

# Will Hard Drives Finally Stop Shrinking?

Linda Dailey Paulson

**T**he past few years have seen explosive growth in the sales of small digital consumer electronic devices such as still and video cameras, TiVo personal video recorders (PVRs), and MP3 players like Apple Computer's iPod. As these devices have gained capabilities, they have needed larger storage capacities in smaller packages, often in the form of hard drives.

Consequently, most major hard-drive vendors—including Fujitsu, Hitachi, Maxtor, Samsung, Seagate Technology, Toshiba, and Western Digital—offer or plan to offer disk drives smaller than 2.5 inches in diameter. This has provided drive vendors with a market at a time when revenue from 3.5-inch hard drives has flattened out in the wake of stagnating PC sales, as Figure 1 shows.

For handheld and consumer electronic devices, the increasingly popular minidrives are generally up to 1.8 inches in diameter with storage capacity of up to 60 Gbytes. However, vendors have been releasing drives just 1 inch in diameter, and some, such as Toshiba, have announced drives as small as 0.85 inches in diameter.

Nevertheless, various experts say the technology for shrinking disk technology has reached its limit and that there is little demand or market pressure for smaller drives.



If vendors can't reduce drive size, companies that want to shrink their devices further may have to turn to flash memory or other types of smaller storage. This potential for losing business has forced drive vendors to look for ways to adjust.

## DEMAND FOR SMALL HARD DRIVES

IBM made small hard drives a decade ago, but they lacked both significant capacity and a meaningful application, noted Amy Dalphy, the Toshiba Storage Device Division's manager of hard-drive activities.

Recently, though, portable consumer electronics—particularly the popular MP3 players—have driven minidrive usage growth. MP3 sales increased from about 15 million in 2003 to 37 million last year and will rise to about 80 million in 2006 and 135 million in 2009, predicted iSuppli, a market research firm.

Smaller devices require smaller disk drives. For example, Toshiba's 0.85-inch-diameter drive holds 4 Gbytes of data and will be used in mobile phones and in removable storage, primarily for digital cameras.

Hitachi's newest 1-inch-diameter drive holds 6 Gbytes and serves as removable and permanent storage, according to John Osterhout, the company's director of marketing for consumer electronics.

Western Digital makes 1-inch, 6-Gbyte drives, noted Tom McDorman, vice president and general manager of the company's Entertainment Group.

According to market research firm IDC, minidrive sales increased from \$7 million in 1999 to \$880 million in 2004, and could grow to \$1.6 billion this year, as Figure 1 shows.

## Inside minidrives

Minidrives work like the magneto-mechanical drives used in laptops, PCs, and servers, and the components are the same, including read/write arms, recording heads, a motor, mechanical systems that move the heads and arms, and firmware.

Because they have to fit in small devices, minidrives currently house only a single platter. Some high-capacity desktop and server drives, on the other hand, have up to four platters.

Minidrives—which are used in portable devices that are more likely to be dropped, sat on, or otherwise abused—are built to be more durable and thus withstand shock better than larger drives.

Also, minidrives can conserve battery life in mobile devices. For example, some drives quickly fill up a memory buffer and then stop spinning, thereby saving energy, while the system accesses data from the buffer, noted Currie Munce, Hitachi Global Storage Technologies' vice president of research.

## Making drives smaller

The difficulty in making minidrives smaller has been in developing manufacturing processes and controlling tolerances to miniaturize the motors and other moving parts, said Tom McGoldrick, the Toshiba Storage Device Division's director of engineering.

In addition to disk size, minidrives' storage capacity is a function of areal

density, the number of bits that can be stored on a square inch of disk, explained Munce.

The principal way to increase a hard drive's capacity has been to make the magnetic crystals that hold data smaller and closer together, a process that also requires making recording heads more sensitive.

### Technical obstacles

According to Mike Kuppinger, digital media product manager with memory vendor Kingston Technology, there is a limit to how much manufacturers can shrink hard drives because they must still include motors and other moving parts in addition to the disk.

Hitachi's Munce said that if a technology makes bits written to the disk too small, their polarity can change unexpectedly. Such changes could corrupt data because polarity determines the binary data's ones and zeroes.

Because of these limitations, Western Digital's McDorman said, areal density, which previously had been doubling each year, is now growing at only 10 to 30 percent annually.

Until researchers overcome the limitations, manufacturers won't want to shrink disks further because that would excessively reduce their storage capacity.

