NTSC-format professional standard definition video – also known as “D1” after a high-end digital video tape standard – states that a frame is 720 pixels wide and 486 pixels tall. Indeed, all Artbeats NTSC standard definition clips are delivered at this size. However,  $720 \div 486 \neq 1.333$ ; instead, it comes out to something wider than a 4:3 image.

To compensate, these pixels need to be displayed on a television screen 10% thinner than normal to compensate (in other words, roughly 90% as wide as they are tall). This is referred to as a PAR of 0.90, indicating how much the image has to be scaled horizontally to look correct upon playback. As long as you keep the image away from a computer and just display it on a video monitor, you'll never see this internal accounting. Alas, as soon as you look at one of these images on a square pixel computer monitor, the images will look a touch wide.

The PAL standard stretches pixels in the other direction: 720 x 576 pixels are used to describe a 4:3 image (and indeed, this is the size Artbeats uses for their PAL standard definition clips). Again, the math doesn't work without some fudging; in this case, the pixels are drawn about 7% wider than they are tall on a video monitor (yielding a PAR of 1.07). But look at a PAL image on a properly adjusted computer monitor, and it will look slightly skinny.

(The NTSC DV standard of 720x480 pixels would initially seem to require a different pixel aspect ratio to compensate. It doesn't: It's the same as D1, with six lines cut off to save on the amount of data stored to a DV tape. In PAL, D1 and DV frames are the same size.)

Aside from providing mind-numbingly boring party trivia, what is the significance of all this? That digital video images won't look quite right on your computer monitor: Circles, people's faces, and the such will look fat if working in NTSC, and skinny if working in PAL. More importantly, they should look “wrong” in this way. If you make an unaltered NTSC or PAL image that looks perfect on your computer monitor, it will then look wrong(!) on a real video monitor, as the video will be compensating for those non-square pixels by squishing or stretching them on playback.



Figure 1a

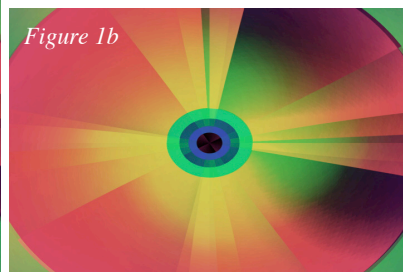


Figure 1b

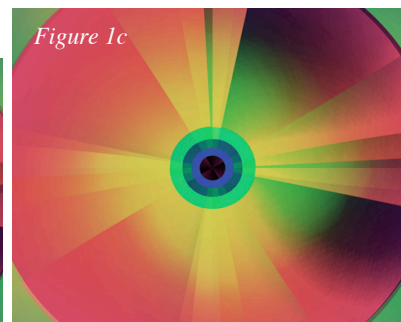


Figure 1c

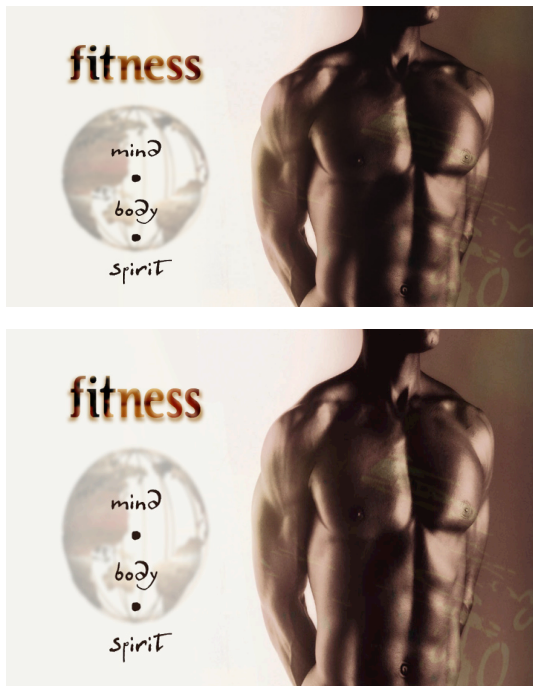
Figure 1a-c: An NTSC clip that looks like a perfect circle on a video monitor (a) will look slightly wide on a computer (b). If it is a PAL clip, it will look slightly pinched on the computer (c). Clip is Artbeats Digidelic DG101, which was given away free in January 2007 to eNewsletter subscribers.

