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# Digital Cameras Face The Sixteen Megapixel Challenge

By Joe LiPetri

A crop of one-shot 16-megapixel digital studio cameras are soon to hit the market. Digital Imaging Day at Seybold Seminars Boston explored the benefits and pitfalls of this new technology. Developers and early adopters discussed how the cameras perform in the field.

The big news in digital photography is the advent of 16-megapixel CCD chips. In time, we expect, they will become the norm in professional cameras but, before that can happen, there are a few problems that the manufacturers must resolve. Most of these are a direct result of using larger chips than the lower-resolution cameras.

Ken Boydston, CEO at Megavision, described how a CCD sensor works, offering an analogy of using buckets in a swamp to collect rainwater. "An image sensor is like acres of buckets collecting rain, but the sensors collect droplets of light," he said, adding that light does not really "fall into the sensor, it smashes into the surface to create electrons." He remarked that an average-size element on a professional CCD sensor holds about 100,000 electrons, which is equivalent to a three-gallon bucket that holds about 100,000 raindrops. "Another interesting fact is six million three-gallon buckets will fit on about 100 acres, and six million pretty-good-size pixels will fit on a piece of 35mm film, so both are doing about the same thing."

Once rainwater is collected in the buckets, transferring it from bucket to bucket to measure the water is similar to the problems of the shift-register method of measuring light from a CCD. "If you move too fast, you'll slosh the water around, making inaccurate measurements," he said. However, taking too much time during this operation causes swampwater from the wetlands to leak into the buckets.

"The swampwater is the noise in the chip," Boydston explained. "There are various sources of noise, such as thermal noise from inside the camera. I call them rogue electrons." He said the ratio between the rainwater and swampwater in a bucket represents the signal-to-noise ratio in the chip. Similarly, after an image sensor has collected some electrons, they have to be moved off the sensor and measured to create image data. Moving the electrons too fast causes them to "spill over" and contaminate each other, whereas moving too slowly allows noise from the chip to "seep" into the collected data. This noise factor is the main challenge in building a digital camera back with a large CCD sensor, he said. "The more pixels you've got, the more you have to move, and moving takes time."

Finally, he said, another challenge is the significantly higher cost of producing larger sensors. Unlike land, which usually falls in price as more acres are purchased, larger sections of silicon "real estate" are much more expensive than smaller chips, which boosts the cost of making digital cameras with larger sensors.

Moderator John Henshall asked Boydston if MegaVision, which sells the single-shot S3 camera back (3K×2K sensor), will be introducing a one-shot, 16-megapixel digital camera to the market. "We're working on it," Boydston said. "We have the sensor, we built a test camera, and we've taken some pictures. And as you'd expect, it takes a pretty good picture."

## BigShot had big problems

Steve Blackstock, president of Mosaic Imaging, related the problems Dicomed had bringing the first 16-megapixel one-shot digital camera, the BigShot, to the market when he worked there from 1997 to 1999.

Blackstock quipped that when the BigShot won an award at Seybold Seminars Boston in 1996 as a "Sizzling New Product," the award should have been called "Boiling New Product" because "boiling is what's used to produce vapor," he said. "It was revolutionary technology that never materialized."

The original BigShot that never made it to the market was the version with the electronic LCD filter lens that cycled through three RGB colors in microseconds to capture one-shot color photos. Dicomed later offered the BigShot 4000 with a dye-colored CCD for one-shot capture and the BigShot 3000 for multi-shot capture.

**Technology ahead of its time.** However, the original BigShot design concept "caused quite a stir in the marketplace" for several reasons, said Blackstock. The first was the use of an electronic LCD filter, which held the promise of artifact-free, one-shot color image capture. The other reason was that the camera had a high resolution. The BigShot used a 4,096×4,096-pixel CCD image sensor supplied by Loral.

