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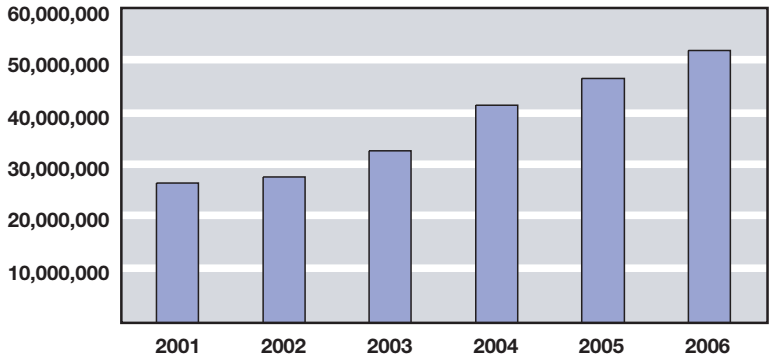
Technology Paper

The Evolving Storage Technology Needs of Notebook Applications

The notebook disc drive market is exploding. New applications for notebook computers, both at the office and home, are driving industry-wide adoption of notebook PCs as a replacement to desktop computers. According to Gartner Dataquest, demand is expected to continue increasing dramatically over the next few years. Today's users employ docking stations and monitors to simulate the look and feel of their desktop PCs. Many desire the flexibility to work or play anywhere—from airplanes to conference rooms to coffee shops. With the performance and capacity gap between notebook and desktop drives diminishing, PC users are transitioning to notebook computers and technology is evolving to accommodate their needs.

Notebook System Shipments



Source: Gartner Dataquest, February 2003

As users demand new, more robust applications, designers and manufacturers must revamp their existing products, focusing on performance, power management, capacity, acoustics and smaller form-factor. However, some of the technology requirements will vary depending on whether a system is being built for a notebook PC as a desktop replacement or solely for portability.

As a new player in notebook disc drives and unconstrained by an existing design, Seagate® meets these changing requirements with ease. Freedom from legacy design restrictions enables Seagate to proactively create the ideal notebook with an eye for emerging technology requirements.

Able to Survive in Today's Rugged Notebook Environment

Robustness is crucial for OEMs who build "true," or the most mobile, notebook products. Hard disc drives store irreplaceable data, making them the most valuable component in the entire system. Beyond the simple inconvenience of a drive failure, the user's inability to recover their priceless data is catastrophic. In addition, a more robust and reliable drive means fewer returns for the OEM.

At 350 Gs, Seagate achieves the highest nonoperating shock specification in the industry for desktop drives. This is equivalent to dropping a standalone desktop drive about six inches onto a concrete surface. In fact, the main reason Seagate desktop drives carry a 350-G shock specification is to protect against handling damage during integration and bumps experienced during shipping. Once the desktop drive is integrated into the system, the likelihood of damage occurring to the drive from shock is minimal.

Notebook computers endure an entirely different type of lifecycle—they get bumped, nudged, opened, closed and powered on multiple times each day. Notebook PCs could not be nomadic if the storage inside was not tough enough to survive today's rugged notebook operating environment.

Seagate Momentus™ is specified at 800 Gs for nonoperating shock, equivalent to dropping a typical notebook computer approximately 18 inches flat onto a concrete surface. During DMT testing, Momentus tolerated up to 1000 Gs.

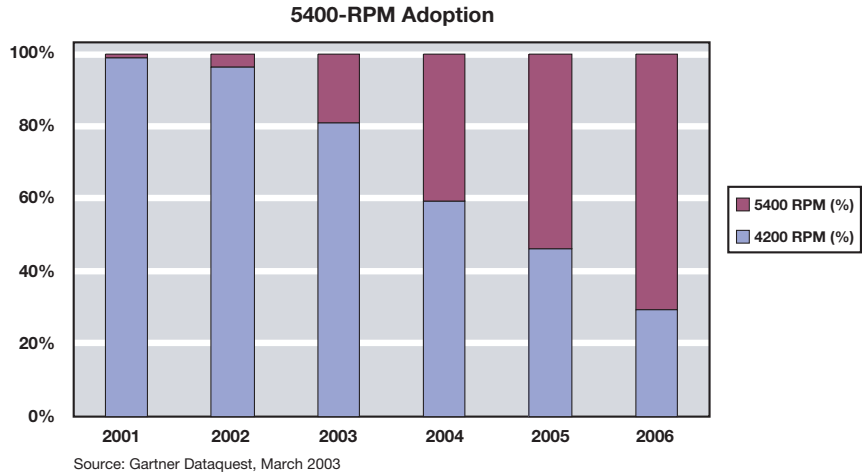
Ramp load technology, which is used in place of a landing zone for the heads, contributes to the increase in nonoperating shock. When the drive powers down or goes into standby, the heads unload onto a ramp positioned at the outer edge of the disc. Because the head is safely parked off the disc, the drive is able to withstand greater amounts of shock; there is no longer potential for head slap when the drive isn't operating.