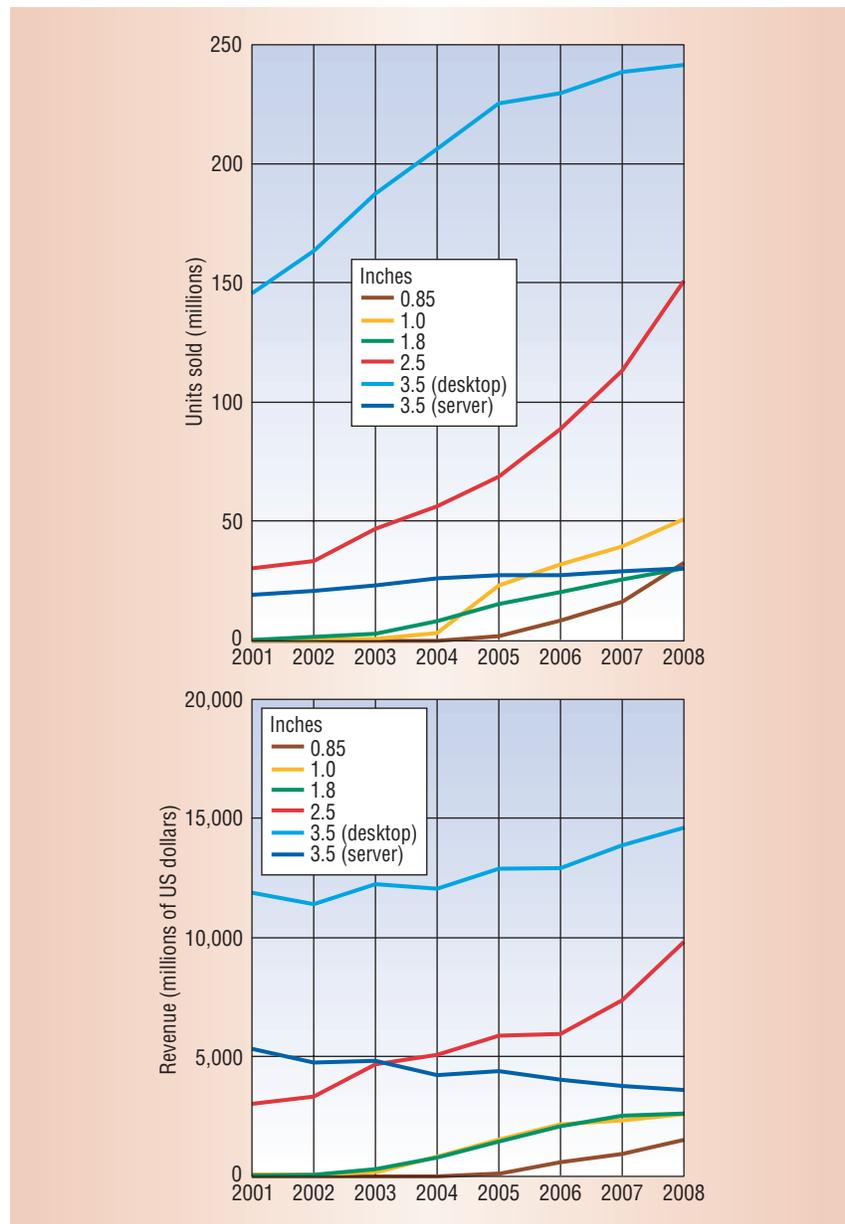
### FLASH COMPETITION

Flash memory is a special type of electrically erasable programmable read-only memory. Like EEPROM, flash retains its contents even when the power is turned off.

Because flash is semiconductor-based rather than magneto-mechanical-based, it is more expensive than disk drives, explained Joseph Unsworth, a flash-memory-market analyst for Gartner Inc., an industry analysis firm.

Flash is ideal for very small devices because it is now the size of a postage stamp, making it much smaller than hard drives, according to Kingston's Kuppinger.

Flash accesses and delivers the low volume of data typical for mobile appli-



**Figure 1. Sales of and revenue generated by 3.5-inch hard drives, used in PCs and servers, have flattened out in recent years and are predicted to continue doing so during the next few years. Sales of and revenue generated by the smaller drives used in handheld devices, on the other hand, have increased and are predicted to continue growing.**

cations faster than disk drives because it doesn't have moving parts and it can be erased and reprogrammed in blocks instead of one byte at a time.

