# Multi-format Editing on DigiSuite DTV

By integrating the DV, DV50, and MPEG-2 compression formats in a single editing system along with analog, 1394, SDI and eventually SDTI input/output, DigiSuite DTV gives you the tools you need to maintain the highest video quality throughout the editing process and to output your program in any format you need.

## The benefits of "native" DV editing

Native editing means that all the video equipment in a production chain (such as the camera, the NLE system, and the VTR) shares a common compressed bitstream format, and video is transferred between the devices in its original digital format. All copies are identical to the original master, so there is no "generation loss." At the moment, DV is the only open-standard digital compression format that can be edited in its native mode. DV cameras, VTRs, and nonlinear editing systems are all widely available from multiple manufacturers. Native DV transfers can be made over 1394 and SDTI links. As an added bonus, SDTI allows you to transfer DV compressed video between devices at up to four times faster than realtime. An hour of video can be transferred from a VTR to an editing system in just 15 minutes. As soon as VTR manufacturers begin shipping DV50/SDTI VTRs, the DV50 format will also lend itself to native editing. In the meantime, DV50 material must be transferred over SDI. When standard MPEG-2 cameras are introduced, it's likely that MPEG-2 will also become a good format for native editing. In the meantime, since you can't shoot in MPEG-2, the only way to edit in MPEG-2 is to transcode.

Native editing preserves video quality in three ways:

- You avoid transcoding. If your editing system uses a compression format other than DV, such as Motion-JPEG or MPEG-2, you must first transcode your DV footage into the format accepted by your system. Every time you transcode, you compound compression artifacts and decrease quality. While you can minimize artifacts by transcoding at a higher bit rate, you do so at the expense of an increase in storage space. (View the test results in "Native editing eliminates transcoding artifacts").
- You avoid analog-to-digital (A/D) and digital-to-analog (D/A) conversions that would be necessary without the 1394 or SDTI link. Video-quality degradation is particularly apparent if you must go through a composite or Y/C analog connection from your DV camera or VTR to the editing system. The image-quality penalty is less for analog component. (View the test results in "Native editing eliminates A/D & D/A conversion artifacts").
- You avoid the decompression/recompression process that takes place when you capture DV material over SDI. SDI transfer is the second-best option, after native transfer, and in most cases does not produce visible degradation. (View the test results in "Native editing eliminates SDI recompression artifacts").

## DV versus DV50

DV is one of the most popular video acquisition formats, and with good reason. Outstanding images can be captured with low-cost cameras. DV relies on a 4:1:1 or 4:2:0 pixel sampling structure and an efficient compression algorithm that gives excellent image quality at a relatively low bit rate (25 Mb/sec). DV formats include Panasonic DVCPRO, Sony DVCAM, Sony Digital-8, and the consumer DV format used by Sony, JVC, Canon, Sharp and Panasonic. Tests have shown DV to be comparable to Betacam SP.

DV50 is a higher quality format than DV. It operates at twice the data rate of DV (50 Mb/sec vs. 25 Mb/sec) and provides twice the chroma bandwidth (4:2:2 pixel structure vs. 4:1:1 or 4:2:0). Panasonic and JVC are now shipping DV50-based cameras and VTRs under the brand names DVCPRO50 and Digital-S (D-9). Tests have shown DV50 to approach the quality level of Digital Betacam. This higher quality environment is better for intense post-production work such as multi-layer compositing, chroma keying, and graphics. (View the test results in "Format comparisons").

## The benefits of "multi-format" native DV/DV50 editing on Matrox DigiSuite DTV

To achieve the best possible image quality throughout the editing process, multi-format native editing on Matrox DigiSuite DTV has several advantages, particularly if you do intense post-production work that includes multi-layer compositing, effects, and keying. The advantages are as follows:

- You realize the benefits of "native" editing — no transcoding, no D/A – A/D conversions, no decompression/recompression passes due to SDI transfers. You keep your material in its native DV or DV50 format in the editing system, and you can mix both formats on the editing timeline.
- Even if your original source material is DV, not DV50, you can composite special effects in DV50 to retain maximum detail and minimize artifacts. Such effects benefit from the higher quality and richer chroma resolution of the DV50 environment. Of course, the original sources are not improved, but quality is better preserved. (View the test results in "Using multi-format DV/DV50 editing to minimize the severity of recompression artifacts").
- You can use higher-quality DV50 when capturing video from analog component or SDI sources to minimize compression artifacts.
- The mix/effects architecture of DigiSuite DTV provides compression-free internal processing that allows you to composite an infinite number of video/graphics layers in one pass. This eliminates the need for multiple decompression and recompression passes within the editing system that can compound unwanted artifacts.

