Challenges of Small Form Factor Disk Drive Design

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Overview

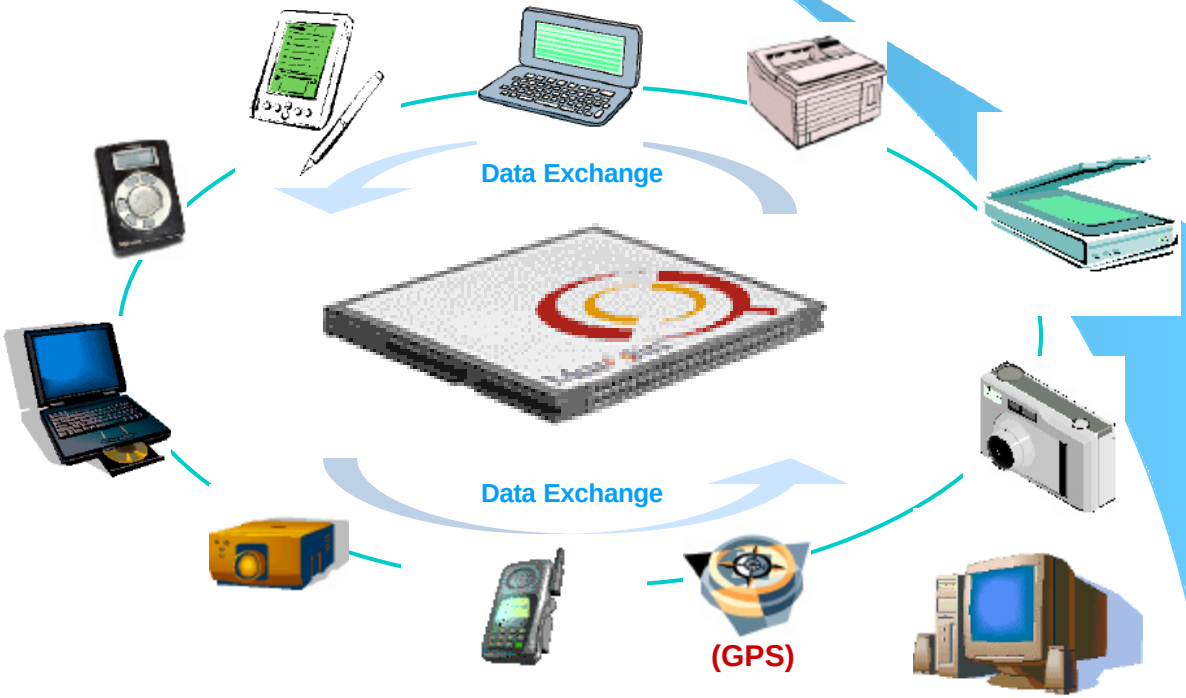
- Form Selection
- Design Considerations
- A CF Example
- Other Possible HDD Form Factors
- Competiting Technologies

Consumer Product Forms

- Choose a Form Consumers Can Use
  - ~~Built-in by OEM~~
  - Easy Attachment – Simple Hardware
  - Simple Configuration – No Software
- Choose a Form with a Large Number of Available Devices
- Choose a Standard Form
  - Ideally already installed and supported by Mfrs
- Choose a Form a Drive Can Fit Into