## Widescreen and HD

Normal 4:3 standard definition video is not the only format that has issues with pixel aspect ratio. For example, widescreen standard definition (SD) video is particularly tricky. Widescreen images are supposed to be displayed with an image aspect ratio of 16:9. Internally, however, *widescreen SD uses the exact same frame size as 4:3 video*. How?

What good cameras do not do is letterbox the video; those black bars above and below the image would waste precious pixels that could be used for the image itself. Instead, when a camera is in widescreen mode, it squishes the video image horizontally to fit the wider image into the available pixels. These images in turn look seriously skinny on a computer monitor, whether in NTSC or PAL. Upon playback, a widescreen video monitor stretches a D1 or DV image back out by 120% for NTSC (PAR = 1.20), and 142% for PAL (PAR = 1.42) to compensate for the camera's squish. This technique is referred to as

Figure 2: An anamorphic widescreen video image (top) will look much skinnier than normal on a computer monitor (bottom).



### anamorphic widescreen.

High Definition (HD) video was originally specified to use only square pixels, just like a computer. The two standard HD sizes are 1920x1080 pixels (which is the size Artbeats uses for their HD clips) and 1280x720 pixels. However, that's a lot of pixels for a camera to store onto tape. Therefore, many HD formats also employ non-square pixels.

HDV – perhaps the most common HD format right now – stores a “1080” image into a 1440x1080 frame (not 1920x1080), working out to a PAR of 1.33. The NTSC DVCPRO HD format stores

a “720” image into 960x720 pixels (not 1280x720), also yielding a PAR of 1.33. Even more extreme is DVCPRO HD's “1080” format, which uses 1280x1080 pixels, yielding a PAR of 1.5 – a very skinny image when viewed on a normal square-pixel computer. It's not just these prosumer HD formats that squeeze pixels; the higher-end HDCAM format also uses a 1440x1080 frame to store a supposedly



Figure 3: Most high definition video (top) – including HDCAM and HDV – is captured to videotape in a squeezed format (bottom). Image is Artbeats' FWR137H2 from Faces of the World HD Vol 2 collection; all Artbeats HD clips are delivered unsqueezed at their full 1920x1080 frame size.

1920x1080 image, just like HDV.

## Workflow

If all you're doing is editing between video clips of the same format, pixel aspect ratio is merely a piece of digital trivia: All of your clips are captured this way, and will be played back through a system that knows how to handle them, so there's no problem – especially if you monitor your work through a video display.

Troubles appear when you combine media from different formats: for example, non-square-pixel video with square pixel photographs, scans, and other artwork. Fortunately, many program can translate between these different PARs – but only if you create your sources