Blackstock explained why Dicomed failed to bring this camera to the market. One of the problems was marketing. "The BigShot was announced too early and delivered too late," he said. Ironically, this initially helped Dicomed, Blackstock remarked, "because it slowed sales for the competition. But in the end, it backfired and Dicomed lost a lot of credibility in the marketplace."

*The LightPhase eliminates the need for active cooling to reduce thermal noise from the CCD because the camera electronics are turned on a fraction of a second before image capture.*

The second problem was the BigShot's technical design. One major error was a poor thermal design, which caused the internal electronics to create too much heat inside the camera, creating noise and reducing the effective dynamic range. In addition, there was no cover glass protecting the CCD image sensor, which made it susceptible to dust particles and damage.

All of these factors degraded image quality and, ultimately, led to the demise of the system. The BigShot did not meet the quality requirements for the high-end photography applications it was designed to handle. Blackstock added that Dicomed did not design or manufacture the BigShot. Engineering and production were handled by Loral Fairchild, which is primarily a defense contractor. Companies like this do one thing really well, noted Blackstock, "and that is sell overpriced and under-performing products to large customers, generally the Defense Department. Dicomed paid a pretty heavy price for this."

**Future products take note.** The lessons learned by Dicomed's pioneering efforts in attempting to bring a 16-megapixel camera to the market should be heeded by other digital camera makers, said Blackstock. Besides the development now going on at MegaVision, in a few months Phase One will be launching its new LightPhase H20, and Eastman Kodak now sells the DCS Pro Back. Both cameras use a 16.6-megapixel image sensor manufactured by Kodak's Image Sensor Solutions division.

Blackstock's main concern is how the new crop of cameras will deal with color aliasing, as well as the dynamic range required by imaging professionals. "The [six-megapixel] Philips CCD used in digital camera backs today has by far the highest dynamic range," he said. "The Kodak CCD will have a long way to go to meet that. The question is: Will it be good enough? I think only time will tell."

## Next phase for LightPhase

Carsten Steenberg, executive vice president at Phase One, discussed the LightPhase H20. In charge of Phase One's U.S. division in Northport, NY, Steenberg said the LightPhase H20 is expected to begin shipping in late June or early July.

Although Phase One sells a number of scanning-back digital camera models, sales of the LightPhase comprise most of the company's sales. Because of the success of the original LightPhase model, which uses the well-regarded six-megapixel sensor from Philips, Phase One decided to use the same basic camera design in conjunction with the higher-resolution Kodak chip.

Product development on the LightPhase H20 is complete. "Now we're dealing with production issues and logistics," said Steenberg. Phase One is also working on calibration to allow images from the LightPhase and LightPhase H20 to match in terms of color, he said. Pricing on the new camera has not been announced, but he said the pressure from the relatively low-priced digital SLR cameras on the market will force Phase One to price the LightPhase H20 as competitively as possible.

Steenberg said the internal design of the LightPhase eliminates the need for active cooling to reduce thermal noise from the CCD because the camera electronics are turned on a fraction of a second before image capture. After the image data is transferred, the electronics switch back off. "With passive cooling of the CCD in the body, we've had good experience with the Kodak CCD in tests in terms of long exposures," he said, "even in taking room shots with 16 to 20 second exposures."

He did admit that the capture rate of about 2.5 seconds per image is slower than the original LightPhase. "This is not a camera for sports photography, but for studio purposes it does a very good job," he said.

Transferring the raw files to a host computer (Mac or PC) is done using FireWire, and software processing of the 48-MB file takes less than a minute, he said. "In 1998, it took the same time to process a raw file from the original LightPhase," he said. "Now, with the advancement of computer technology, it only takes 15 seconds. In a few years, I wouldn't be surprised if it takes 15 seconds to process a 48-MB file."

"But I feel the secret of our image quality is the algorithms we use to process the raw file," added Steenberg. "We have several patents pending on this technology."