Flash also performs better because semiconductor-based technologies are faster than magnetomechanical approaches, said Rainer Spielberg, vice

president and Flash Memory Business Unit general manager of chip maker Infineon Technologies' Memory Product Group.

In addition, because flash has no moving parts, it can offer better shock resistance, lower power usage, and less noise than hard drives, said Dave

Reinsel, IDC's storage-research program director.

Manufacturers are beginning to increase flash memory's capacity, which traditionally has been smaller—currently 64 Mbytes to 2 Gbytes—than that of minidrives. Moreover, new multichip-packaging techniques adopted by companies such as Advanced Micro Devices will let manufacturers stack two or four flash chips in a space that traditionally held one.

As flash capacity increases and prices drop, Unsworth said, it will compete more successfully with lower-end, lower-capacity disk drives. So, while flash still might not be useful in players of data-intensive video, which require high storage capacity, the technology could become attractive for use in MP3 players, currently one of minidrives' major markets.

Thus, attempts to shrink minidrives further could cost the technology one of its major advantages over flash: data capacity. Said Reinsel, "At some point—IDC believes 0.85 inches in diameter is on the absolute edge—a tiny disk drive won't be able to compete with flash storage."

### MINIDRIVE MAKERS FIGHT BACK

Minidrive makers are improving their products to compete better with flash memory.

### Perpendicular storage

"Companies promise to have perpendicular recording ready at end of this year," said Jim Porter, owner of Disk/Trend, a disk-drive-market research firm. The technology has existed for decades but it is finally poised to become commercially viable, he explained.

This year, for example, McGoldrick said, Toshiba has released 40-Gbyte and 80-Gbyte, 1.8-inch-diameter perpendicular-storage drives.

In perpendicular storage, the system writes data to the small ends of magnetic crystals, which are perpendicular to the plane of the disk, as well as on their long axes running along the

plane, where information traditionally has been stored. This increases storage capacity by about 10 times, according to Hitachi's Munce.

Perpendicular drives will require different electronics and heads that can read and write data both vertically and horizontally. Because of this and manufacturers' desire to recapture their significant R&D costs, perpendicular storage could be expensive when introduced, according to Porter.

**Technology and competition from flash memory could keep minidrives from shrinking further.**

### Other measures

Even though minidisks won't get smaller, various measures might let manufacturers shrink the overall drives a bit.

For example, Hitachi plans to make its Mikey minidrives, scheduled for release later this year, 20 percent smaller by developing smaller motors and reducing packaging, even though they will still use 1-inch-diameter disks, according to the company's Osterhout.

Because of their storage capacity, the smaller Mikey drives could be used in new cell phones that also perform as media players with audio and video capabilities. Cell phones have traditionally worked with the smaller, faster flash memory.

**W**estern Digital won't make disks smaller than 1 inch in diameter until the market for such drives becomes apparent, explained the company's McDorman.

In fact, it appears that minidrive disks won't get smaller than 0.85 inches in diameter during the next 10 years, said Cindy McCurley, an analyst for In-Stat/MDR, a market research firm. Manufacturers still have to work on increasing the capacity and

decreasing the price of current minidrives, she noted.

According to McCurley, there is still plenty of demand for today's small-form-factor drives. In fact, she explained, there's likely to be a shortage of drives again this year, and demand will continue rising as the number of media players increases.

Many analysts expect flash memory and minidrives to continue thriving, but in their own market niches.

Applications with smaller storage requirements—including many cell phones, PDAs, MP3 players, and digital cameras—might use the smaller, faster flash memory, although versions that require more capacity, such as commercial digital cameras, might use a disk drive. IDC's Reinsel said that applications with larger requirements—such as PVRs and gaming consoles—would also use a hard drive.

In each case, the choice of storage technology is based on the capacity the application needs, the speed at which it needs to access information, its price sensitivity, and the room it has for storage elements, explained Disk/Trend's Porter.

"Now and within the next three years, minidrives will lead in applications featuring high capacity for media storage because of their low cost per bit and high density," said Infineon's Spielberg.

Over time, though, he said, "This might change. Considering the trends visible today, flash memory clearly has the potential to replace minidrives also for high-capacity storage."

McCurley noted, "Competition is definitely heating up." ■

*Linda Dailey Paulson is a freelance technology writer in Ventura, California. Contact her at [ldpaulson@yahoo.com](mailto:ldpaulson@yahoo.com).*

**Editor: Lee Garber, Computer,**  
[l.garber@computer.org](mailto:l.garber@computer.org)