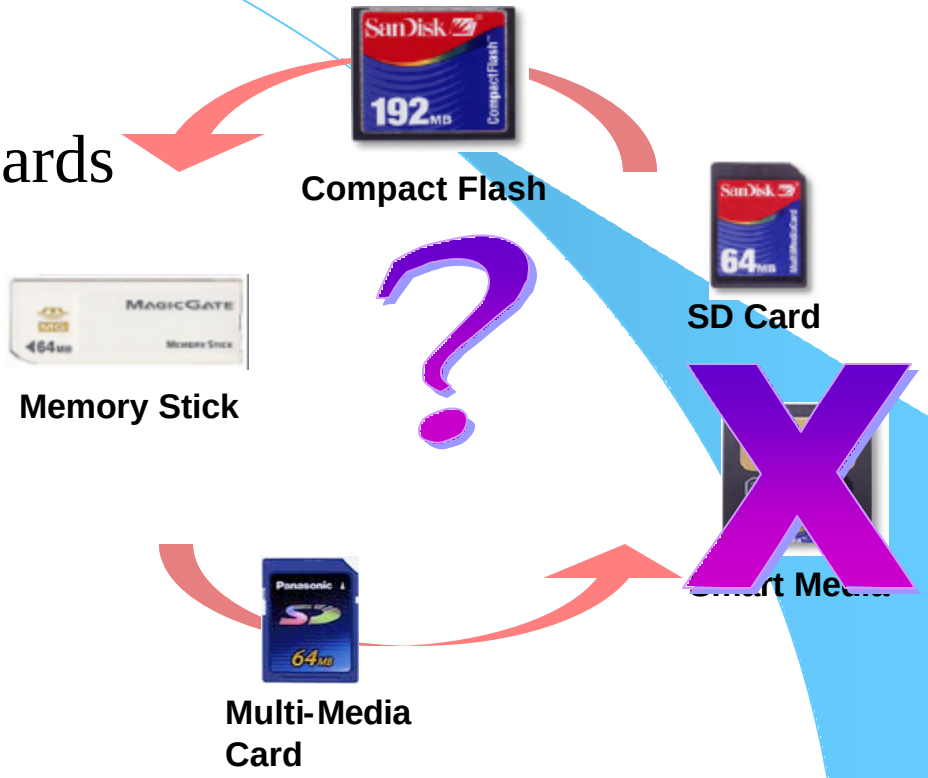
MarQlin Markets

Host slots available for CompactFlash & PCMCIA:

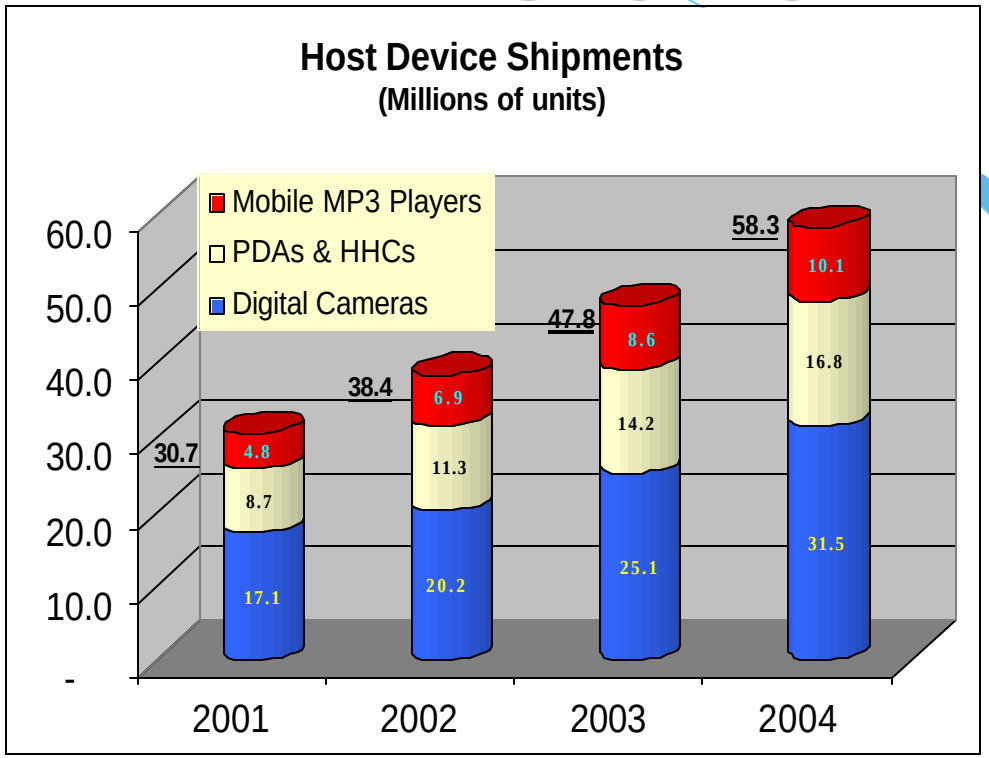


Form Wars

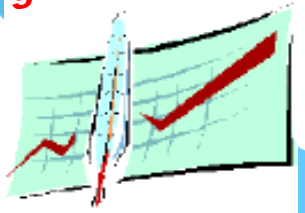
- Today's Standards
- Tomorrow's Standards



Consumer Electronics Markets Overview



Markets are hot, getting Hotter!



