Benefits of Native DV Editing on Matrox RT2000

By integrating DV and MPEG-2 compression formats in a single editing system along with analog and 1394 input and output, Matrox RT2000 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 select.

Native editing means that all the video equipment in a production chain (such as the camera, the NLE system, and the VCR) share a common compressed bitstream format, and therefore 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, VCRs, and nonlinear editing systems are all widely available from multiple manufacturers. Native DV transfers are made over 1394 links. Native editing on RT2000 preserves video quality in two 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. (See 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 link. Video quality degradation is particularly apparent if you must go through a composite or Y/C analog connection from your DV camera or VCR to the editing system. (See the test results in "Native editing eliminates A/D & D/A conversion artifacts.")

DV

DV is one of the most popular video acquisition formats, and with good reason. DV uses an efficient compression algorithm that gives excellent image quality at a relatively low bit rate (25 Mb/sec). Outstanding images can be captured with low-cost cameras. 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. (See the test results in "Format comparisons.")

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 on the market about MPEG-2 editing. Despite what you may have heard, MPEG-2 is not 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 is not so simple.

The various versions of MPEG-2 permit editing system developers to 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 the 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. Streams containing only "I" frames 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 the 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 a related "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. By optimizing the quality of your master prior to encoding for distribution, you maximize the quality of your program. Thus, if you started with DV footage, you can achieve the best quality by keeping your source material in native DV right up until the final output stage.

MPEG-2 on Matrox RT2000

In addition to native DV editing, Matrox RT2000 gives you the flexibility and benefits of MPEG-2 editing and output, without the drawbacks.

MPEG-2 I-frame editing on RT2000 provides the features that are important in a professional-level editing system, notably 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. Although DV runs at a fixed data rate of 25 Mb/sec, MPEG-2 I-frame lets you choose from lower bit rates. Thus, you can make the trade-off between storage and video quality when working on long-form projects. You can edit offline at lower bit rates and then autoconform at higher quality MPEG-2 or DV.

Matrox RT2000 uses hardware acceleration to let you quickly export your production in MPEG-2 MP@ML, with the IBP GOP structure, for distribution purposes.

Have it all!

Your goal is to maintain the highest video quality throughout the editing process, and to output your program in whatever format required. Matrox RT2000 provides all the tools you need by integrating DV and MPEG-2 compression formats in a single system, along with analog and 1394 inputs and outputs.

If you start with DV footage, you can achieve the best quality by keeping your source material in native DV until the final output. 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, CD, DVD, or the web in composite, Y/C, DV, MPEG-2, MPEG-1, RealVideo, Windows Media ASF, or QuickTime. Edit once, then output anywhere!

Understanding the 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 recaptures 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.

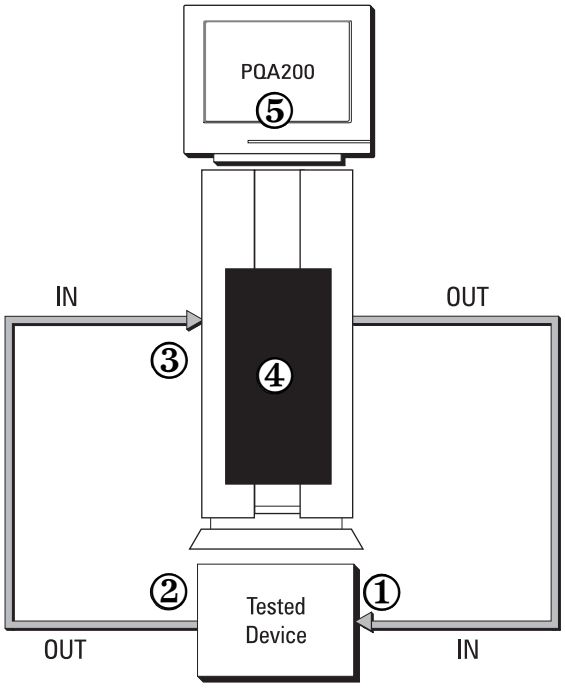
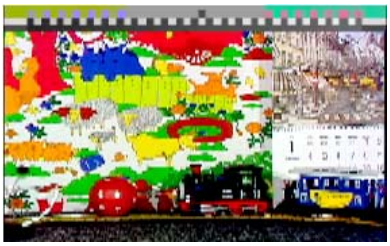


Figure 1 PQA200 test setup

Compression efficiency is based on image complexity. Figure 2 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. At 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've used the "Mobile" test pattern.

