

Removable Disk Storage Successes & Flameouts: What Can We Learn from the Past as We Move Forward?

**David J. Kalstrom
CEO, Trace Affex, Inc.
1609 B Regatta Lane
San Jose, CA 95112**

**Phone: +1-408-441-3535; FAX: +1-408-441-7259
e-mail: dkalstrom@trace.com**

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The Premier Advanced Recording Technology Forum

THIC Inc.

Trace Affex

My Background

- **Marketing Specialist with some of the first 8" Floppy drives and later 5-1/4" floppies (mid to late 70's).**
- **Director of Marketing at Seagate in early 80's. During that time, involved with support of the 3-1/2" floppy (and some other unsuccessful formats).**
- **Involved with the standards efforts in the mid-80's on 5-1/4" removable optical discs, both Magneto-Optical and Phase Change.**
- **Author of section on CD-ROM/CD-R for the Encyclopedia of Electrical & Electronics Engineering.**
- **Presented THIC paper in June 2000 on OSD technology.**
- **Currently CEO of company manufacturing duplication and printing equipment for CD-R, DVD-R, and DVD+R.**

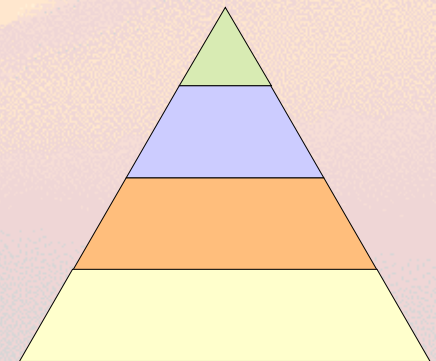
Outline

- **Categorize the different types of removable Disks (Discs)**
- **Explore some real-world examples of Successes and Flame-outs**
- **What can we learn that can help predict the future? In particular, the current battleground for recordable DVD**
- **My analysis is Commercial, not Technical**

First, a Warning . . .

This presentation will contain:

- **NO Areal Density Trend Charts**
- **NO Roadmaps**
- **NO cross-sections of recording surfaces and materials**
- **NO hierarchical pyramid charts**



...

Commercial Implementations of Removable Disk (Disc) Technologies

- Some were successful . . .



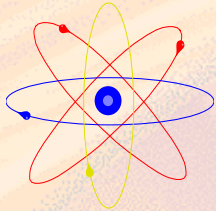
- Some were not . . .

Floptical

OSD

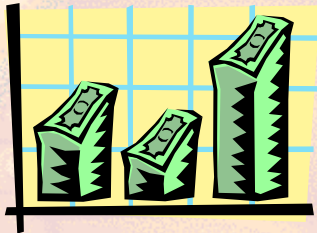
NFR 5-1/4"

Success vs. Failures



Was it the technology?

Was it the implementation?



Was it the \$/GB?

Was it Access Time?

Was it Transfer Rate?

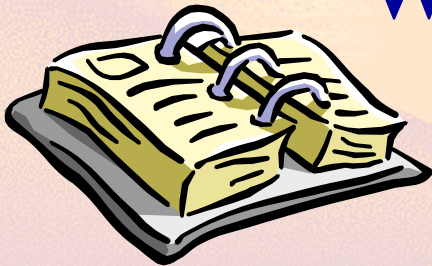


Was it timing?

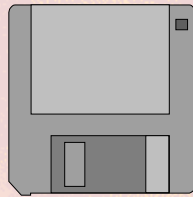
Was it money?



Or ... ?



Media Cost Comparisons



Specification	Floppy	Zip	5-1/4" MO	CD-R	DVD+/-R
Capacity:	1.44 MB	750 MB	9.1 GB	650MB	4.7 GB
Cost/Disc (US Retail):	\$0.20	\$12.00	\$84.00	\$0.30	\$3.00
US\$/GB:	\$139.00	\$16.00	\$9.20	\$0.46	\$0.64
Libraries ?	No	No	Yes	Yes	Yes

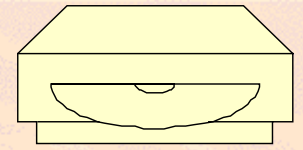
Let's look at some predictions:

In a THIC paper given by a respected author in April 1997, the most promising emerging storage technologies were cited as

- Near Field Recording (NFR)
- Optical Tape
- Holographic Recording

...one of these was a Removable disk technology...

Removable Disk (Disc)



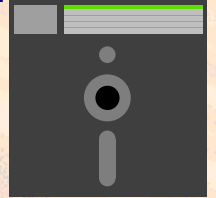
Technologies have not been predictable like HDD

- Non-removable (HDD) disk cost vs. capacity charts have been reasonably predicable
 - Hard Disk capacities keep growing and drives keep getting cheaper (superparamagnetism? -- Damn the torpedoes, full speed ahead !!)
- Removable Disk Technologies have not been consistent or particularly predictable
 - Multiple challenges, such as interchangeability, contamination, costs, reliability, money . . .

Categories of Removable Disks

- Pure Magnetic Recording
 - Such as Floppies, Bernoulli, Zip, JAZ, Syquest, Removable HDD
- Optically-assisted Magnetic Recording
 - Such as Magneto-Optical, Floptical, NFR, OSD, HAMR
- Pure Optical Recording
 - Such as CD-R, Phase-Change, DVD-R/RW, DVD+R/RW, Blu Ray

Is Pure Magnetic Recording Dead as a Removable Disk Storage Technology?