## Editing versus distribution in MPEG-2

MPEG-2 is not a single rigidly-defined standard, but rather a set of compression tools that can be adapted to a wide variety of applications, from editing to satellite broadcasting, DVD authoring, and even HDTV distribution.

There's a lot of confusion in the market about MPEG-2 editing. Despite what you may have heard, MPEG-2 is not yet a native editing format and it cannot become a native editing format until standard MPEG-2 cameras start shipping. To date, the camera bit stream, the editing bit stream, and the distribution bit stream are all different. Some manufacturers would like you to believe that if you edit in MPEG-2, you're somehow closer to your distribution format. Unfortunately, it isn't so simple.

The various versions of MPEG-2 let editing system developers make the trade-off between editing efficiency and compression efficiency. MPEG-2 makes use of both intra- and inter-frame compression. Bitstreams can consist of three different types of video frames—"I", "B" and "P" frames—that constitute a Group of Pictures (GOP). I frames (intra-coded frames) compress the entire frame similar to Motion-JPEG and DV, and serve as reference frames. I-frame-only streams are the easiest to edit because they provide instant access to every frame in real time for frame-accurate edits, fast cuts and seeks, and a responsive scrubbing interface, but they provide the least efficient compression. P frames (predicted frames) contain differential information from previous frames. B frames (bidirectional frames) are predicted from previous and subsequent frames. B and P frames are more difficult to deal with in an editing environment because the system must refer to an I-frame and then reconstruct the desired image. IB- and IP-based systems provide more compression but at the expense of reduced interface responsiveness and increased seek times.

MPEG-2 with long IBP GOP structures are typically used for distribution, playout, and streaming purposes because they optimize video quality for a given bandwidth. The most common GOP structure used for DVD production and broadcast distribution is 15 frames long (IBBPBBPBBPBBPBB). Because of the length of this sequence, it is not used for editing.

Changing the GOP structure of an MPEG-2 bitstream always requires recompression. Regardless of the compression structure used for editing—MPEG-2 I, IB, IP, or DV for that matter—your edited program files must be completely decompressed and re-encoded into the MPEG-2 IBP GOP structure for distribution. You maximize the quality of your MPEG-2 program by optimizing the quality of your master prior to encoding for distribution. If you started with DV footage, the best quality is achieved by keeping your source material in native DV right up until the final output.

## MPEG-2 on DigiSuite DTV

DigiSuite DTV gives you the benefits of MPEG-2 editing and output without the drawbacks.

MPEG-2 I-frame editing provides the features that are important in a professional-level editing system including a responsive scrubbing interface and instant access to every frame in real time for frame-accurate edits, fast cuts, and seeks.

MPEG-2 editing gives you the ability to work at variable bit rates. DV and DV50 run at fixed data rates, but MPEG-2 I-frame lets you choose from 10 Mb/sec–50 Mb/sec. You can make the trade-off between storage and video quality when working on long form projects. You can carry out offline editing at lower bit rates and then autoconform at higher quality MPEG-2, DV, or DV50.

DigiSuite DTV uses hardware acceleration to let you quickly export your production in MPEG-2 MP@ML, with the IBP GOP structure, for distribution purposes. You can export in real time using the MAX or Matrox SDTI cards.

## Have it all!

Your goal in today's digital post-production environment is to maintain the highest video quality throughout the editing process, and to output your program in whatever format your client requires. DigiSuite DTV provides all the tools you need by integrating DV, DV50, and MPEG-2 compression formats in a single system, along with analog, 1394, SDI, and SDTI inputs and outputs.

