

# Storage in the Long Run

The unwavering trend towards consolidation has left only six players with market share above 1 percent in the hard-disk-drive (HDD) industry: Seagate, Western Digital (WD), Fujitsu, Hitachi Global Storage Technologies (HGST), Samsung and Toshiba. Of these, Seagate and WD are independent suppliers, whereas Fujitsu, HGST, Samsung and Toshiba are subsidiaries of or divisions of large industrial conglomerates. WD has recently acquired Komag, the media manufacturer, in a deal expected to close in the third calendar quarter of 2007. Complementing the earlier acquisition of ReadRite, the magnetic heads manufacturer, by WD in 2003, WD is looking more and more like Seagate - independent and vertically integrated. However, the HDD companies' quarterly statements, losses reports and seasonal price wars have investors concerned. What is today's situation in the HDD industry, and where it is going? Well, the doctor has just left and found the patients with plenty of years to live.

When looking at the HDD industry, one must recognize influences and trends and rank them appropriately. About in the order listed, the following factors are key in understanding the industry: the demand for storage, the cost of storage, the sweet spot dictated by the consumers, manufacturing competence and technology trends and innovation.

One may be surprised to see technology trends and innovations at the trailing end of the list, a placing which deserves to be explained. There is no doubt that the almost miraculous technological advances have brought the industry to where it stands today, able to supply storage capacities easily in the hundreds of gigabytes at a cost of between 20 to 40 cents per gigabyte.

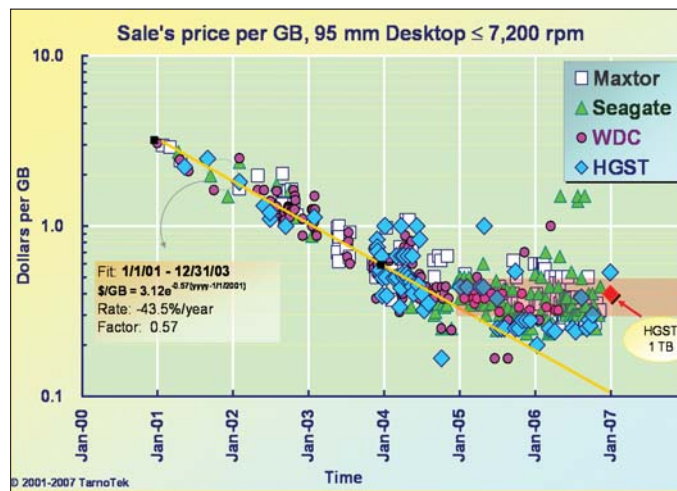
As shown in the chart, the price per gigabyte decreased exponentially into the first half of the decade as result of the introduction of technologies that enabled higher capacities without increasing the bill of materials. This has resulted in HDD's of large capacity in all market segments. These huge and inexpensive drives' capacities are large as compared with users' needs. The HDD capacity, in general, exceeds customer demands. When the present-day technology comfortably surpasses the customer needs, technology becomes a lesser competitive factor and, important as it is, becomes less of a differentiator. A second factor that almost precludes competitive differentiation based on technology prowess is that the globalization of the economy has been accompanied by a globalization of the highbrow intellectual property (IP) on which the HDD business is based. As a result of concerted internal R&D investments as much as by the IP transfer inherent in the M&A activity, the companies remaining in the business possess IP above the threshold needed to succeed in the marketplace. Although this statement of IP-above-threshold or

pseudo-IP-parity would be contested by those HDD producers that own a genuine IP advantage, the fact is that even "the best of the HDD producers' crop," IP-wise, cannot leverage their knowledge into a singular competitive advantage. That's the reason behind the rather similar HDD products being offered by the HDD producers, with differences sometimes in the markets in which they decide to participate. Paradoxically, large R&D expenditures are still needed, because lagging in the technology would result not just in losing market share but in losing the business altogether.

Storage is an indispensable building block of any digital data system, such as are the central processing unit (CPU) and the operating system (OS). Why is it, then, that the HDD industry is so different from the semiconductor and software businesses, where, for instance, Intel (CPU) and Microsoft (OS) enjoy market shares so large as to be virtual monopolies? The answer is that the HDD is a remarkably complex device, and, in spite of the evolving trend towards vertical integration, not one of the HDD producers is truly completely vertically integrated.