Cropping the original 48-MB files from the LightPhase H20 to the same aspect ratio as the 18-MB images captured by the LightPhase produces 32-MB files. In addition, said Steenberg, Phase One's FlexAdaptor can be used along with the LightPhase H20 to capture two 48-MB files, which are stitched together to create a 96-MB landscape image for high-

end advertising applications. For lower-end projects, the LightPhase H20 generates 5-MB preview images for small-size reproduction or Web publishing.

Phase One's home office in Denmark feels the new camera will appeal mainly to photographers serving high-end advertising clients. "I disagree a little bit in terms of the target market," Steenberg said. "Early adopters who want this camera are fashion and portrait photographers."

He did, however, express some concern regarding these types of photographers using the LightPhase H20. "It takes some discipline to realize that every time you press the shutter you're generating a 48-MB file," he said, "which can immediately fill up a hard drive." Photographers will find they always need more storage—but that's been the case for as long as digital cameras have existed.

**User experiences.** Manhattan-based photographer Joseph Cartright related his experiences using a prototype of the LightPhase H20. A LightPhase user for the past year and half, Cartright said the new camera would fill a need he has for higher-resolution images. Although the six-megapixel resolution of the LightPhase is adequate for most high-end fashion projects, Cartright said clients often hesitate in using digital in case the project calls for large-format reproduction further down the road.

"We've lost clients because we could not provide what they thought was required for a telephone kiosk," said Cartright. He added that one creative benefit to working with 48-MB files is the ability to crop photos and not worry whether there is enough image data for the photo to be reproduced at the required size. "This was something I was desperately wanting to do," Cartright said.

There were problems encountered with working with files that are nearly three times the size of the 18-MB images captured by the LightPhase. The main one was moving that amount of image data around on a network. "Moving these files around has a certain latency to it," he said. Working with the LightPhase H20 would require an upgrade of his studio's current 100-megabit network, and his capture and imaging workstations would require substantial RAM upgrades.

## Kodak gets into the act

Eastman Kodak is readying its latest entry into the professional digital camera space, the DCS Pro Back. Steve Noble, advanced development manager of professional digital cameras at Kodak Professional, said the DCS Pro Back was designed using a total-system approach to provide a complete package of features.

Priced at $20,000, the DCS Pro Back is a single-shot camera with a 16.6-megapixel (4,080×4,080-pixel) image sensor made by Kodak that captures 12-bit-per-color, 48-MB images. The camera is compatible with medium-format (2¼-inch) Hasselblad 555ELD and Mamiya RZ67 view cameras. Noble said that in the future, interfaces for a wider range of medium- and large-format studio cameras will also be available.


**Chip talk.** Steve Noble detailed Kodak's plans for its new 16-megapixel DCS Pro Back.

Looking under the hood of the DCS Pro Back, a 32-bit, 1200-MIPS DSP (digital signal processor) from Texas Instruments and a 128-MB internal RAM buffer enable the camera to capture images at a rate of less than two seconds per image at the equivalent of ISO 100.

The camera generates 4K×K losslessly compressed 36-bit image files, 1K×1K 36-bit RGB preview images, thumbnails and, if the camera is connected to a monitor, a live video image. When tethered to a host computer, the camera will continuously pump image data from memory out through FireWire. Noble said it takes two to three seconds to move a file from memory through FireWire to a Mac.

The DCS Pro Back can also be used in the field, with storage handled by Type II CompactFlash cards or 1-GB IBM Microdrives, which can hold about 100 images. Power is provided through a Quantum rechargeable battery pack. The camera's back-panel color LCD screen can pivot up by 80 degrees to easily review captured images. The LCD screen is also used to display the 1:1 zoom with panning capability, histogram information, and densitometer readings.

On the desktop, Kodak's Mac-only Capture Studio software provides software tools for reducing color aliasing in captured photos. Offering a photographer-friendly contact-sheet interface, Capture Studio provides color-editing tools through the adjustment of curves and histogram levels, as well as image-editing features such as the ability to resize and sharpen images.