If you start with DV footage, the best quality is achieved by keeping your source material in native DV right up until the final output. DV and DV50 multi-format editing maintains the quality of your original footage and gives you the benefit of the high-quality DV50 environment for intense post-production work. MPEG-2 I-frame editing lets you perform efficient offline editing at low bit rates and then autoconform for high-quality finishing.

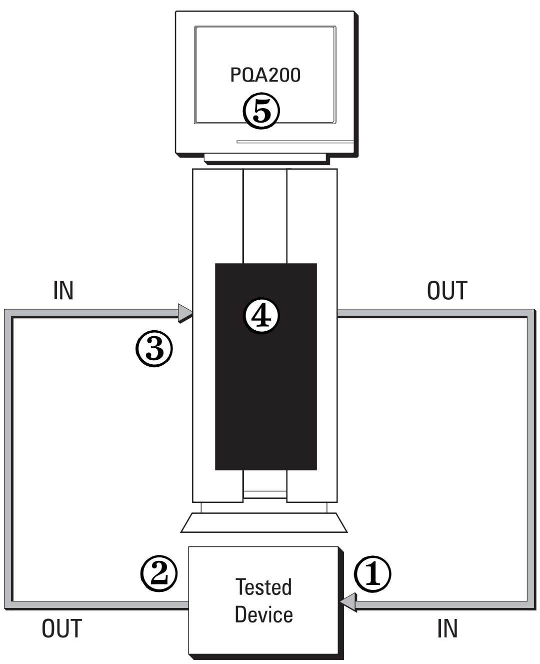
Versatile output capabilities let you deliver programs on tape, video servers, DVD or the web in composite, Y/C, analog component, SDI, DV, DV50, MPEG-2, MPEG-1, RealVideo, Windows Media, or Quicktime. Edit once, then output anywhere!

## Test results

All numbers provided here have been obtained using the Tektronix PQA200. The Tektronix PQA200 performs objective measurements resulting in a single numeric value of picture quality, called the Picture Quality Rating (PQR). Using a human vision system model based on years of research at the David Sarnoff Research Center, the PQA200 contains the three necessary dimensions for evaluation of dynamic and complex motion test sequences: spatial analysis, temporal analysis, and full color analysis.

The test procedure involves the following steps:

1. The PQA200 outputs video test sequences that are captured by the device being tested. Artifacts and/or noise might be introduced by the device during capture.
2. The device plays back the captured video test sequence.
3. The PQA200 re-captures the output of the device.
4. The PQA200 performs a comparative analysis between the original test sequence and the output played back by the device.
5. The PQR scores are provided to the user on the PQA200's console.

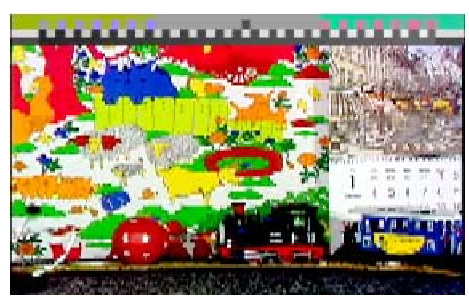



A PQR above 10 indicates clearly observable artifacts. A PQR of 3 indicates artifacts that are generally only visible to the trained eye. A PQR of 1 indicates that artifacts are virtually undetectable. A PQR of 0 indicates no mathematical difference.

Compression efficiency is based on image complexity. Figure 1 demonstrates how a simple image such as the "Suzie" test pattern scores a low PQR number (no observable artifacts) when compressed using the DV codec. On the other extreme, the complex "Mobile" pattern scores a much higher number, indicating that the DV compression algorithm has introduced visible artifacts. In order to highlight the differences and ensure consistency throughout our tests, we have used (whenever possible) the "Mobile" test pattern.

