Are Imaging Board Makers Meeting Microscopy Community Needs?

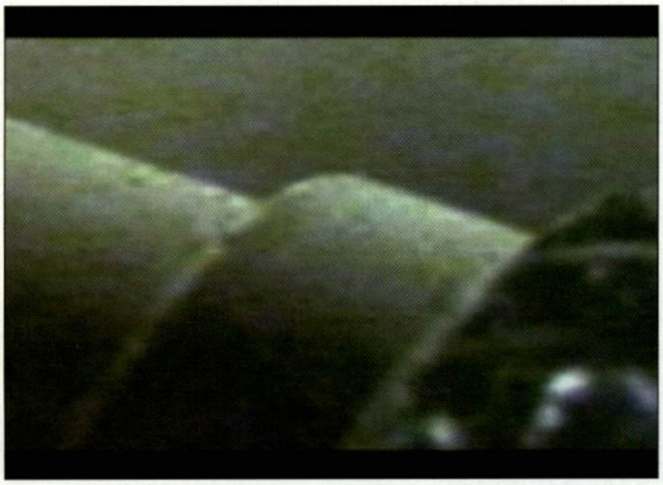

Fig. 1: Composite video signal showing softened edges and mottling artifact.

Fig. 2: RGB signal with sharper edges and improved color rendition.

Our newest Advanced Imaging *Contributing Editor, Barbara Foster, is certainly one of the best-known authorities in the microscopy and scientific image analysis marketplace. Barbara is President of Microscopy/Marketing & Education (MME), a Springfield, MA-based consortium of consultants from across the U.S. who offer on-site workshops to microscopists and conduct market research and support for manufacturers in microscopy and the related imaging technologies. She's contributed to this magazine a number of times over the years, most recently with this past November's report on the sudden uptick in digital imaging acceptance. We've finally persuaded her to make this new column—which, in our typical way, we've dubbed "The Micro Brew,"—on imaging for microscopy, image analysis and the lab into a regular feature. Barbara welcomes comments from readers via e-mail:* mme@map.com; *or* URL: MME-Microscopy.com.

When it comes to digitizing images, microscopy is very much in a state of transition. For decades, the cameras and the other detectors that we put on our microscopes of all kinds generated only analog signals. If the end use of that signal was to display the image on a monitor, there was no problem, but as we became more sophisticated and recognized the need and ability to process and measure, it meant that we needed to convert that signal from analog to digital. Conventionally, this task was managed by a specialized computer board known as a "frame grabber." As with other video equipment, microscopy borrowed this technology from the image processing industry. But how has this industry responded to this small niche market? And, in this age of transition from in-computer frame grabbers to on-board digitizing cameras, what is the impact?

What do microscopists *want* from a board?

A logical place to start is with the requirements for this special application called microscopy. For many years, high-quality black-and-white images were enough, so a frame grabber which could manage an RS170 signal sufficed. (That was standard here in the U.S.; it might have been a PAL equivalent in Europe.) Today's white-light confocals and sophisticated optical microscopes work in a world of color and computer connectivity, expanding those needs from just high spatial resolution to true color and electronic compatibility. As always, most microscopists don't enjoy enormous budgets, adding price to this mix.

The key to matching current board offerings to these needs is found back at the type of electronic signal color cameras put out. The simplest of these is the *composite signal*, easily identified by the single cable coming from the back of the camera. The cable attaches to monitors and frame grabbers with a standard push-and-twist BNC connector. Composite signals carry all the color information (red plus blue plus green), as well as the synchronization pulse in that one cable. While this one-size-fits-all approach may provide satisfactory images for a classroom demonstration or a quick production floor inspection on a monitor, it provides neither the good spatial resolution nor the true color rendition required for scientific imaging. All the signals are digitized together and, during signal processing, all are managed by common brightness and contrast functions. Edges in the image are often rounded or softened because of the lower spatial resolution, and colors gently bleed into one another because of the modest color separation.

A good test object is a simple color bar, often built into the test program of many cameras. If you watch the boundaries generated by a composite video system on a monitor, you will actually see them "wiggle" as the less defined pixels at edges are allocated first to one color than the other.