- A Feb. 2003 article in the San Jose Mercury news proclaims “The Death of the Floppy”.
- Dell announced last month that floppies would no longer be included as standard
- Apple announced the same with the iMac in 1998
- Capacities of floppies simply too low
- ALL computers are now networked

FLOPPY FACTS

- \$750** • Price of an 8” floppy disk drive in 1977
- \$14.99** • Current price of a 50-pack of floppies (with a rebate offer of \$10)
- 3** • # of times the diskettes sold last year would wrap around world, end-to-end
- 0.08** • MBs on IBM’s first 8” floppy (1971)
- 0.4** • MBs of storage on Sony’s 3.5” floppy (1981)
- 340** • MBs of storage in a single, 1” IBM Microdrive, introduced in 1999

Source: SJ Mercury News, Feb. 2003

FLOPPY TIMELINE

- 1971 • IBM develops 1st 8” floppy for program load**
- 1976 • Shugart Assoc. introduces 1st 5.25” floppy**
- 1981 • Sony introduces 3.5” floppy with 0.437 MB, eventually winning over 3”, 3.25”, and 3.9”**
- 1997 • Worldwide production of 3.5” floppy discs peaks at 5 Billion/year (10.4 Petabytes)**
- 1998 • Apple intros iMac with no floppy drive**
- 2003 • Dell announces 3.5” floppies will not be standard equipment**

Source: SJ Mercury News, Feb. 2003

Optically-Assisted Magnetic Recording

- **5-1/4” MO topped out at 9.1 GB (14x)**
- **Remember these names?**
 - Floptical from Insite Peripherals ***21 MB***
 - Pinnacle APEX (“Put a fork in it, the HDD is done”) ***4.6 GB***
 - OSD ***Maxoptix -- 26GB***
 - NFR ***TeraStor -- 10/20 GB***

Let's study an example of 2 failures and one possible success

NFR, OSD, UDO . . . All similar specifications:

- **Disc Cartridge physically the same as 5-1/4" MO cartridges**
- **Drive size to be the same as current 5-1/4" drives (important for libraries/jukeboxes)**
- **Capacities of 10 to 30 GB per removable cartridge with a roadmap indicating future growth.**

What happened?

What is still happening?

- **Many 10's of millions of dollars were invested into TeraStor to commercialize NFR.**
- **A smaller amount, but still substantial, was invested into OSD at Maxoptix for similar capacities and performance.**
- **A substantial amount is now being invested into UDO at Plasmon, again for a similar product. But UDO is pure optical recording, using Blu Ray technology.**



Scorecard

NSF / TeraStor



Flameout



OSD / Maxoptix



Flameout



UDO / Plasmon



**Jury still out, but
chance of success**

Why the Flameouts ??

- **Do not know all the reasons, but generally related to:**
 - **POI: Patience Of Investors**
 - **UTACT: Unable To Achieve Cost Targets**
 - **UTMIW: Unable to Make It Work**
 - **TLTL: Too Late, Too Little**
 - **SBUP: Somebody Beat Us to the Punch**

High Capacity 5-1/4”

	NFR	OSD	UDO
• POI:	<i>Absolutely !</i>	<i>A factor</i>	<i>OK, so far</i>
• UTACT:	<i>Yes</i>	<i>Yes</i>	<i>OK, so far</i>
• UTMIW:	<i>Contamination issues</i>	<i>Plug pulled</i>	<i>OK, so far</i>
• TLTL:	<i>Not at time</i>	<i>Not at time</i>	<i>Probably not</i>
• SBUP:	<i>We were first</i>	<i>We were 2nd</i>	<i>We're still there</i>

So What about Pure Optical Recording?

- **We all agree that CD-R is a success**
- **The first to announce this product was a big winner, correct?**
- **And that company was:**
 - **TANDY, of Radio Shack fame**
 - **The THOR product was introduced in 1988**
 - **The next CD-R was introduced by “That’s CD”, known today as Taiyo Yuden**

Why was THOR a Flameout ?

- POI: *PROBABLY A FACTOR*
- UTACT: *PROBABLY A FACTOR*
- UTMIW: *WORKED IN SMALL QUANTITIES*
- TLTL: *NO*
- SBUP: *NO, THEY WERE FIRST*

Blu Ray from Sony



- Product announcement on March 3, 2003
- 23 GB / disc
- Recorder Price: 450,000 Yen (\$3800)
- Media Price: 3500 Yen (\$30)
- Will play DVD-R and DVD-RW, but not DVD-RAM or DVD+RW
- If backward compatibility is an issue, is forward compatibility also an issue?

Current Battleground is DVD Recordable

- Are there any lessons from the past that can help predict the future?
- Is DVD recordable a Beta vs. VHS situation? Well, not exactly because recorded discs can be read in the same low cost readers (except for DVD-RAM).
- Is co-existence possible?
- Let's look at some criteria . . .

Recordable DVD

	DVD-R/RW	DVD+R/RW
• POI:	<i>So far OK</i>	<i>So far OK</i>
• UTACT:	<i>So far OK</i>	<i>So far OK</i>
• UTMIW:	<i>OK</i>	<i>OK</i>
• TLTL:	<i>No</i>	<i>No</i>
• SBUP:	<i>We were first</i>	<i>We were 2nd</i>

Recordable DVD

- **Repeat, this is NOT Beta vs. VHS**
- **Perhaps co-existence is possible**
- **Maybe there should be a recording drive that handles most types of DVD recordable media**
- **Oh, there is such a product**
- **On that note, I thank our Sony hosts. Blu Ray is coming.**

