Coughlin Associates
Data Storage Consulting

OBJECTIVE ANALYSIS
Semiconductor Market Research

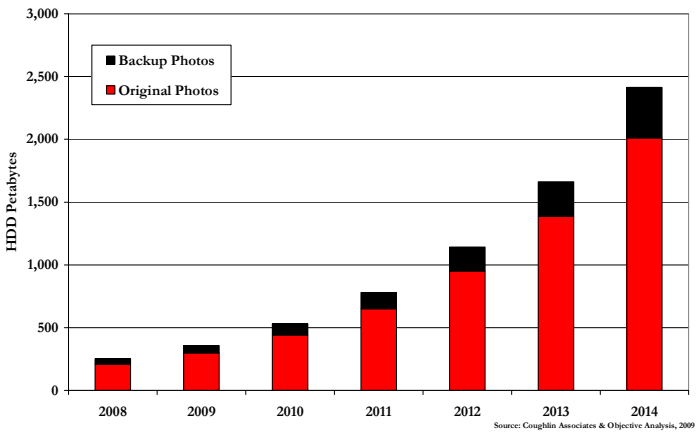
MULTIDISCIPLINARY WHITE PAPER

FLASH & HDD – SYMBIOSIS, OR SURVIVAL OF THE FITTEST?

There has been a lot of discussion recently pitting flash memory against HDDs, but we believe there is another way to view these two apparently competing technologies: from a larger perspective, they complement one another, enabling applications and improving demand Perhaps a better analogy for flash memory and hard disk drives is to see them as parts of an interdependent ecosystem rather than as contestants in a bitter battle where the winner takes all. Companies involved in the development, manufacture, application and integration of each storage technology would be wise to factor in the use of the other technology in their long term business strategies.

As an example of this symbiosis, let's look at three typical consumer flash applications and examine their impact on HDD storage demand. These applications are: digital still cameras, portable music and video players, and video camcorders. The analysis presented here is based upon data in the 2009 Digital Storage in Consumer Electronics Report (available from Coughlin Associates, www.TomCoughlin.com).

Figure 1. HDD Storage Growth from DSC



Digital Still Cameras

A typical digital still camera user shoots an average of 549 photos per year. Most people do not keep their photos on their flash memory cards, they move them onto computer hard drives (either in computers, on-line, or in external storage devices).

At an average size of 4.7 MB/photo, those 549 photos will need to be moved to hard disk drive mass storage (either on the PC, on-line, or most likely both) accounting for consumption of at least 2.6GB of HDD storage every year per household.

What's more, camera and camera phone sales are growing at an annual rate of 5% or more, while the average megapixels per camera is growing at a 25% rate. Consumers' generation of photos appears to be rising by about 24% every year. These numbers are multiplicative, giving an annual increase of 63% in the amount of storage required for keeping an average family's photos. Hard disk drives are not usually filled to capacity and we

assume 70% utilization. In addition some amount of the original photos taken each year will be backed up on external hard disk drives and our surveys indicate that roughtly 20% of the digital photographs today are backed up. Using these numbers and estimates of increasing capacity for primary computer storage as well as backup storage devices we can estimate the total annual digital photography storage capacity growth and the number of hard disk drives required to support that growth.