Notebook applications also demand greater operating shock. Specified at 225 Gs of operating shock, Momentus again surpassed its specification by withstanding over 350 Gs of operating shock during DMT testing. An operating shock of 225 Gs is equivalent to dropping a typical notebook computer approximately three inches flat onto a concrete surface while it is running.

Contributing to this highly robust specification is the actuator arm, which is shorter in a notebook drive employing ramp load. Because of the smaller form-factor (2.5 inch vs. 3.5 inch), the actuator arm is much shorter than those of desktop drives, making it stiffer, more stable and reducing the risk of head slap and damage to the disc during operation. As new generations of notebook drives become available, continued improvements in both nonoperating and operating shock are expected.

Blazing Performance

According to Gartner Dataquest, 5400 RPM will be the mainstream notebook spin speed by 2005. As technology and applications continue to advance, end users' requirements and performance expectations also increase. This phenomenon is driving the migration from 4200 RPM to 5400 RPM in notebook computers.



Source: Gartner Dataquest, March 2003

Although many factors influence this conversion, the most significant are the performance advantages of 5400 RPM, benefiting the end user who desires greater efficiency and the OEM who wants to clearly differentiate their systems.

Test (seconds)	4200 RPM	5400 RPM	5400 ADVANTAGE
WinXP start-up and open WordPad	46.7	35.5	24%
WinXP shutdown	10.7	5.8	47%
170-Mbyte folder copy	51.4	36.2	30%
Open 12-Mbyte file	6.2	3.3	47%

Note: Both drives tested had a 2-Mbyte cache.

Users demand the power to run the same applications on their notebook as on their desktop computer. 5400 RPM provides up to 47 percent more performance, a critical factor as users begin utilizing their notebook computers as desktop replacements. For extreme-performance enthusiasts, Seagate offers an 8-Mbyte cache option that delivers approximately 10 percent more performance than its already blazing 2-Mbyte cache model.

Preserving Battery Life

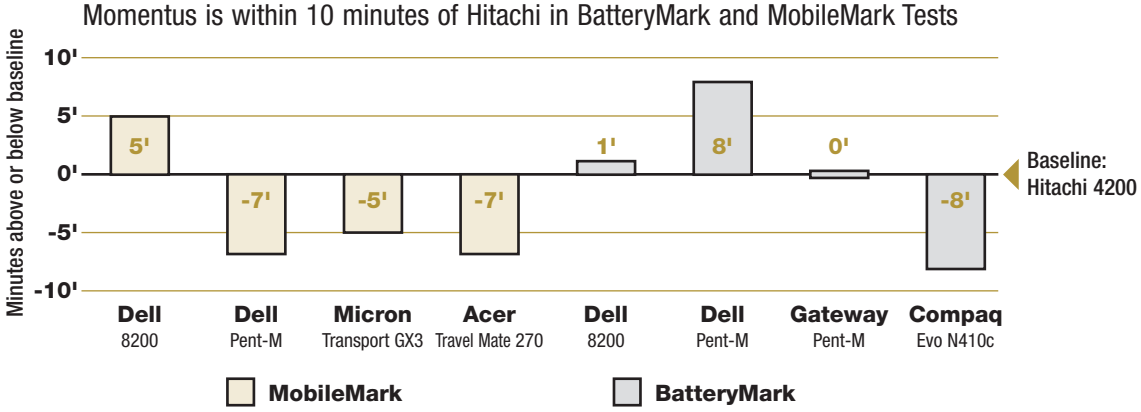
Another key element that contributes to the mobility of notebook applications is its ability to run for extended amounts of time on a five-volt battery. The scope of battery life becomes more or less important based on whether the notebook computer is truly mobile or simply a desktop replacement.

Many components in a notebook computer draw power from the battery, including but not limited to the monitor/screen, processor, CD-ROM drive and disc drive. Although the disc drive is only a piece of the entire system's power consumption, it is important that it contributes to the preservation of the onboard battery. With the introduction of Intel's new Centrino line of processors that draw less power, the power consumption of the disc drive becomes more noticeable compared to the processor.

Typically drives that spin faster require higher power and draw more current as a result. For example, a 7200-RPM desktop drive needs nearly twice as much current as a 5400-RPM desktop drive in a five-volt system. The industry-wide migration from 4200 to 5400 RPM is limited by how much the faster-spinning drive can contribute to preserving the battery life of the system. For users willing to compromise battery life for faster spin speed and performance, a quicker drive makes sense. However, those interested in a true mobile computer are unwilling to make the sacrifice. Seagate Momentus was designed to satisfy both types of users.