# Tips N Tricks

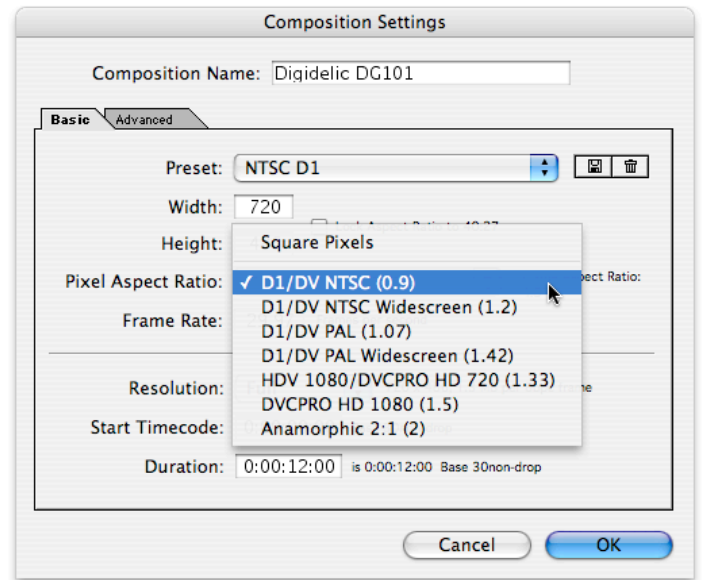
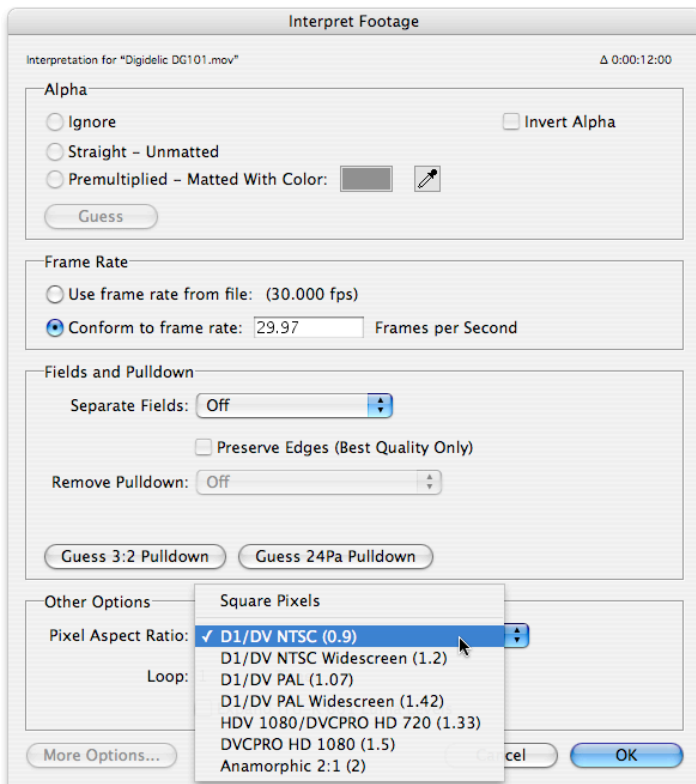
More available at [artbeats.com](http://artbeats.com)

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correctly, and tag all of your sources and compositions truthfully. We will discuss this in more detail in our next article, but in short, most problems with PAR arise when a user tries to out-smart their software.

For example, in Adobe After Effects there are two places where you need to set the pixel aspect ratio: for the source, and for the composition where you are combining layers. To set PAR for a source, select it in the After Effects Project panel, and type Command+F on Mac (Control+F on Windows) to open its Interpret Footage panel. In the Other Options section is a popup for Pixel Aspect Ratio: Set it to match the format of your source. After Effects does a reasonably good job at auto-sensing the correct PAR for a footage item when you import it, but it is always good to double-check this popup –

*Figure 4: In your software (Adobe After Effects is shown here), make sure every source clip has its PAR set correctly (below), as well as your sequence or composition (right). Then your software will know how to properly translate between different format sources when building the final image.*



As long as you set the PAR popups for every footage item and composition correctly, programs like After Effects will then know which images to stretch and which to squash to correct everything as needed for your final video.

## Zooming Out

In our next article, we will talk about common mistakes and pitfalls when working with non-square pixels, including the right and wrong way to prepare Photoshop artwork, and problems with effects that don't understand non-square pixels. We will also discuss alternative ways of working, including building square-pixel sources and compositions that you can later squish down to the correct non-square-pixel frame size for your final render.

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pecially when using widescreen footage.

To set PAR for a composition in After Effects, select the comp and type Command+K (Control+K) to open the Composition Settings dialog. It too has a Pixel Aspect Ratio popup; set it to match your intended output format. This happens automatically when you pick a Preset in the Composition Settings, but is easy to miss when you manually set up a comp.