# The Case of the Pixilated Pixels

## Square vs. Rectangular Pixels in Digital Video

By Dan Reid

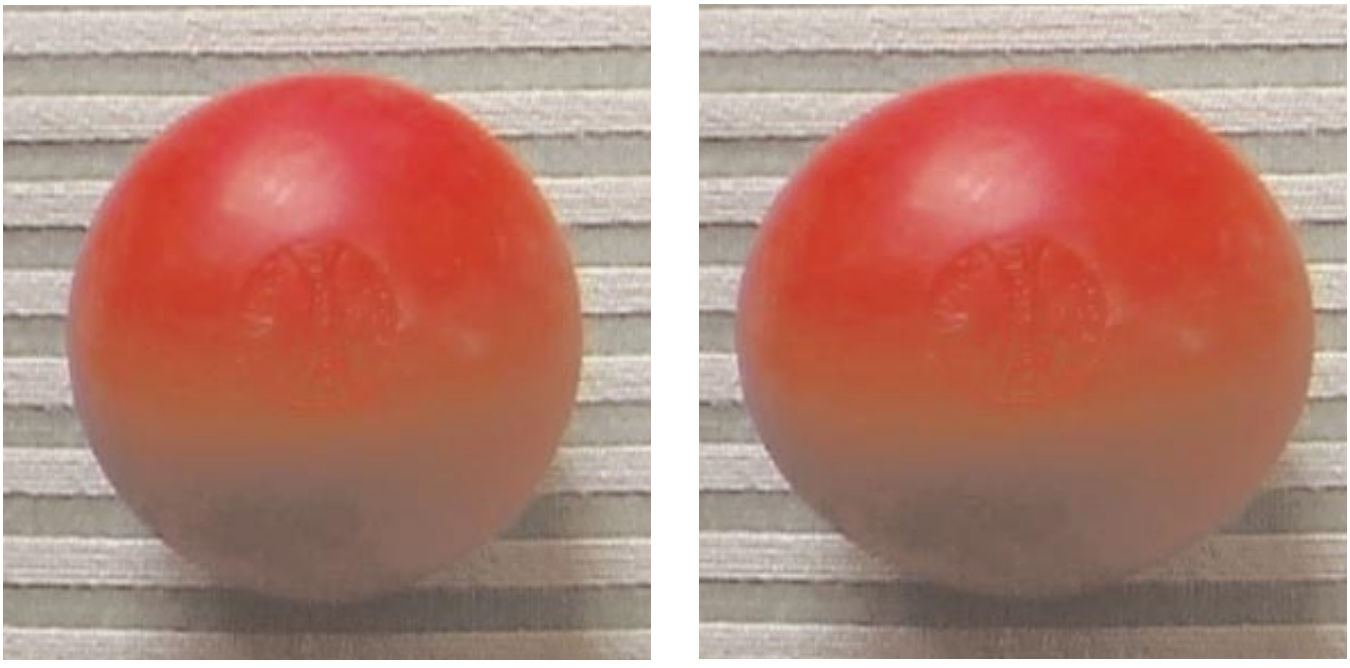
While I've been singing the praises of the mini-DV format and Apple QuickTime 3.0 for some time now, I haven't yet discussed how various software applications handle digital video (DV) files using QuickTime 3.0.

One of the most confusing aspects of editing DV footage is how the clips are displayed and rendered on square pixel devices. Most software and hardware are designed to work with square pixels. However, DV, D1 (ITU-601 or CCIR-601), and MPEG-1 video formats are encoded with rectangular pixels. If a rectangular-pixel image is displayed on a square-pixel monitor, there will be noticeable distortion. The converse is also true.

Mini-DV, DVCAM (Sony), DVC-PRO (Panasonic), and MPEG-1 all use a resolution of 720x480 pixels and are encoded using rectangular pixels. D1 is a slightly higher resolution file, representing 720x486 pixels. All of these formats have a viewable aspect ratio of 4:3 on a television set, even though the aspect ratio of the digital file is different.

The confusion sets in when files that use a rectangular pixel aspect ratio are brought into the computer. QuickTime 3.0 supports the DV file format. It does not, however, instruct software applications on how to render in a rectangular-pixel aspect ratio, nor explain how these unique video files are compensated for on square-pixel computer monitors, with the exception of visual correction for MPEG-1 files.