HIGH PERFORMANCE & BATTERY LONGEVITY: Seagate Momentus vs. Competitors' 4200-RPM

Momentus is within 10 minutes of Hitachi in BatteryMark and MobileMark Tests



Momentus provides the best of both worlds—whether you desire the higher performance of a faster drive for a desktop replacement system or merely a computer with superior battery longevity for travel. Momentus spins at 5400 RPM and delivers the extra performance you expect, but only consumes the notebook battery like a 4200-RPM drive.

Room for More

As demand for desktop replacement increases, disc drive capacity for notebook applications begins to play a featured role. Like desktop systems, users expect notebook computers to support new applications and consumer devices, such as MP3 players, PDAs and digital cameras. Users store music, pictures, videos, games and more on their notebook hard drive. All of these consumer devices share a common characteristic: a limited amount of storage capacity with a hefty file size. They also rely on an external system, such as a notebook computer, to provide permanent storage for these files. Increases in areal density and the evolution of the disc drive make this possible.

The long-term life expectancy of a computer is another factor driving higher capacities in notebook disc drives. Users want a system that will perform soundly for at least three years with available drive capacity until they choose to replace it. Since applications like business software, databases, spreadsheets and presentations can easily test upper capacity limits, users exhaust system capacity relatively quickly. Today's operating systems also require many times more disc capacity.

Consumer Applications	
10 MB	One-minute clip of TV-quality video
700 MB	One CD-ROM
1 GB	One symphony in high fidelity sound or twelve hours of MP3 audio files for true music-on-demand
2 GB	Sixty-two rolls of low resolution digital film for e-mailing to friends and distant relatives
2.5 GB	Installation of Windows XP, Microsoft Office, Quicken, Netscape, TurboTax, America Online and Palm Desktop—the basic apps that make people productive
50 GB	A volume of encyclopedias, ten movies, a large music collection, some family photos and many books—typical files for a 21st century PC user
Commercial Applications	
5.5 GB	An office computer with Windows 2000, Microsoft Office, Visual C++ and FoxPro 7.0—applications used to manage today's typical office
20 GB	A computer-based training program, five pivot tables, ten multimedia presentations, five product manuals, two electronic brochures and a medium-sized collection of clip-art—just a few of the boundless business files that are accessed every day

Notebook Computers Should Be Seen and Not Heard

Not long ago it was common to hear a notebook computer hum while running. Those loud, annoying noises were emitting from the hard drive as it idled. The system fan added to the loud acoustics. At one time desktop systems were just as noisy, but today standard acoustic levels for 3.5-inch drives are established at 2.7 bels or lower. As notebook systems become more versatile, consumers are demanding portable and equally unobtrusive—even imperceptible—solutions.

Users often erroneously associate unexpected noise with defects. By leaving a notebook computer idle for several minutes, the firmware of the drive will direct it to go into standby. Going into standby causes the drive to park the heads on the ramp and the drive spins down to conserve power. The clicking sound many competitors' notebook drives emit when the head loads and unloads onto the ramp annoys users. Seagate Momentus eliminates this problem with QuietStep™ ramp load technology.

QuietStep technology provides more latitude to control the load and unload velocities. Regulating how fast the heads load and unload enables the acoustics of the operation to run quietly and more consistently.

The human ear's threshold of hearing is 2.6 bels, meaning that any noise occurring below this threshold is inaudible. Seagate Momentus idles at just 2.2 bels—a key feature attributed to the exclusive Seagate SoftSonic™ fluid dynamic bearing motor.

Size Matters

Technology advancements allow internal system components to shrink. Notebook computers are following suit, resulting in practical benefits like the convenience of transporting a smaller, lighter-weight case while traveling.

Momentus meets the 2.5-inch/9.5-mm z-height industry standard form-factor for notebook disc drives, making it thin enough to fit into a notebook computer chassis. Weighing only 99 grams (less than a quarter pound), Momentus enables the lightest-weight notebook computers available.

Summary

Users demand that technology evolves to suit their needs. They require products to be faster, smaller, lighter weight, more robust and essentially indestructible. As the requisites for notebook and mobile applications change, designers and manufacturers must strive to address the burgeoning marketplace. A new player in the notebook market and unhindered by an existing product design, Seagate is ideally positioned to successfully meet these expectations. Seagate has the flexibility essential to design a product that exceeds current customer requirements while concurrently addressing emerging technology roadmaps.

Going forward, Seagate will be a significant contributor to the continued industry-wide migration from 4200- to 5400-RPM drives. As users increasingly replace their desktop systems with notebook computers, Seagate will deliver innovative, cutting-edge technologies like Momentus to make the transition a reality.

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