S-video is the next step up on the imaging ladder. Bill Miller, a long-time system integrator, imaging specialist and microscopist, prefers this format for most of his clients. When asked how he described the difference between S-video and the other two approaches, he explained that it was like having all the benefits of high-resolution black-and-white imaging coupled with the true color rendition of an RGB system. To illustrate his point, he provided the images shown in Figures 1, 2, and 3. These are all electronic enlargements of one corner of a color video image. As expected, the edges on the composite image (Fig. 1) are rounded. Notice that there is also a considerable amount of mottling in the background and there are pixels which seem to be undecided in terms of the true color of the object. Fig. 2, the RGB image, is much crisper and has better color fidelity, but the S-Video image in Fig. 3 goes still another step further: its edges are sharper, the color is more realistic, and there is less background artifact. To Bill's trained eye, S-Video provides the best image on the monitor and the best color prints from video printers.

Fig. 3: S-video signal, which, to the eye, produces the best edge definition and color rendition. (Images courtesy of William I. Miller, III.)

S-video systems are easily recognized. They have a single output cable, annotated with the terms "S-video" on the back of the camera. Some cameras, monitors, and frame grabbers provide multiple capabilities, allowing users to switch to the signal approach which best meets their needs. This series of figures, for example, was imaged by simply switching from one approach to the other, then capturing each image with a frame grabber, digitizing it, and storing it in the computer. In S-video, the luminance component (essentially, the black-and-white information) is carried on an RS170 signal, while the color is sampled independently and is "painted" on the high-resolution black-and-white image. While Bill allows that the color registration may not be as exact as in an RGB image, the eye-brain combination compensates for the small offset, producing a better picture "to our eye."

On the top of the imaging hierarchy is the "*RGB signal*." As its name implies, this approach carries each individual signal for red, green, blue, and synchronization on independent cables. RGB cameras, monitors, and frame grabbers are easily identified by the handful of color-coded cables coming out of the camera and the matching connector pins on the back of monitors and frame grabbers. When asked how he explains the difference between these two approaches to his clients, Scott Berman of Applied Imaging Systems said that he frequently uses the simple analogy of garden hoses: three hoses could carry much more water than one. RGB systems provide clean separation of both spatial and color data. When those data get to the frame grabber, each signal is digitized separately. At the processing end, each color has its own brightness and contrast control. The result is a crisp, clean image with sharp, well-defined edges and good color rendition. For anyone doing spectral analysis, this is the system of choice.

Are board manufacturers listening?

Now *that* brings us back to frame grabbers and the question of whether manufacturers have, first of all, been *attentive* to the needs of microscopists. Clearly, we need boards that do a good job with RGB signals, whether from S-video or pure RGB sources. The problem—until just recently—was that the RGB boards used by the digital signal processing industry also had lots of automated signal processing capability on them, making them very expensive ($3,000-$10,000).

While this signal processing is important in machine vision applications (*i.e.* for making sure labels are on straight or tops are on bottles), it can be disastrous in scientific imaging, where measurement is our final goal. For validity and accuracy, we need to carefully control what happens to our digital data in the steps prior to measurement.

A stand-out

In defense of board manufacturers, there *are* very real market drivers pulling them toward machine vision first—and sometimes away from scientific imaging as a result. The machine vision market is much larger and more lucrative, making it the logical choice for a growing business.

One company, **Integral Technology** (Indianapolis, IN), took the road less traveled and has developed the Flashpoint 128, a stand-out in its acknowledgement by all those interviewed for this report as the best board for microscopy currently available.

Dave Woodward, Integral's president, came from TrueVision, the veteran board manufacturer. Early on, he encountered the inexpensive and highly popular desktop image analysis system from **Media Cybernetics**. His continued relationship with Media Cybernetics brought him in contact with their then "new" scientific software, *Image Pro Plus*, and Doug Paxson. Both impressed him and had a profound impact on the direction his new company would take. Discussions with Doug, the quality of the software, and the readiness of Media Cybernetics' engineers to develop universally-compatible drivers prompted him to develop the Flashpoint series specifically for scientific imaging. His astute market analysis helped to identify three key criteria for these boards: the Flashpoint 128s are inexpensive, have RGB input for true color, and are easy to install.