Software applications that correctly interpret the DV files will show a 4:3 aspect ratio on the computer monitor, but they will render using a 0.9:1 pixel aspect ratio. If the file is not correctly interpreted, the image will appear distorted on the square-pixel monitor. QuickTime does compensate for the MPEG-1 rectangular-pixel aspect ratio: MPEG-1 movies generated at 352x240 will display as 320x240 on the computer monitor. Unfortunately, however, DirectShow 6 on the Windows platform supports only square pixels, making it difficult for media authors to decide how to encode MPEG files. Most commercially available MPEG players do not support square-pixel MPEG-1 files, and may therefore exhibit distortions.



*The image on the left illustrates how a rectangular-pixel DV file will look on a square-pixel computer monitor; the image on the right shows how the video will look on an NTSC monitor.*

*Figure A*

*Figure B*

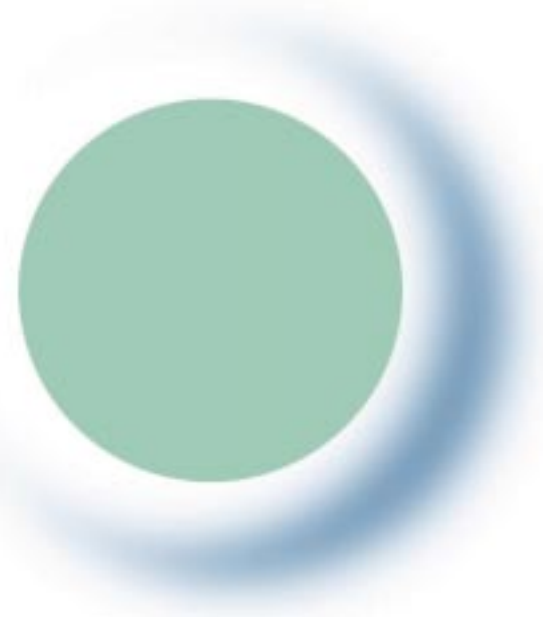


*Figure C*

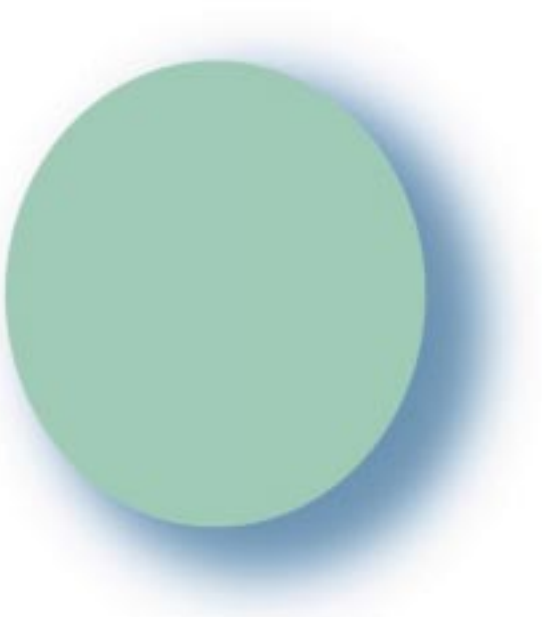


*Figure D*

*These four graphics illustrate how non-square files look on various devices. Figure A shows how a DV or D1 clip will look on an NTSC monitor. But if viewed on a computer monitor, the image will appear elongated (Figure B). Figure C shows how the graphic will look on your computer screen when you are creating your graphic for non-square output. Distorting the graphic for non-square pixel output now makes the graphic look like Figure D. Remember that the DV clip (Figure A) will not render properly for non-square output. It will look accurate on a computer monitor, but on an NTSC monitor, it will look like Figure D.*

**Software Interpretation**

Media Cleaner Pro 3.1, from Terran Interactive, has robust support of non-square pixel files. Within its preference settings, the user can correct ITU-601 resolution clips for (square-pixel) computer monitors, which does not alter the file or change the pixel aspect ratio. This correction can be manually applied to movies or automatically corrected by recognizing CCIR-601 resolution files. Media Cleaner Pro 3.1 supports a unique feature not found in other applications—the ability to account for input and output aspect ratios. Because Media Cleaner Pro adjusts the CCIR601 files to view properly on a computer screen, it allows for accurate cropping when the aspect ratio for output is different from input. The manual cropping marquee is constrained to the output aspect ratio selected in the Image tab, which simplifies an otherwise confusing operation.