Some HDD producers possess wholly owned means, themselves or their affiliated corporations, of producing some of the necessary bill of materials: recording disks, recording heads, the system-on-chip (SoC) semiconductors that orchestrate the functioning of the HDD, the fluid-bearing spindle motors that rotate the disks, the electromagnetic actuators that move the head stack to record and read data, the interface chips that enable the HDD to communicate with its host and so on. However, not one HDD producer possesses all of this technology; all companies are dependent on a complex supply management chain of critical components. The SoC is a good example of the dependence of the HDD producers on outside vendors. These chips have become sophisticated over time, are of a complexity similar to that of a CPU and the companies that make them are happy to sell them to more than a single HDD-manufacturer customer. These are powerful forces that preclude dominance by a single company. Therefore, for the foreseeable future there will be no dominance of the HDD market by a single company in contrast to the "Wintel" paradigm, because no HDD manufacturer controls the supply chain of key components.

There are other factors that impede translating technology into market share. There are presently two huge technology trends. The first is the transition from the so-called "longitudinal recording" technique (any drive manufactured in the nineties and until about 2002) and the newer "perpendicular technology" being rapidly implemented nowadays. The second important trend is the competition from non-volatile solid-state memory, flash, either as a stand-alone solid-state disk (SSD) or as a complement to the



HDD, an integrated solid-state component into the HDD that would enhance the HDD performance.

Concerning the transition from "longitudinal" to "perpendicular" recording, the basic electromechanical HDD configuration has not changed as a result of this technology evolution. The technical changes are buried deep in the recording media and the recording heads and the consequences to the consumer manifest themselves only in the fact that the HDD capacity is higher for perpendicular products than it is for longitudinal products. Virtually no customer of HDD's needs to know which is the magnetic technology implemented in the drives in their systems. Furthermore, all the companies, as said, are above threshold with the perpendicular IP.

More interesting and highly topical, is the discussion of SSD, flash replacing magnetic memories. Not a chance. The HDD has been, is today and will continue to be the absolutely dominant technology for mass digital data storage. Although one could write a book about flash vs. HDD applicability, the consequences at the end of the day are clear. Except in some limited niche markets, for the foreseeable future the price and performance of flash will not displace any hard drive product above a certain capacity. That capacity is estimated to be about 50 GB. In other words, while portable electronics with storage needs in the 10 to 20-ish gigabyte capacity will definitely use flash, for the mainstay applications that feed market share (traditional PC computing, laptops, enterprise storage, video streaming, etc.) the HDD producers will comfortably dominate the number of units sold and the storage capacity sold. Paradoxically, the expanding applications of flash memory result in added demand for magnetic storage.

All those graduation and wedding pictures initially stored in flash memory, all those business contacts stored in phones' flash memory, they end up being uploaded and backed up into magnetic memory. It is estimated that the investment required to create sufficient SSD's to replace HDD's is approximately \$190 billion, or about 15 times the annual revenue of the flash memory business. The sources for that investment are nowhere to be found.

Coming back to the other factors, then, if not technology, what will differentiate one HDD company for another, especially as investors look at these companies? The winners will be the companies that, within the flat landscape of a quasi-commodity market, are able to supply unwavering reliability, manage efficient supply chains and manufacturing, and address emerging consumers' needs. Among these emerging needs are reliable and readily available external storage, long-term storage, as well as secure HDD storage. The latter are HDD's whose data can only be decrypted by the owner. Even though it is difficult to conceive that in these new applications there will be just one winner, the important point is that the expanding applicability and the need for storage create tremendous new revenue opportunities for all players.

*Dr. Giora Tarnopolsky is a data storage systems and magnetic recording expert, founder of TarnoTek, a technology and management consultancy in Palo Alto, California. TarnoTek clients include technology and intellectual property companies, and venture capital firms. He lectures frequently on disk drive technology and data storage systems. He is a Contributing Editor to Magnetics Business & Technology.*

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7355 E. Orchard Road, Suite 100, Greenwood Village, CO 80111 USA  
Phone 720-528-3770. Fax 720-528-3771. [www.infowebcom.com](http://www.infowebcom.com)