Looking for Storage in All the Small Places

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Over 20 years ago, relocating a disk drive with a capacity of a few megabytes required brawny men and forklifts. Today hundreds of gigabytes of data can be stored on a desktop computer hard disk drive which can easily be picked up and transported by a single person. This amazing increase of digital storage capacity in smaller hard disk drive form factors is due to the continual increase in disk drive areal density. At the end of the 1990s and the beginning of the 2000s hard disk drive areal densities were increasing at rates of over 100% annually. That means the capacity in a disk drive with the same number of components would double from one year to the next. In 2002 and 2003 the areal density rate began to slow down to more historical rates (prior to 1997). It is estimated that the increase in areal density was 50-60% annually in 2003. That equates to a doubling of drive capacity in about two years time. Table 1 gives my projections for the increase in the digital storage capacity of a mainstream product single double-sided 3.5-inch (95 mm) diameter hard disk from 2002 through 2006.

Table 1. Single 3.5 inch Disk Digital Capacity Growth

Year	95mm Mainstream Capacity Per Platter
2002	40
2003	80
2004	120
2005	180
2006	270

Honey, I shrunk the Disk Drive

What this means for the digital content storage capacity of a given form factor hard disk drive is shown in Figure 1. In 2003 a single 95 mm diameter disk could hold 80 GB so a 4-disk 95 mm disk drive could have a storage capacity of 320 GB. We project that by 2006 or 2007 that same storage capacity would be possible with a two disk 65 mm (2.5 inch) disk drives. By about 2008 we could see a two disk 48 disk drive with 320 GB capacity. We should also note that a Terabyte 95-mm hard disk drive will be possible by 2006! Such large digital storage capacities in smaller form factors make rich AV content possible on smaller consumer electronic devices as well as higher density network storage systems. Smaller disk drives with large capacities could be a major factor in the growth of rich content in small personal video players, mobile video cameras or even for video cameras located in mobile phones (still digital cameras are all the rage in Asia these days).

Large capacity storage combined with attractive prices for disk drives in consumer applications will be major factors in the growth of hard disk drives in consumer electronics. Companies such as Toshiba, Hitachi GST, Cornice and GS Magicstor have shown that high capacity small form factor hard disk drives are possible. In fact the Cornice 25-mm (the so-called 1-inch form factor) Storage Element has capacities up to 2 GB and sell for less than $60. The Cornice storage elements are intended for embedded rather than removable storage applications.

Figure 1. What Increasing Areal Density Means for Storage Capacity of Small Form Factor Disk Drives.

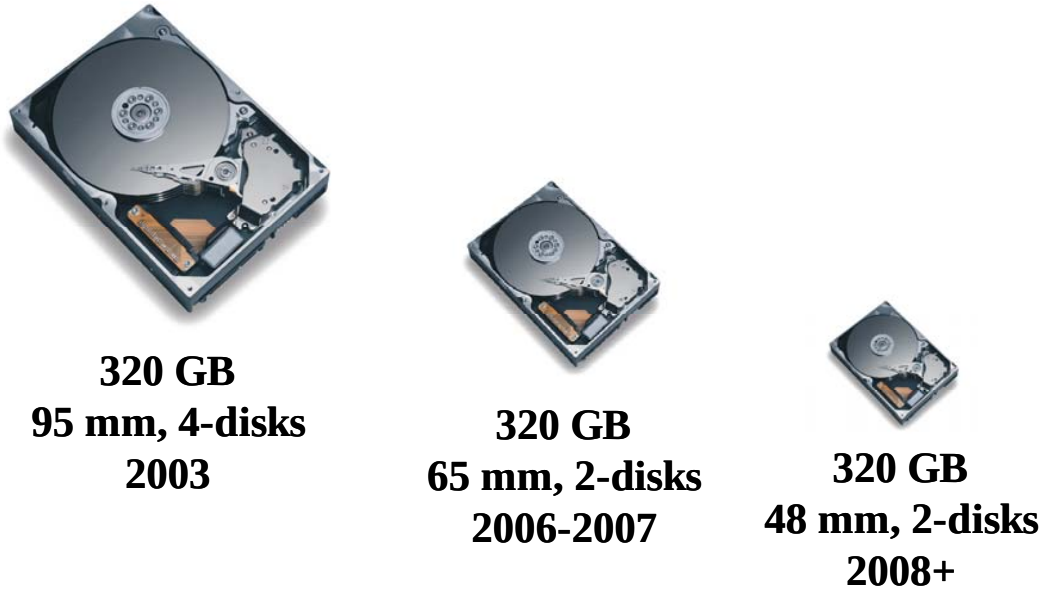
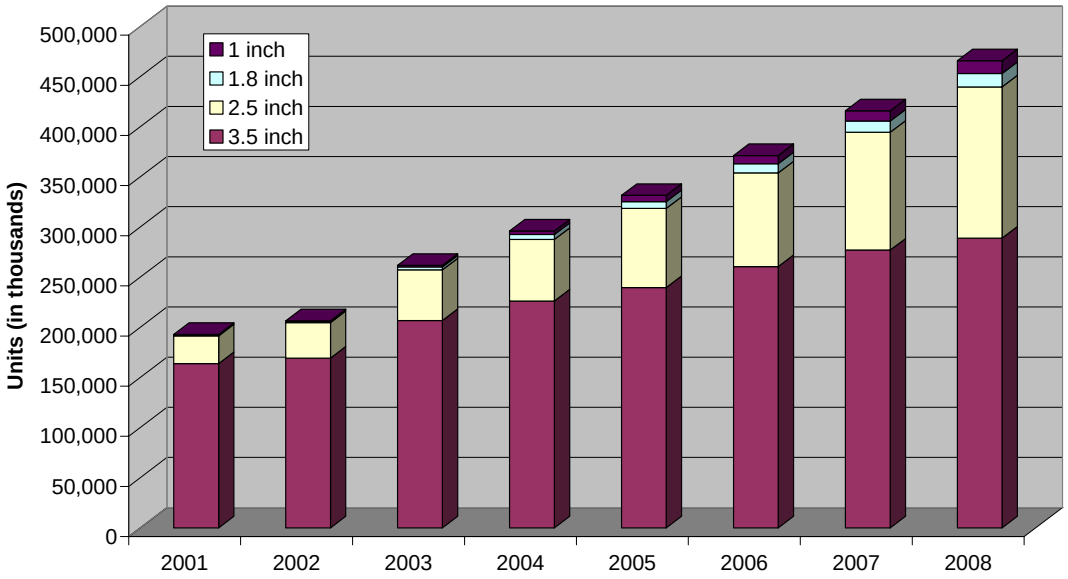