Suzie PQR=1.86

Ferris Wheel PQR=2.39

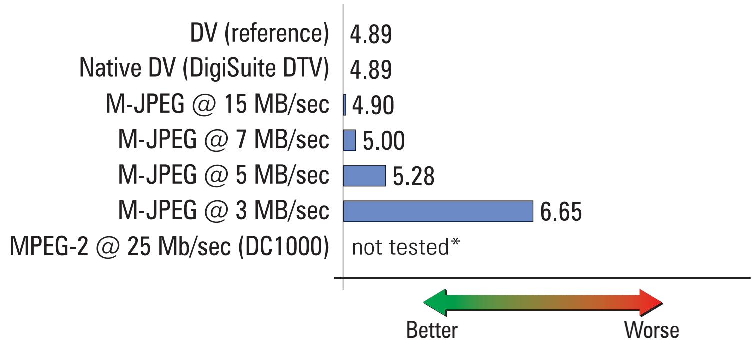


Mobile PQR=4.89

**Figure 1** Image complexity affects PQR-YC score

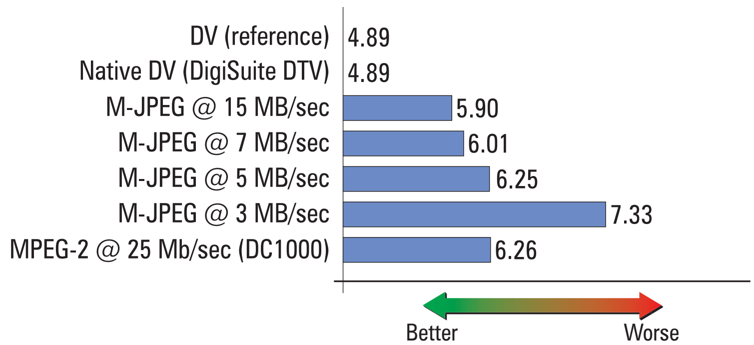
## Native editing eliminates transcoding artifacts

**Figure 2** Effects of transcoding from DV to another compression format.



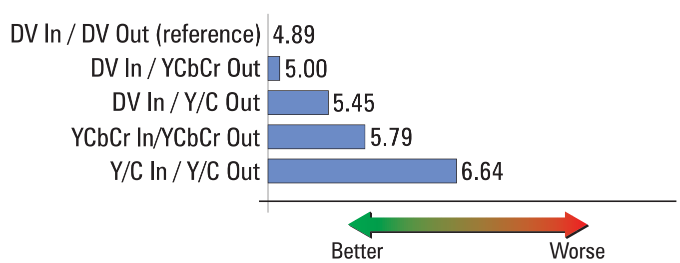

* DC1000 was not used in this test because it does not have SDI output, only Y/C output, which itself introduces significant artifacts.

**Figure 3** Effects of transcoding from DV to another compression format and then back to DV for output.



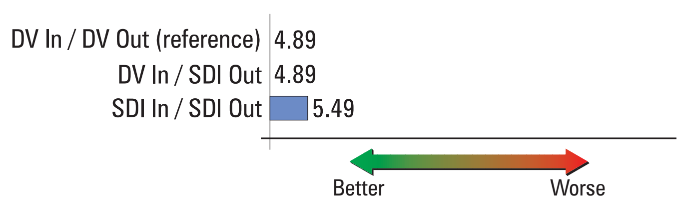

## Native editing eliminates A/D & D/A conversion artifacts

**Figure 4** Impact of A/D and D/A conversions when acquiring or exporting DV material over the analog input/output on a DV editing system. There is no transcoding.




## Native editing eliminates SDI recompression artifacts

**Figure 5** Capture over SDI introduces recompression artifacts. SDI output has no effect on video quality.



**Format comparisons**
The test results below demonstrate the performance of various formats with images of differing complexity.