A word about the very inexpensive ($150) little *Snappy* card from **Play, Inc.** (Rancho Cordova, CA): Some integrators in fact *favor* it, indicating that it's a very accurate, low-cost image capture device. Others question the accuracy of its digitization and speed. Bill Miller thinks that this is the only board whose "images look as good in print as they do on the analog monitor." Having said that, he also pointed out that the Snappy requires two monitors: one for the live video system and the other for the computer. Secondly, for high-resolution 1500 x 1125 pixel images, the Snappy samples eight or nine frames and then averages them, a process which can take 20-30 seconds and limits imaging to very still objects. For conventional 640 x 480 images, it will capture one frame, essentially in real time.

The proof is in the image. If this is the direction on which you decide, we recommend testing the Snappy on a typical sample to make sure that its speed and accuracy of digitization meet your needs.

Upgrades: a mindset clash?

Compatibility is a challenge on two fronts: upgrading and installing new equipment.

In some real ways, scientific imaging is suffering from cognitive dissonance with the board manufacturers: microscopy-based research is a long-term, ongoing process, while board development (as you've probably noticed, since you're an *Advanced Imaging* reader!) is aggressive and fast-paced. While board manufacturers provide great technical support on current devices, virtually *all* of the system integrators interviewed on this issue complained about the ***poor upgrade path***. In particular, they cited difficulty in keeping up with new drivers, those hidden-but-necessary software components which allow hardware to talk to the rest of your system.

To make matters worse, microscopy imaging systems are put together *à la carte*. As Scott Berman pointed out, "Imagine building cars using a steering wheel from one manufacturer, engines from a second, chassis from a third."

What does this mean for the researcher who has a system which is several years old? ***If it isn't broken, don't fix it.*** Think of your investment as a tool: keep it as long as it is functional. Scott groaned when asked what was involved in an upgrade. He pointed out that a typical PC chassis just doesn't have the real estate to accommodate the necessary boards for today's image processing systems. A fairly routine upgrade may require four side-by-side ISA slots for the processing board, as well as additional ones for the modem, video card, and SCSI card. Even if a new PC comes with two or three available ISA slots, the RAM chips typically reside behind one or more of them, limiting the size of the card which will fit. As a result, his company suggests industrial backplanes with 4 to 8 full-sized PCA slots and 8 full-sized ISA slots. The price on the backplane, CPU, 64MB of RAM, and the special case to hold it all averages out to about $9,000, without hard disk, floppy, video card, monitors, etc. His suggestion: buy another computer, collect images on the original system, and export them to the new workstation, then put the money you've saved into upgrading the microscope optics and camera equipment.

Even putting a system together from scratch can present challenges. One of the biggest culprits is, "Where is the video display chip, and who has one?" If it is on the frame grabber, will it interfere with similar technology mounted in the computer, the camera, or even the monitor? To make matters worse, the same chip manufactured by a different company might be implemented differently. As Bill Miller pointed out, "Boards are developing at such as furious rate, what works this week might not work next week."

The second culprit is compatibility between PCI buses and the video display chips, especially the new Advanced Graphic Port (AGP) video cards. One customer had a system integrator build a system which worked fine on installation. However, they decided a few months down the road to upgrade to a new flat screen 19" digital monitor, a $7,000 investment which brought the system to its knees. The monitor had its own on-board video card and, with a different plug, different driver, and different signal, was totally incompatible with the existing system.

The bottom line

Very few manufacturers have stepped up to the simple needs of the scientific imaging community: a reasonably priced board with RGB input, on-board video display, and a reasonable upgrade path. Buying state-of-the-art technology is not always our best solution. We need to define our current and near-term imaging needs, and then follow Occam's Razor and find a simple answers. In today's market, that seems to be the Flashpoint 128. The good news is that digital cameras are developing at a cyclonic rate, which means that within the next three to five years, the response of board manufacturers will be a moot issue. ■

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