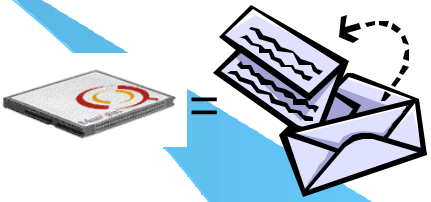
Sources:
(1) MP3 Players:
Cahners' In-Stat Sep-00
(2) PDAs & HHC's:
Cahners In-Stat Nov -00
(3) Digital Cameras:
IDC May -01

- Above markets are prime targets for 1.0" HDDs
- Market opportunity: one million units per year generates *hundreds of millions $ revenue.*

Design Priorities (in order)

- Robustness (Fitness for use)
  - Impact Resistance

- Low Mass



- Bumpers

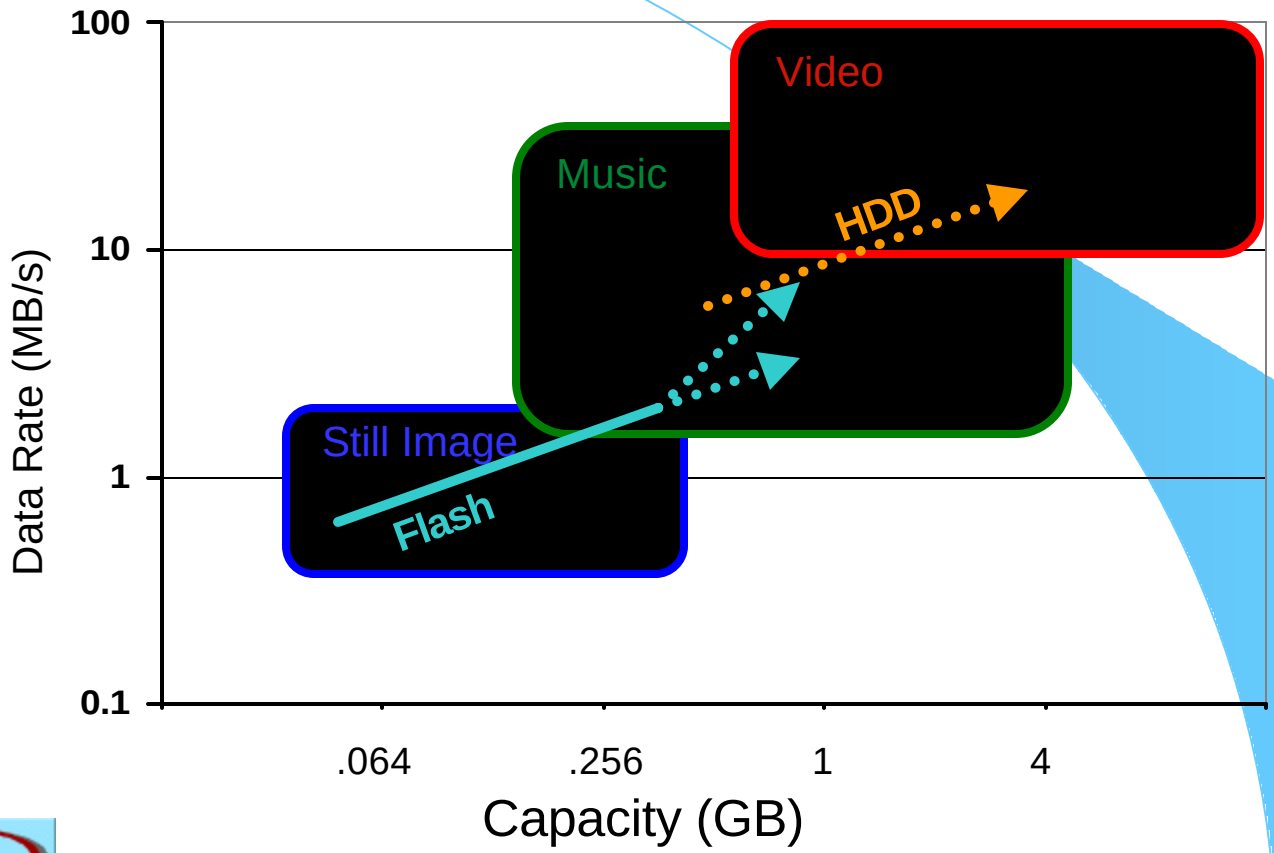
- Head Unload

- Water Resistance

Design Priorities (in order, continued)

- Power consumption
  - Longer Battery Life
  - More Pictures, Songs, etc.
- Cost Ideals
  - 5 -10X < Flash per GB
  - $199 No Spouse
    - $99 Impulse
- Capacity
  - Must Beat Existing Technology
- Performance
  - Music, Cameras, Video

Flash vs. HDD Write Speeds