Adobe Premiere 5.1 uses QuickTime 3.0 as the backbone for rendering and importing footage. Unfortunately, CCIR601 resolution files brought into Premiere 5.1 neither render nor view properly

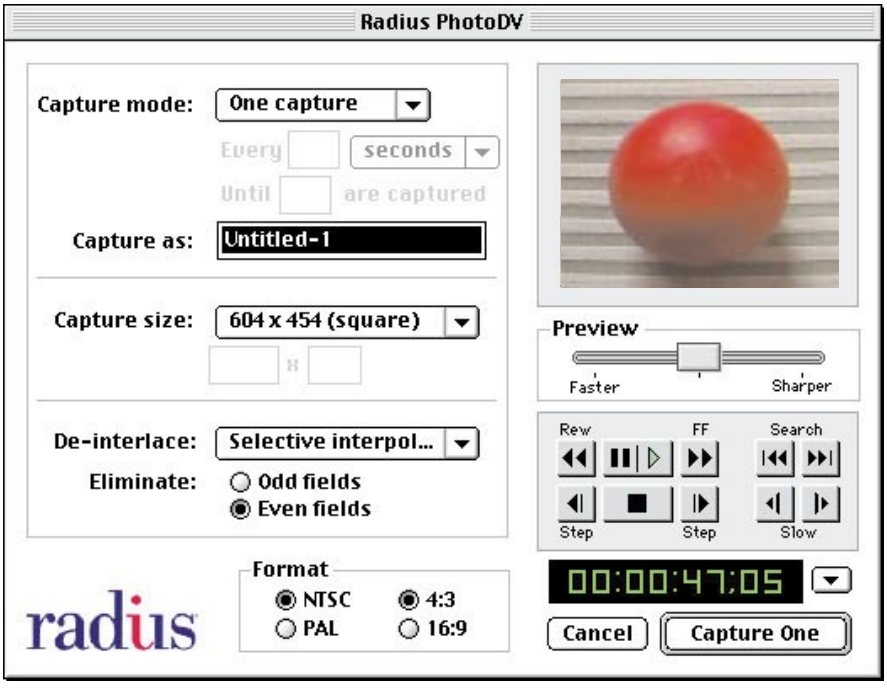
on the computer screen. The distortion that is created when rendering transitions is minor, because the aspect ratio of the analog output of CCIR601 devices is 4:3; the distortion is not as apparent as you might think.

Adobe After Effects 3.1 has supported CCIR601 resolution files for some time. Importing a graphic, still image, or video clip with a CCIR601 resolution triggers the file to be interpreted as a D1 resolution clip. DV files, which have a resolution six pixels fewer than D1 resolution, require manual interpretation. Part of correctly interpreting the file in After Effects is accurately interpreting the pixel aspect ratio. After Effects allows both rectangular and square pixel footage to be used in a composition, as long as each file is correctly interpreted. You can import a graphic with a resolution of 720x480 pixels, but encoded with square pixels. After Effects allows each file to be interpreted independently. The Windows version of After Effects recognizes DV files as D1 resolution files with rectangular pixel dimensions, while the Macintosh version does not.

Radius EditDV 1.5 fully supports all aspects of DV files; it is one of the few editing applications that correctly interprets these files. It was originally designed for the VideoSP line of video capture cards but, seeing the coming revolution of DV, Radius dropped its line of analog capture cards and rewrote the code to deal with rectangular pixels. DV files viewed in EditDV are proportioned correctly on a computer monitor and render properly.