**Figure 6** *Suzie*, a simple image that emphasizes skin tones and hair detail.

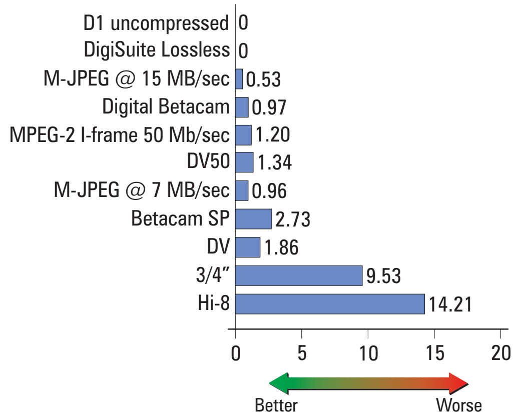



**Figure 7** *Ferris Wheel,* more complex and with an emphasis on fast motion.

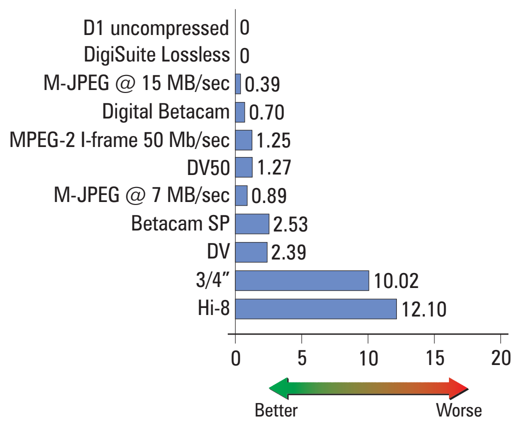
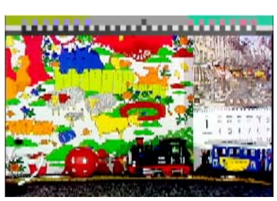
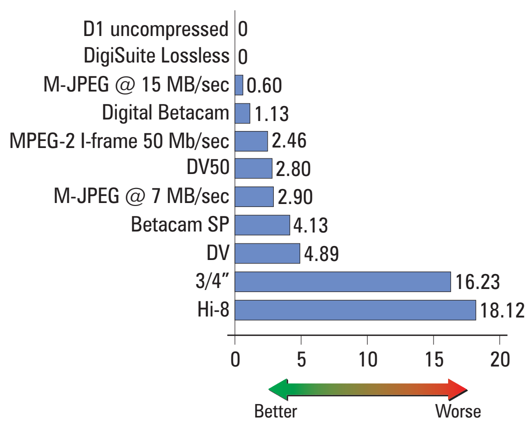



**Figure 8** *Mobile*, an extremely complex image with many contrasting colors and fine details.



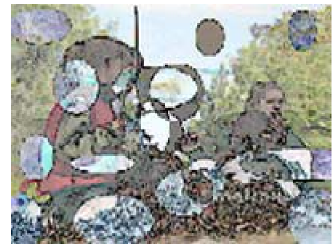


### Using multi-format DV/DV50 editing to minimize the severity of recompression artifacts

The four-step production chain depicted below was used to create a test sequence and demonstrates the benefits of using the DV50 format when applying special effects to DV video segments. In each step, a new effect was applied to the DV source and rendered in DV, DV50, and uncompressed formats. The output of Step 1 became the input of Step 2, and so on.

**Step 1** Original DV footage

**Step 3** Edge enhancement applied using Adobe After Effects



**Step 2** Bubbles added using Discreet paint*

**Step 4** Contrast added using Adobe Premiere

**Figure 9** Four-step production chain used to develop test sequences

Figure 10 shows difference maps that highlight compression artifacts introduced in DV and DV50 processing. The image obtained at the end of the typical four-step post-production chain in an uncompressed environment was used as a reference because processing in an uncompressed environment introduces no artifacts. Sections of the images processed in the DV and DV50 environments were compared by subtracting them from the uncompressed reference. Artifacts introduced by the DV and DV50 codecs are revealed. DV50 is clearly superior to DV; artifacts are barely visible