Figure 2. HDDs Driven by Digital Photography

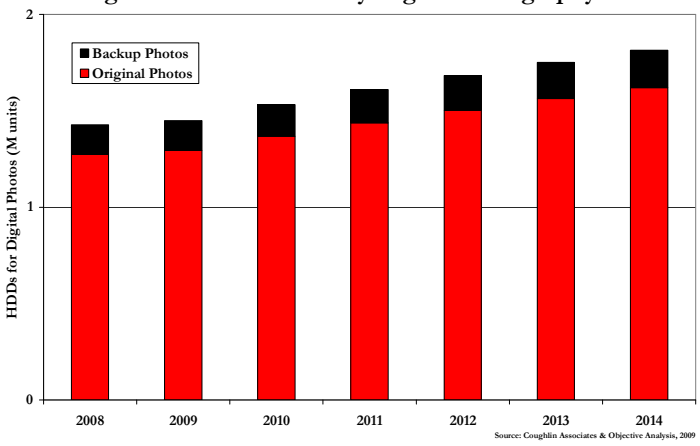


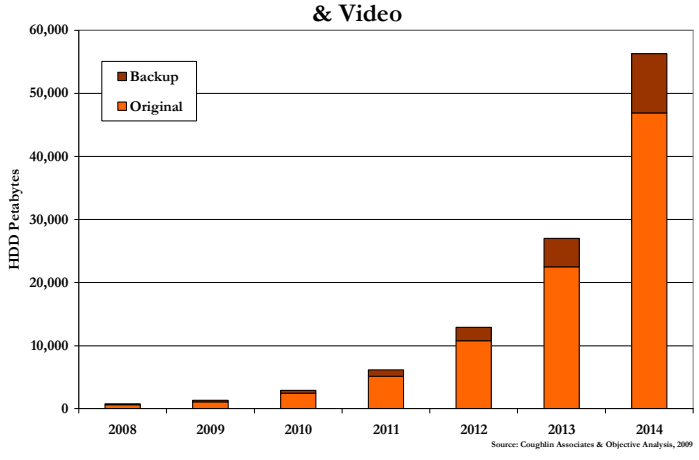
Figure 1 shows the worldwide annual trend of storage capacity growth to support digital photography. **Figure 2** shows our estimates of the total number of HDD units needed to support this annual growth in storage for still digital photography. In the next few years close to 2 million HDDs per year will be needed to support digital photography.

Note that without inexpensive hard disk drive storage, few people could afford to take and store as many pictures as they do today. Thus a majority of digital still camera photographs and the demand for flash memory in digital still cameras (estimated at about 152 million flash cards or 1.8 exabytes in 2009) is driven by the existence of hard disk drives.

Digital Music & Video Players

To see how the flash in a portable digital music or video player depends upon HDDs, just consider the way that a song or video gets onto that player. Generally a song is downloaded from the web or is "Ripped" from a CD (or other source) and stored on a computer hard disk drive. In general, songs or videos are managed on PCs since their larger storage capacity and multiple input sources makes managing the content easier. Songs or videos are then selectively moved onto a digital music player, such as an iPod or mobile phone handset.

Figure 3. HDD Storage Growth from Portable Music & Video



The average owners of a digital music or video player have three times more music or videos on their PCs than on their playout devices. With today's average player boasting a memory size of 4 GB, music and video for portable players, typically accounts for 12GB of storage capacity on a PC's HDD.

If we assume 70% PC HDD utilization and that 20% of the music and videos are backed up (as we did for digital photographs) then we can estimate trends for increasing storage capacity for primary computer storage as well as backup storage devices to support portable digital music and video players. We can also estimate the number of hard disk drives required to support that growth.

Figure 4. HDDs Driven by Music & Video Players

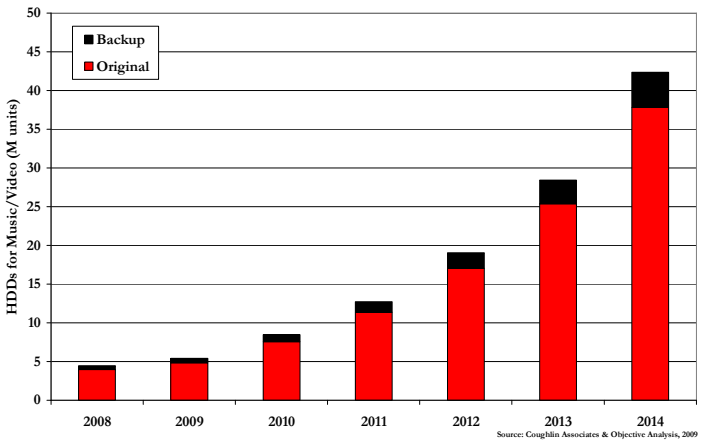


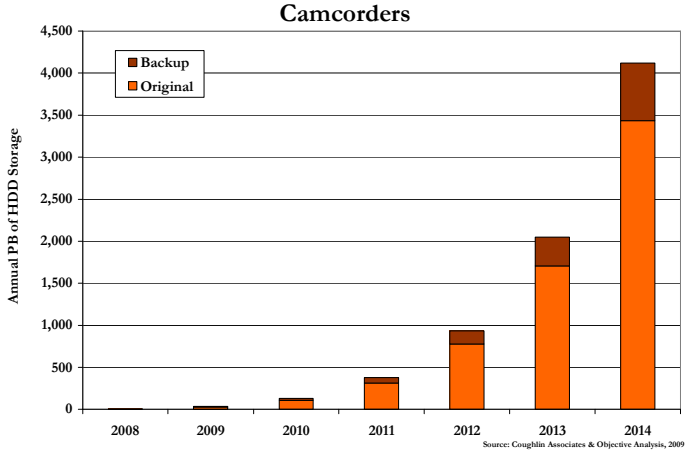
Figure 3 shows the worldwide annual trend of storage growth to support portable music and video players. **Figure 4** shows our estimates of the total number of HDD units needed to support the annual growth in storage for portable music and video players. In the next few years close to 42 million HDDs per year will be needed to support portable digital music and video players.