The QuickTime 3.0 scaling algorithm for video is optimized for playback, but not necessarily for compression. When changing from one pixel dimension to the next, especially when compressing more than 50 percent, scaling becomes very important. Terran Interactive uses a different algorithm for situations requiring this drastic reduction in resolution, which produces noticeably sharper compressed frames with compression greater than 2X (e.g., 720x480 to 160x120 pixels). There is no significant difference when employed for compression less than 2X (e.g., 720x480 to 640x480)

Applications that take advantage of QuickTime may yield varying results, as its scaling component for distribution is drastically different from its original purpose.




*Radius has a plug-in for Adobe Photoshop that takes the guesswork out of de-interlacing and compensating for rectangular pixels. The Radius PhotoDV allows the user to select from the pull-down menu compensation for non-square pixels.*

**Creating Rectangular Pixels**

Scanned images or artwork created in Adobe Photoshop must be distorted to render properly in CCIR601 resolution video projects. Adobe Photoshop, like many other graphic programs, uses a square pixel geometry. Therefore, a canvas of 720x486 in Photoshop does not make a rectangular-pixel file. Though the pixel dimensions are rectangular, the pixel aspect ratio is still square. To create graphics that can be used in rectangular pixel projects, we must manually distort the file to simulate rectangular pixels.

Creating a file with 4:3 pixel dimensions and then compressing the image to a rectangular pixel dimension can be tricky in programs that do not interpret different pixel aspect ratios. If we create an image with a canvas size of 720x540 (4:3), then distort the aspect ratio of the frame to 720x486 pixels, we can simulate rectangular pixels by squashing the image.

Creating graphics and images for

DV requires a slightly different pixel dimension. DV and MPEG-1 files are six pixels shorter horizontally than D1 files. DV and MPEG-1 frames are 720x480, and therefore require graphics to be created at 720x534 (six pixels shorter) to be correctly proportioned when reduced to the 720x480-pixel resolution.

**Rendering Problems**

If a video file is properly interpreted by the software, transitions and effects will render correctly based on the output settings. Though this seems logical, some software applications that use video disregard the pixel aspect ratio of each file independently. CCIR601 resolution files will look like they're stretched horizontally on a computer monitor, but will appear correctly proportioned on an NTSC monitor. CCIR601 resolution files have a viewable aspect ratio of 4:3, but a different pixel aspect ratio. Photoshop files that are not adjusted for rectangular pixel geometry will appear to be squashed inward on a computer monitor, but will render and view properly on a NTSC monitor.

If editing software does not support rectangular pixels, you will have to live with the distortions or do some rendering trickery. Instead of using 720x486 output size for D1 clips, use a 648x486 output resolution and crop the final output three pixels from the top and bottom, and four pixels from each side. You will have a true 640x480 square-pixel video file. Sizing directly down from 720x486 to 640x480 will cause serious problems in the field order. When working with DV footage (720x480), use an output size of 648x480 instead, and crop four pixels from each side.

Radius EditDV is one of the few applications that natively supports rectangular pixel geometry files. The internal scaling algorithm properly shows rectangular pixel files on square pixel monitors. Without this special processing, exact placement of effects and titling would not be possible. Clips would also appear distorted on the computer monitor, though they look correct on an NTSC monitor.

Adobe After Effects, used in many high-end production facilities, can correctly interpret the rectangular-pixel formats of D1 and DV when compiling a final composition. After Effects relies heavily on QuickTime, and a viewable aspect correction is not an option when viewing footage on a computer monitor. The end user must make a separate "viewing composition" with the correct aspect ratio and then "nest" the original composition inside the viewing composition. Although this will correct image distortion, rendering will become more complex, thus adding to the compiling time. Some analog video capture cards do support CCIR601 resolutions, and offer video overlay on computer screens to properly display rectangular-pixel images.

**Surprise Endings to Avoid**

When dealing with DV files, be wary of how your editing or compositing application handles pixel aspect ratios—you could be in for a surprise. Some applications do a better job than others in handling these non-square pixel files. Eventually, other software manufacturers will offer support, but until then, pay close attention.

Creating graphics to be used in CCIR601 projects can be especially confusing. If at all possible, create your titles within an editing application that supports non-square pixels. Scaling video to different distribution platforms requires special tweaks if the original footage was recorded in rectangular pixels. Having an application that allows you to correctly preview the output dimensions and cropping prior to compression can be a real plus, eliminating unexpected surprises in the end. ◀

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