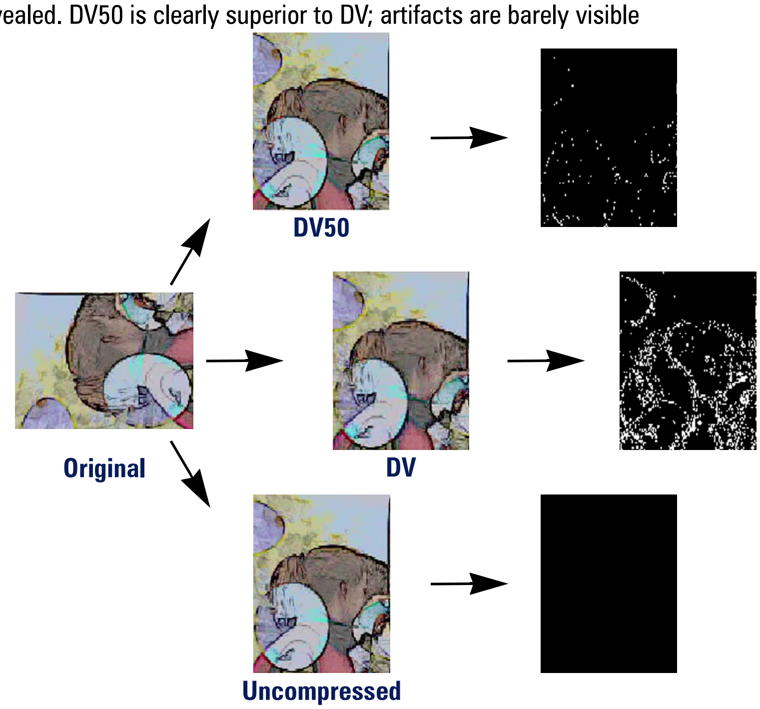



**Figure 10** Difference maps highlight compression artifacts introduced in DV and DV50 processing

Figure 11 shows PQR scores for the last three steps where effects were applied. It's important to note that the noise has been introduced by the DV and DV50 codecs, not by the applications! The uncompressed format was used as the reference against which the image degradation was compared.

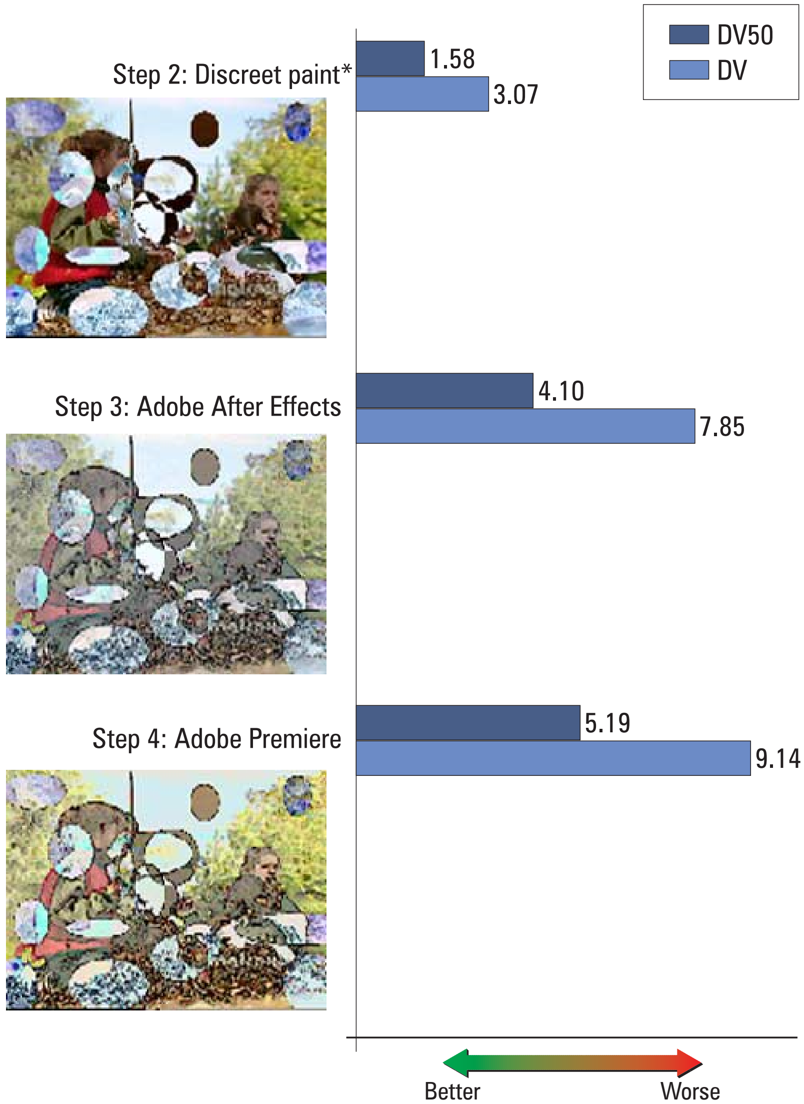



**Figure 11** PQR scores show the difference between DV and DV50 processing at all stages of the production chain

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