The portable music player market would be a lot smaller without PCs and external hard disk storage for the master and backup copies of music and video. Thus a majority of portable digital music and video players is driven by the existence of hard disk drives, growing the demand for flash memory in these devices to about 372 petabytes in 2009.

Flash Camcorders

Digital video recording using flash memory is a growing trend, particularly by technically savvy users and youth. With the general growth of user generated content and with an increasing ability to index and organize this content, we expect this growth to continue, particularly for the most cost conscious consumers.

Figure 5. HDD Storage Growth from Flash Camcorders



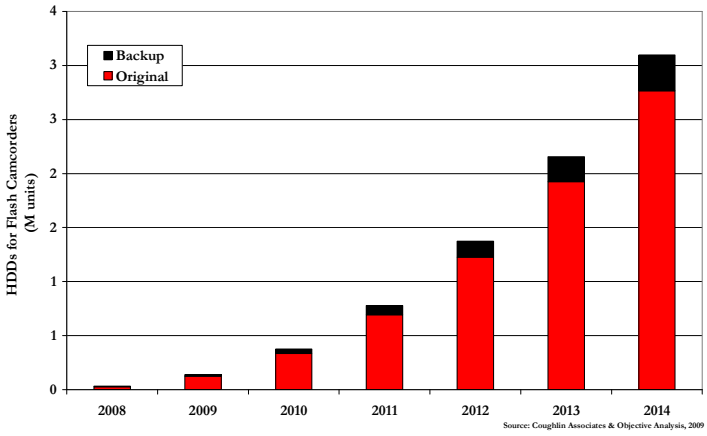
We expect to see increased popularity for low-priced flash-based consumer video recording devices, both in the form of dedicated camcorders and in the use of video functions built into digital still cameras and mid-to-high-end camera phones. We project that 60% of camcorders sold in 2014 could use flash memory.

If we again assume 70% PC HDD utilization and that 20% of the flash camcorder videos are backed up (as before) then we can estimate trends for increasing storage capacity for primary computer storage as well as backup storage devices to support flash-based video camcorders. With these estimates we can also project the number of hard disk drives required to support that growth.

Figure 5 shows worldwide annual storage growth to support flash-based camcorders. **Figure 6** shows our estimates of the total number of HDD units needed to support this growth. In the next few years about 3 million HDDs per year will be needed to support flash-based camcorders.

HDDs will be critical to the growth of flash-based camcorders. Thus a majority of our projected flash-based camcorders (using 24 PB of flash memory in 2009) would never be sold if hard drives weren't available.

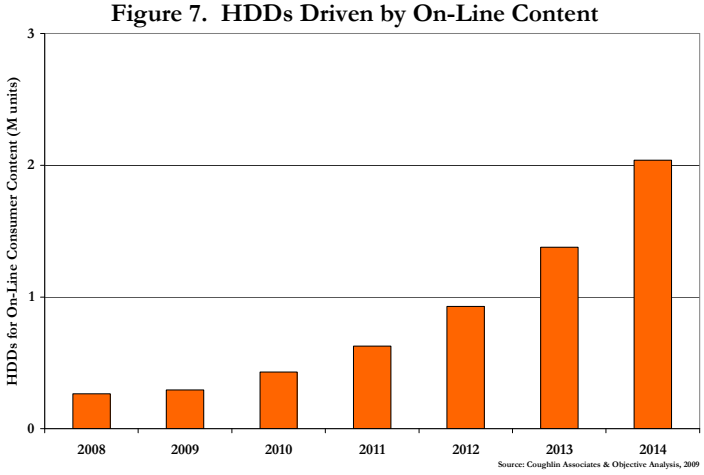
Figure 6: HDDs Driven by Flash Camcorders



Storing User Content Online

There is a growing trend for users to store their various types of content on-line. This is done to share this content or as a form of remote disaster recovery for user generated content. If we assume that 5% of the content calculated above makes its way on-line then we can estimate on-line HDD capacity and demand driving the unit consumption illustrated in **Figure 7**. By 2014 a full 2 million HDDs will be used solely for online storage of consumer content.