Suzie PQR=1.86

Ferris Wheel PQR=2.39

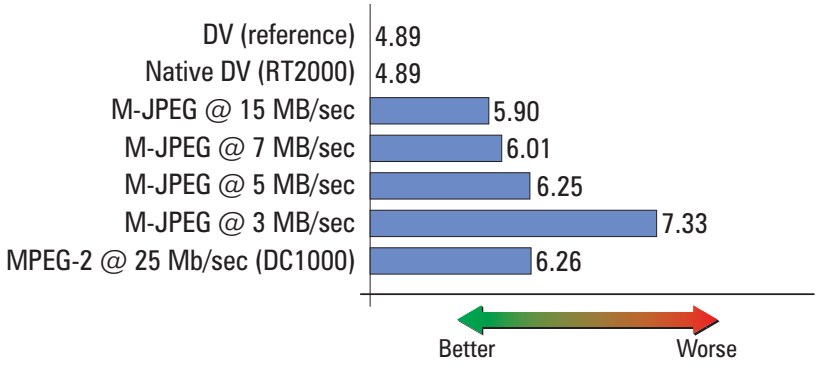


Mobile PQR=4.89

Figure 2 Image complexity affects PQR-YC score

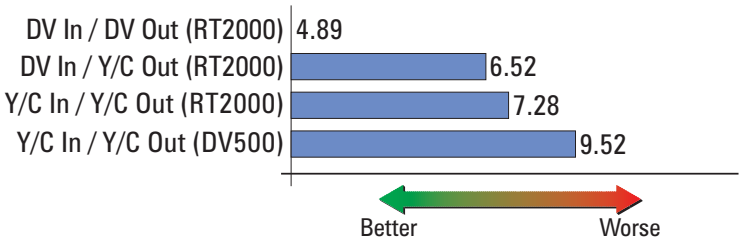
Native editing eliminates transcoding artifacts

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.



Format comparisons

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

Figure 5 *Suzie*, a simple image that emphasizes skin tones and hair detail.

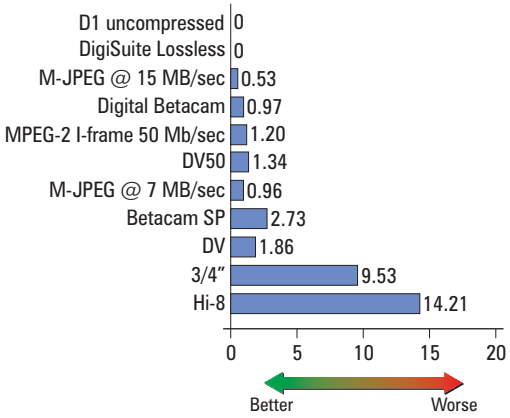


Figure 6 *Ferris Wheel,* more complex and with an emphasis on fast motion.

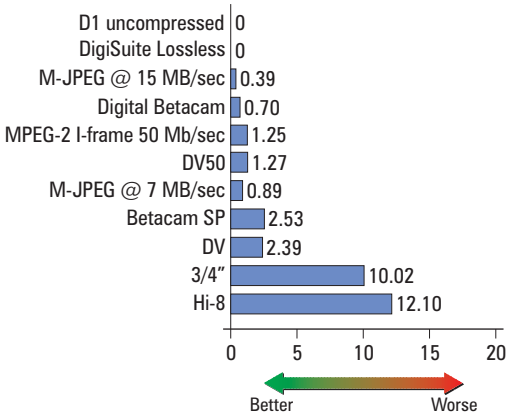
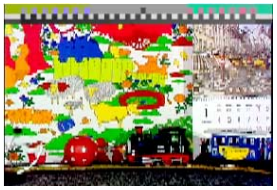
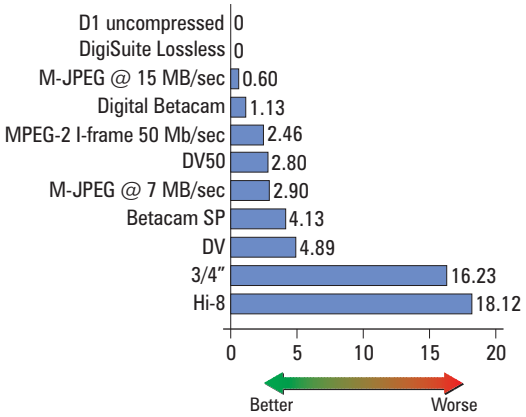


Figure 7 *Mobile*, an extremely complex image with many contrasting colors and fine details.





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