Figure 2. Projected Breakdown in Total HDD Shipments vs. Disk Form Factor.

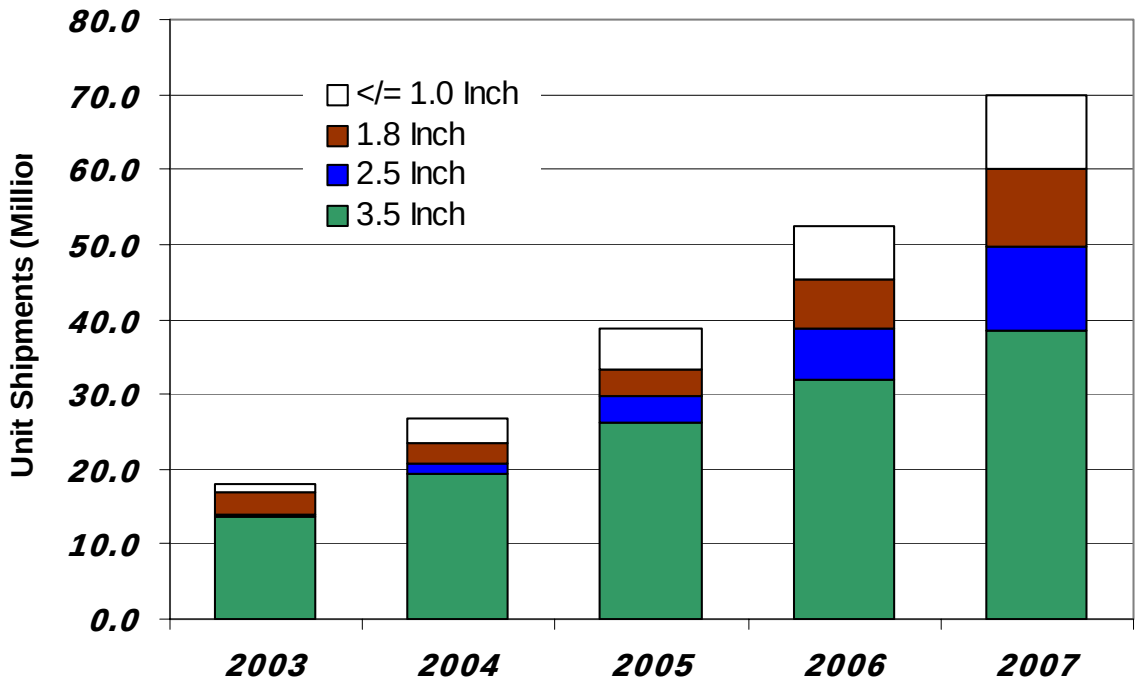


With higher areal densities it will be easier to store useful amounts of digital content on smaller form factor disk drives. Smaller form factor disk drives could result in smaller consumer electronics devices.

Smaller and more light weight HDD form factors are particularly attractive for mobile applications but may also be a factor in creating smaller form factor household consumer electronic devices as well as smaller foot print network storage systems. Overall we expect the most robust growth in smaller form factor disk drives as shown in Figure 2 particularly for 2.5 inch (65 mm) hard disk drives since with increasing drive areal densities useful capacities will be possible on these drives allowing the creation of smaller systems using these drives.

