Iomega's Zip Drive

Why it is Important

The first half of the 1990s saw the convergence of the World Wide Web, digital camera technology, and the widespread availability of graphic-oriented software and hardware. As a result, desktop publishing became a household name, and the need for digital storage of large files became critical. Hard Disk Drive (HDD) technology was also rapidly evolving, with the typical capacity of a client HDD going from around 100MB in 1990 to about 100GB in the year 2000, for a 1000-fold increase in only 10 years. However, Floppy Disk Drive (FDD) technology did not experience a similar improvement, with the capacity of a 3.5" floppy disk leveling out in the 1.4-2.0MB range in the same period. Removable storage was critical for people not only to use as backup in case of HDD failure, but also to port personal data between computers, in an age of course when cloud storage was not yet available. Time was therefore ripe for innovation in this area.

Zip Launch and Market Reception

Iomega's focus on R&D and technical innovation is reflected in its large number of patent filings. In fact, a total of 456 patent applications were filed in the 30 years after the start of the company in 1980 [1], that built a significant technology and IP portfolio, and ultimately led to the successful launches of the Bernoulli products in the 1980s, and the Zip drive in 1994. Unlike the Bernoulli box, the Zip drive was aimed at the personal computer market and was relatively inexpensive (<$200), with its 100 MB cartridge selling for $20. With little competition in the space and a significant market demand, both drives and disk cartridges quickly became ubiquitous (Figure 1). Zip drives sold with various interfaces (IDE, Parallel, SCSI, USB etc..), in external as well as internal models [2]. Its success, mostly through word-of-mouth, led major OEMs (Dell, Gateway, Apple) to soon offer the internal version in their desktop products [2].

Figure 1: Iomega Zip drive (left, [2]) and 100MB Zip cartridge (right, author's collection)

When it comes to designing commercially viable technical products, three attributes are critical: performance, cost, and reliability. Iomega's Zip drive was clearly a cost/performance leader, at the expense perhaps of reliability. Some of these performance attributes were discussed in a 1995 conference paper by Iomega [3], whereas cost and reliability information were obtained from publicly available data and news channels. Some of this is summarized below.

Performance and Cost

Some of the limitations of the standard 3.5" floppy disk drive (FDD) include the use of an open loop, stepper motor driven track positioning, as well as a low rotational speed of 300RPM. The lack of precise radial positioning obviously limits track density and overall capacity, whereas low RPM limits data rate.

Iomega implemented a fine linear voice coil actuator with a servo scheme that enabled a >20x improvement in the number of tracks per surface from 80 for the FDD to 1,817 on the Zip [4] (Figure 2). This servo positioning scheme was implemented using sector servocontrol, with magnetically written track position information embedded on the disk surface [5]. This scheme also became ubiquitous on all rigid disk drives at the time.

The 10x improvement in disk rotational speed compared to FDD (3,000 vs 300RPM) was a major challenge that was quite a bit more difficult to solve, as flexible disks tend to flutter (oscillate) uncontrollably past a certain speed. In earlier products, Iomega circumvented this issue using a Bernoulli plate that stabilized the media [6]. This technology, however, could not be easily used for a double-sided disk drive like the Zip. Instead, Iomega's technology relied on an innovative solid cartridge design with a sturdy case, reduced open area and dual fabric liners, that minimize friction and Position Error Signal (PES) [3, 7] (Figure 3).