The software is also ICC-compliant. One default input profile is provided with the camera. "It's a good ballpark average of lots of different lights and daylight sources," said Noble. Users can select other input profiles, as well as create their own using the software's Profile Wizard. The camera comes with two color profiles, with more to be added. Noble said his development group is working on a profile that will increase

the saturation of all colors in an image except for fleshtones. "This is good for fashion photography when you want to make clothes look snappier but hold the flesh [colors] constant," he said.

**Support for Pro Photo RGB.** The Kodak software can also render the images using a wide variety of standard output profiles employed for print production. But perhaps more important, he noted, is the software's ability to render images using the new ProPhoto RGB color space, which has a larger color gamut than sRGB.

*"The question of what's the best sensor will be answered by photographers."*

"We're pushing ProPhoto RGB into the market because it's a major improvement," he said. Indeed, Noble showed side-by-side examples of digital photos captured using the DCS Pro Back in which the ProPhoto RGB images exhibited improved saturation and more accurate hues than those rendered in sRGB.

**Sensor designs.** At the heart of the DCS Pro Back is the image sensor manufactured by Kodak. Speaking on this front, Brian Benamati, product engineer for image sensor solutions at Eastman Kodak, discussed some of the engineering decisions that went into the design of the new Kodak sensor.

Benamati said the decision to use the chip's square format (as opposed to the usual landscape-oriented rectangular one) was to differentiate cameras using the new chip—like the DCS Pro Back and Phase One's upcoming LightPhase H20—from the digital SLR cameras on the market.

The new chip uses a nine-micron pixel elements, while most other cameras use 12-micron elements. "Larger pixels doesn't always mean better image quality," Benamati asserted. "It depends on the design of the image sensor from a particular manufacturer." Moreover, he added, larger pixels in a 16-megapixel sensor have the potential of generating more noise in an image. So for the DCS Pro Back, Kodak engineers decided to strike a balance by designing the chip with nine-micron elements.

"The question of what's the best sensor will be answered by photographers," asserted Benamati. "They will determine what gives them the best value and image quality."

**User feedback.** One photographer currently testing the DCS Pro Back is Helene DeLillo, owner of Dancing Icon, a New York City-based digital-imaging studio and system integrator. DeLillo enjoyed the general operation of the camera and noted that the FireWire transfer of images to a tethered Mac was quite fast. "I liked how quickly the images showed up on screen," she said.

DeLillo also liked the portability of the DCS Pro Back and the convenience of having CF card slots on the camera. She was particularly impressed with the rechargeable Quantum battery, finding it easy to use and compact. But she noted that IBM MicroDrives might be too fragile for photo shoots. "I'm not a proponent of these because photographers drop things pretty regularly," she said.

While it was nice to be able to capture 48-MB files, "what's more important is the quality of the captures," she said. "The accuracy of color in the camera was very good, and I was surprised at how saturated some of the colors were." A large portion of her testing involved shooting live models, and the fleshtones were accurate in the unedited files.

"There was also not a lot of noise, which was surprising to me," she said. "I thought there would be noise from the larger chip." Interestingly, the DCS Pro Back sometimes had "too much resolution" for live-model shooting, DeLillio explained, because the camera captured every detail, including models' blemishes and large pores.

DeLillo liked the contact-sheet interface of the Capture Studio software, including the ability to double-click on a thumbnail to open an image, and to select an image area and have that portion of the image open up in another screen for editing. In addition to the variety of color-editing tools, she liked working in the wider color gamut of the ProPhoto RGB color space.

Echoing Steenberg's concern about ample storage, DeLillo said three half-days of sporadic testing had generated 14 GB of data. "Dealing with these large files is a big issue," she said, especially in the field, where she recommends the use of portable FireWire hard drives to store off-loaded image files. **TSR**

**About the Author**

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