Figure 7. HDDs Driven by On-Line Content



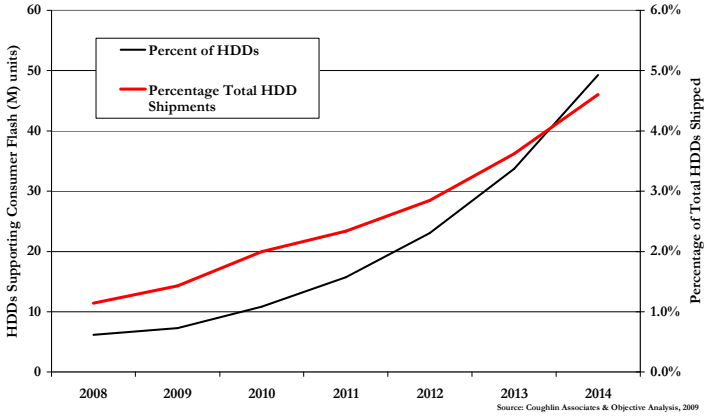
Total HDD Consumption Driven by Consumer Applications of NAND Flash

Adding up all the consumption in the preceding sections we arrive at the HDD unit forecast depicted in **Figure 8**. Between 2009 and 2014 total HDDs shipped to support flash-based consumer applications will grow from 7 to 49 million units. During the same period the percentage of HDDs shipped to support flash-based consumer applications will increase from 1.4% to 4.6% of total projected HDD shipments (also charted in **Figure 8**). Clearly NAND flash is helping HDD consumption to grow!

At the same time many of these flash-based consumer applications would not

be as popular without inexpensive high capacity HDDs to support them. Altogether our projected 2.2 exabytes (2,200 petabytes) of flash memory in 2014 (estimated to be 59% of total consumer flash demand) would be significantly smaller if HDDs were not available to support them. Clearly HDDs are helping NAND flash consumption to grow as well.

Figure 8. HDD Units & Percent of HDDs Driven by Flash-Based Consumer Applications



We conclude that in these consumer applications there is much more symbiosis than competition between HDDs and flash memory. The existence of one enables the growth of the other. Together HDDs and flash memory are part of a consumer storage ecosystem.

Although the analysis in this brief white paper covers three consumer flash applications we believe that a good case for a more symbiotic relationship for HDDs and flash memory can also be made for enterprise and computer applications.

Authors

Tom Coughlin, President, Coughlin Associates has many publications and six patents to his credit. Tom is also the author of Digital Storage in Consumer Electronics: The Essential Guide, which was published by Newnes Press in March 2008. Coughlin Associates provides market and technology analysis (including reports on several digital storage technologies and applications and a newsletter) as well as Data Storage Consulting services. Tom is the founder and organizer of the Annual Storage Visions Conference (www.storagevisions.com) as well as the Creative Storage Conference (www.creativestorage.org). Tom is also the chairman of the annual Flash Memory Summit. For more information go to www.tomcoughlin.com.

Jim Handy, is a widely recognized semiconductor analyst Before founding Objective Analysis Mr Handy had over 30 years in the electronics industry including 14 years as an industry analyst for Dataquest (now Gartner) and Semico, and marketing and design positions at Intel, National Semiconductor, Infineon, and others. Mr. Handy holds a Bachelor's degree in Electrical Engineering from Georgia Tech, an MBA from the University of Phoenix, is a patent holder, is on the Advisory Board of the Flash Memory Summit, a member of the Mass Storage Technical Working Group of the International Electronics Manufacturing Initiative (iNEMI), and is a Leader in the Gerson Lehrman Group Councils of Advisors. He is the author of "The Cache Memory Book" (Harcourt Brace, 1993).

Roger F. Hoyt is a technology consultant in mass data storage and manufacturing. He has over 25 years of professional and managerial experience including positions with IBM Research and Storage Systems divisions, and Hitachi Global Storage Technologies. His holds a bachelor's degree in Engineering Physics from the University of Illinois, and M.S. & PhD degrees in Physics from the University of California at San Diego. He is also active in the IEEE Magnetics Society and iNEMI Mass Data Storage roadmapping.