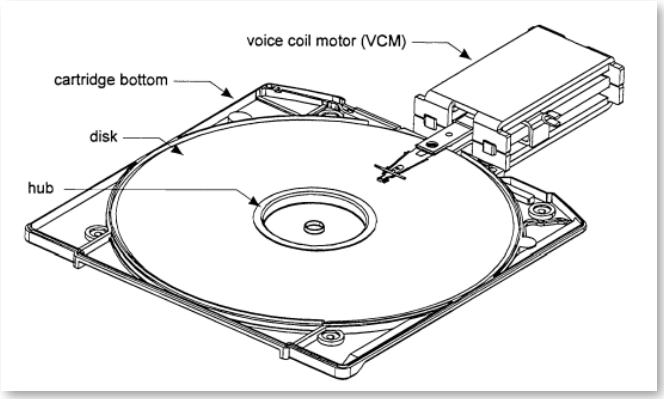

Figure 2: Left - Schematics of the Head/Disk assembly (from ref. [3])

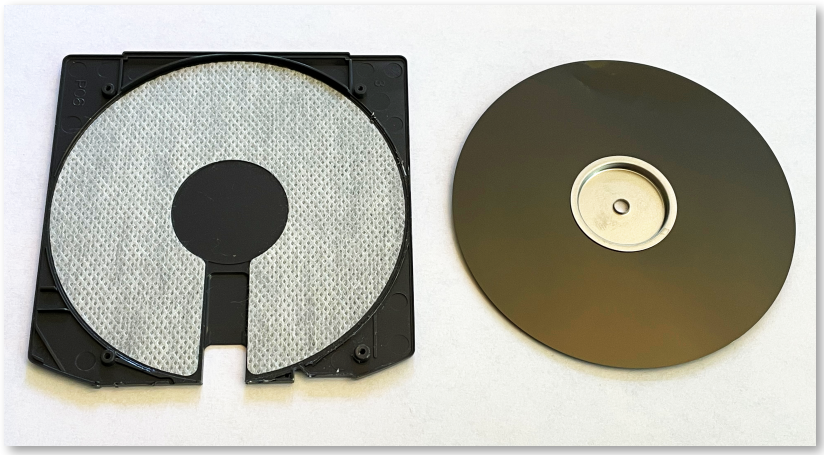

Figure 3: Zip cartridge inner case (left) and media (right)

A key to the management of disk vibrations at high RPM was also to use commercially available head nano-sliders used in rigid disk drives, a first at the time for flexible disk recording [3, 8]. Once loaded, the two flying heads would “pinch” the spinning disk, essentially pinning the standing wave vibration pattern and helping force a stable node at the recording location. These heads, designed to fly at 30nm [3], also enabled low magnetic spacing for high linear bit density, while minimizing friction and wear rate compared to FDD heads that are designed to slide in contact with the disk. Finally, leveraging high volume manufacturing components from the HDD industry allowed Iomega to keep prices low.

High linear bit density was also enabled by advanced media technology from Fujifilm [3, 9-10]. Their *Advanced super Thin layer and high-Output Metal Media (ATOMM)* media involved a Polyethylene Terephthalate (PET) substrate, a Titanium Oxide underlayer for roughness control, a metal nanoparticle recording layer and a topical lubricant, a clear departure from the simple Mylar/γFe_2O_3 (gamma ferric oxide) stack for standard FDD media. The media clamping scheme using a stamped piece of Aluminum (Figure 3-right) is very similar to a regular 3.5” floppy disk, helping to keep the cost down.

Iomega Zip’s business model was another example of the razor/razorblade Gillette model, where the drive was sold near breakeven price, and the disk cartridge providing a hefty profit margin of ~75% [11]. The company’s unrelenting pursuit of low component cost (heads, media, motors, IC’s) led to a retail price below $200, far below competing products [3]. This allowed for a meteoritic growth of the company, with sales peaking near 10 million units in 1999, and 64 million cartridges sold that year [2] (Figure 4). It is estimated that about 7 cartridges were bought for each drive sold, with a total over 60 million drives and 400 million cartridges over the life of this product, far outnumbering the total of all high-capacity removable magnetic storage devices put together.