Of course it is in mobile consumer applications that the biggest demand for smaller form factor HDDs will be seen. Figure 3 gives our projections for unit shipments for consumer electronic applications. 3.5 inch (95 mm) drives will continue to have the largest volume because of their use in the DVR/PVR market but the mobile devices will rely on 1.8 inch (48 mm) or smaller disk drives. Recently Panasonic and Toshiba have announced development of a 0.85 inch disk drive for use in mobile telephones.

Figure 3. Projections for Unit Shipments by Form Factor of HDDs Used for Consumer Electronics Applications.



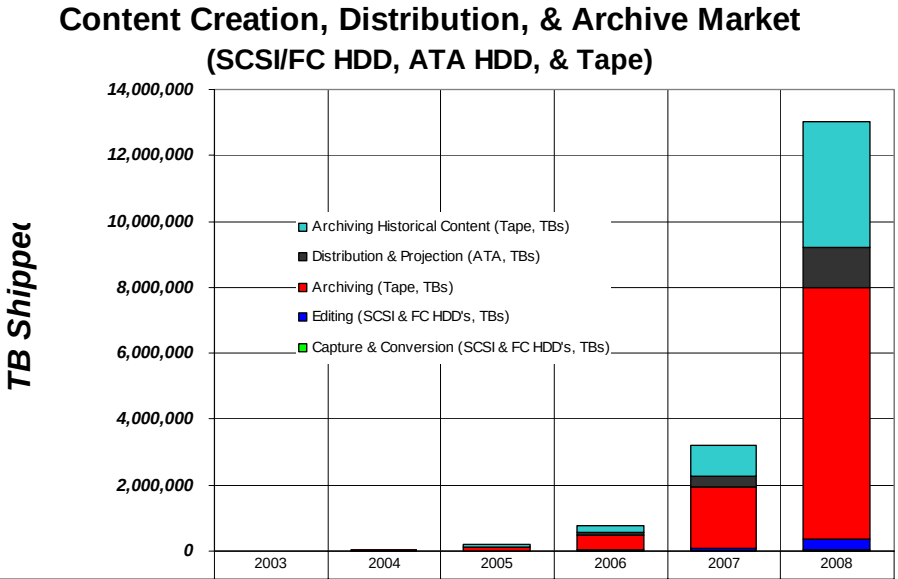
Small Store/Large Store

Growth in the consumption of content storage by home and mobile devices will drive the creation and distribution side of content storage as well. All elements of the content

value chain drive one another to create a greater overall demand for storage for digital content. Like Metcalf's law for networks the value of (and market for) digitized content increases as the number of users increases. With a pricing model that appeals to both consumers and the content owners digital entertainment content will be an increasingly significant driver for the use of content storage as the 21st century goes on. The combination of increasing access to digital content combined with the insatiable appetite for higher resolution video will result in enormous demand for content storage in the years ahead. Figure 4 shows our projections for digital storage requirements in Terabytes for content creation, editing, archiving and delivery as well as expectations for the types of storage devices that will be the beneficiaries of this increased demand.

An interesting feature of this projection is that as more rich content is made and as that content goes to higher resolutions the storage requirements for preserving or archiving that content grow considerably. Our estimates for archiving capacity requirements are also swelled by our expectations that digital conversion and preservation efforts for historical content will accelerate creating very large historical archives. Ultimately, all of this archival content can be contribute significantly to the bottom line of the content owners as they find ways to make it available to consumers.

Figure 4. Projections for Digital Content Storage Demand for Content Creation, Distribution and Archiving.



	2003	2004	2005	2006	2007	2008
Archiving Historical Content (Tape, TBs)	4,530.0	13,900.0	56,600.0	230,000.0	937,000.0	3,820,000.0
Distribution & Projection (ATA, TBs)	1,420.0	4,360.0	17,800.0	72,300.0	294,000.0	1,200,000.0
Archiving (Tape, TBs)	9,060.0	27,800.0	113,000.0	461,000.0	1,870,000.0	7,630,000.0
Editing (SCSI & FC HDD's, TBs)	390.0	1,200.0	4,870.0	19,800.0	80,700.0	328,000.0
Capture & Conversion (SCSI & FC HDD's, TBs)	51.2	157.0	639.0	2,600.0	10,600.0	43,100.0

About the Author and his sources:

All of the figures in this article are from the recently released 2004 Entertainment and Digital Media Storage Report, written by Thomas M. Coughlin, Pat Hanlon and Dennis Waid for Coughlin Associates. This report covers data storage drives and requirements throughout the entire digital content value chain including content creation, editing, archiving, distribution and reception. Copies of this report can be ordered from www.tomcoughlin.com or by calling 408-978-8184.

Thomas M. Coughlin has worked as an engineer, senior manager and consultant to the data storage industry for over 20 years. Besides his various consulting activities he also writes and publishes digital storage market and technology reports as well as produce the annual Storage Visions conference that focuses on data storage and the content value chain. More information on Tom Coughlin and Coughlin Associates can be found at www.tomcoughlin.com .