

Cost-conscious drive makers hone focus on media

Rick Merritt

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Hard drive makers are now predicting the perpendicular recording technology they began adopting last year will be viable for perhaps five years longer than previously thought, thanks mainly to advances in media research. That would let drive makers put off until 2015 a difficult and expensive transition to a new recording technology.

Meanwhile, seeking an edge in a consolidating industry, No. 2 drive vendor Western Digital Corp. (Lake Forest, Calif.) has acquired media maker Komag Inc. (San Jose, Calif.) to become one of just three drive makers that can design media and heads. Industry speculation has it that one of the three remaining independent media makers will be acquired by another drive maker, given the key role media will play in the next several years.

"One or two years ago, people thought perpendicular recording might be limited to packing 500 Gbits per square inch on a drive, but now we think there's a reasonable chance we will get to a terabit per square inch," said John Best, chief technologist with Hitachi Global Storage Technologies (Tokyo), the world's third-largest drive maker. "That's just my gut feeling. We have not done a thorough technical analysis yet."

"Getting to a terabit per square inch is now seen as possible," agreed Hossein Moghadam, CTO of Western Digital.

Drive vendors are still making the transition to a recording technology that stores magnetic charges vertically on media. They are now exploring as many as four technologies in media to expand the life of the perpendicular approach.

"Most of these extensions are in getting better aerial density and signal-to-noise ratios in media while keeping stability at room temperature," said Best.

"We have some credible ideas for going to at least a terabit with perpendicular," said Mark Re, senior vice president of research for Seagate Technology (Scotts Valley, Calif.), the world's largest drive maker.

Re said Seagate has more R&D staffers working on such extensions today than it did two years ago. As people switch from projects on older, longitudinal recording technology, they are being assigned to perpendicular recording research rather than to projects focused on future alternatives.

The drive industry has long been the most cost-sensitive segment of the penny-pinching PC industry. Staving off major technology transitions means the drive industry may be able to delay major capital outlays at a time when staying profitable has been a challenge, said John Rydning, hard-disk research manager for International Data Corp.

In addition, the market for 3.5-inch drives may become increasingly narrow, given the amount of capacity drive makers will be able to pack into 2.5-inch units. Even at 500 Gbits/square inch, a three-platter 2.5-inch drive will be able to hold 1 Tbyte of data.

After the Komag acquisition, the chief executive of Seagate publicly speculated that another round of

industry consolidation would come in Japan. His comments were likely directed at the three remaining media companies (Showa Denko, Fuji Electric and Hoya), as well as the two drive makers that might want to buy them (Fujitsu and Toshiba). All are based in Japan.

Today the drive industry supports just one independent maker of recording heads, its other key component.

"In the past, heads have been the most critical component, and media has played second fiddle," said Rydning of IDC. "[But] a lot of these changes in the media have interactions with the heads, so having both components is key going forward."

The biggest impact of the Komag acquisition may be felt by one of the industry's smallest players. Excelstor (Shenzhen, China) uses media only from Komag and will probably have to devise a transition plan. Excelstor makes less than a million desktop drives a quarter, mainly for its home market.

Western Digital likely will continue supplying merchant media for a while to keep its factories humming. But its own needs are significant and rising. The company has grown in the past two years from supplying 24 percent to 32 percent of the industry's drives, according to IDC.

Meanwhile, the industry is coalescing around a new road map for hard drives. Today's disks pack about 200 Gbits/ square inch, and models packing 300 Gbits have been demonstrated in the lab. To commercialize perpendicular recording drives, designers had to flatten the magnetic layers on the medium from 2,200 angstroms to just 500 Å.

Next, drive makers plan to extend the two magnetic layers on the medium to four and eventually six layers over the next three years to gain storage density. Beyond that, a new approach to media called exchange-coupled composite (ECC) looks like the most promising step.

ECC essentially places on the medium alternating layers of highly switchable and difficult-to-switch magnetic materials. One layer helps activate the switching of a bit; the other helps keep the charge state stable.

"ECC has great promise, but right now it's only university work and computer models," said Moghadam of Western Digital.

"I think pretty much everyone in media has some work on ECC in the lab now," said Seagate's Re. "We all started looking at it pretty much right after the University of Vienna published" a paper on the topic three years ago.

An alternative approach, exchange spring media, uses a reference layer that flips a charge over a protecting wall. But it requires a thinner domain wall than drive makers have been able to fabricate.

Yet another approach, discrete track recording (DTR), might prove able to nearly double the density of storage on a drive. Currently, drives require placing a read/write head over a certain spot on a disk to find a particular piece of data. The new technique defines data locations by patterning continuous tracks onto a bare disk before it is integrated. The tracks are defined by placing layers of materials with different magnetic characteristics on the medium.

"It's probably not a factor of two better than today's approach; just how much better it could be is still being debated," said Best of Hitachi.

Neither is it clear whether DTR would be significantly less expensive than a separate and more ambitious method that defines a unique space on a blank disk for each data bit. That approach, called bit-patterned media, is seen as the next major leap in magnetic recording but could take five years or more to bring to

market.

DTR, by contrast, might be available for commercial drives in as little as two years, but it requires etching a land-and-groove pattern into the medium, which would force drive makers to acquire new equipment. "That's not a primary path you want to go down, so you start with ECC," said Re.

Read-channel circuits are also undergoing a transition. LSI Corp.'s former Agere Systems unit started sampling so-called iterative channels this year. The chips use new statistical techniques to predict bit patterns so they can read data even under noisy conditions. The chips could be big enablers for the next several generations of drives, leading up to models that pack 400 Gbits/square inch.

Meanwhile, drive makers continue to research methods that will ultimately replace today's approach to perpendicular recording, including the use of patterned media and heat-assisted recording.

Seagate recently published a paper describing its first demonstration of recording data with a head that integrates both optics and electronics for heat-assisted recording. The technique uses a focused laser to heat a small patch of medium during the recording process, improving data density.

Hitachi has been pioneering work in patterned media, a technology that requires a new form of nano-imprint lithography to place each bit in a specific spot on a disk. Drive makers are divided over whether they can use the nanoscale lithography approaches being developed by chip makers.

Drive makers believe they will need both patterned media and heat-assisted recording, but they are still debating which comes first on the road map.

"We're pretty optimistic about patterned media," said Best of Hitachi. "We work on thermal recording, too, but we have been pretty open about what our priorities are."

"Patterned media has a few more contingencies than heat-assisted recording," said Re of Seagate. "But you don't want to be caught without the next thing, so we are actively working on both."

"Most of the improvements we have made in the history of the disk drive have been incremental, with really only three or four revolutionary shifts in the last 50 years, so these shifts tend to have a lot of longevity," said Moghadam of Western Digital.

About 80 percent of the drive industry's R&D money is going into enhancements to perpendicular recording for drives that will ship in the next three years, Moghadam estimated.

"Making incremental improvements is much more cost-effective than making a new-technology transition," he said.



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