Reliability

Unfortunately, Iomega's Zip drive suffered a similar fate as most other removable magnetic disk drives of the time. Unlike hard disk drives that are sealed from outside contamination, removable disks inevitably absorb a small amount of contaminants when inserted or ejected from the drive. Schemes were implemented by Iomega to wipe both heads [12] and media [13] during operation, but a small number of drives would nonetheless fail after enough material had accumulated. The low flying height of the head offered little tolerance for contamination or wear, and it exacerbated the problem. The symptom of failure was the inability for the head to read the servo information upon loading, leading the voice coil actuated arm to hit the metallic crash stop at the inner diameter of the disk. Upon many retries, the failing Zip drive would make a characteristic clicking noise, dubbed the "Click of Death" [14]. It is estimated that the warranty return rate was well into double digits [11].

End-of-Life

Iomega's Zip technology that propelled the company's market valuation in the late 1990s was unfortunately also mirrored by its quick demise. Although the company later launched higher capacity versions and a rigid disk offering (Jaz drive), the combination of rapidly deteriorating brand recognition brought by poor reliability and the advent of CD-RW and thumb-drive technologies, led to declining sales and poor stock performance (Figure 3). It is surmised that progress in HDD technology, which in 1998 was doubling drive capacity annually, also contributed to the problem: large capacity and increasingly reliable HDDs reduced the need for backup and removable storage. Iomega Corp was eventually sold to EMC in 2008 for $213M. At the end, the Zip brand only lived for about 10 years, but its impact on personal computing and data storage was significant, at a time when demand for backup storage was very robust.

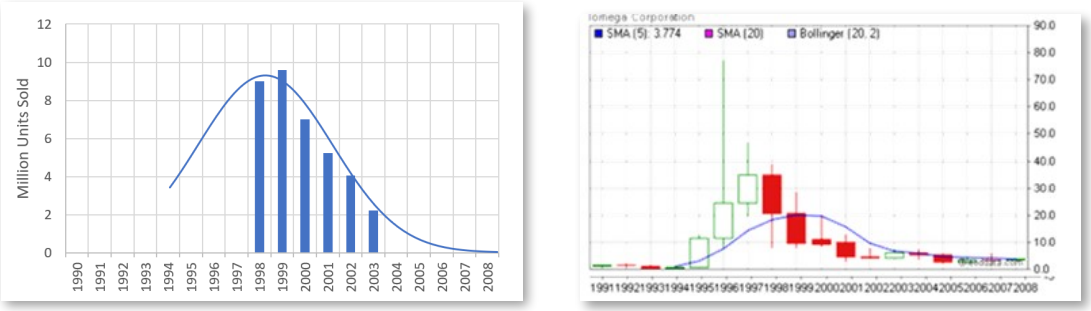

Figure 3: Left - Number of Zip drives sold between 1994 and 2008 (from [10]). Right - Iomega stock price in the same period (courtesy www.eoddata.com)

Acknowledgments

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References

[1] Espacenet search

[2] https://en.wikipedia.org/wiki/Zip_drive

[3] J. Briggs, Enabling technologies for a 100MB 3.5" floppy Zip disk drive, Photonics East 1995, 220/SPIE vol. 2604. https://doi.org/10.1117/12.230058

[4] https://www.grc.com/tip/codknowledge.htm

[5] Servo control of seek operation in magnetic disk drive, US Patent 4,532,562-A

[6] Bernoulli plate for stabilization of flexible magnetic disk, US Patent 4,419,704-A

[7] Flexible disk cartridge having disk stabilization means, US Patent 5,537,281-A

[8] Integrated read/write heads, flexure assembly and air-bearing on common unitary substrate, US Patent 5,166,845

[9] https://www.fujifilm.com/us/en/business/data-storage/fujifilm-technologies/atomm

[10] Magnetic recording medium, US Patent 5,219,670-A

[11] R. Brown and J. Briggs – Private communication

[12] Head cleaning cartridge for magnetic disk drive, US Patent 4,663,686-A

[13] Particulate removing means for cartridges, US Patent 4,969,061-A

[14] https://en.wikipedia.org/wiki/Click_of_death

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