Design Priorities

- Robustness
- Power consumption
- Cost
- Capacity
- Performance

Design Strategy

- Desktop HDD design turned on its head
- Use Small Size to Advantage
  - Break HDD Design “Rules”
- Use Proven Technology
- Use Proven Components and Suppliers
- Packaging Problem, NOT HDD Technology Problem

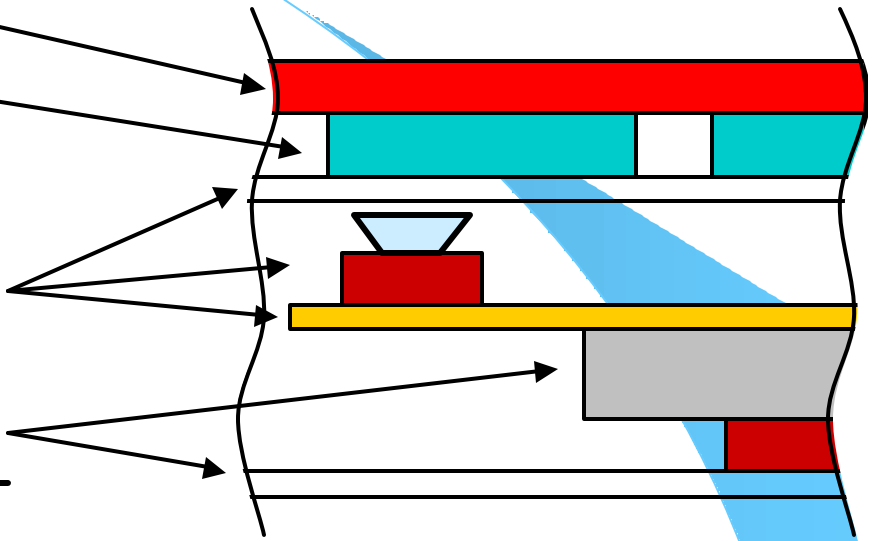
MarQlin CF HDD General Specifications

- Compact Flash Type 1, Power Level 1 conformance per CF Spec 1.4 (Fits into existing Type 1 slots)
- Outline Dimensions (mm): 36.4±.15 L x 42.8±.10 W x 3.3±.10 H
- Shock & Vibration Internal Specification: 2000 G, 0-2ms
- Temperature & Humidity: 0-55C, 5-95%RH non-condensing
- Peak Power: <300 mA @ 3VDC
- Weight: <15 grams

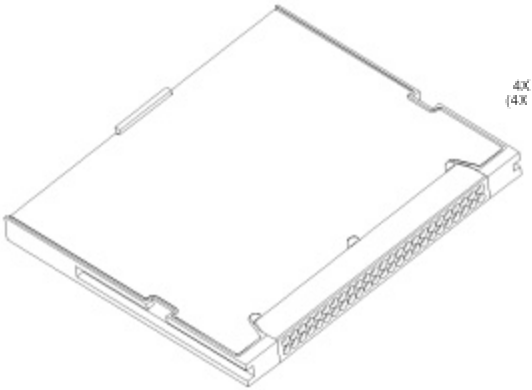
Package Thickness, The Real Challenge

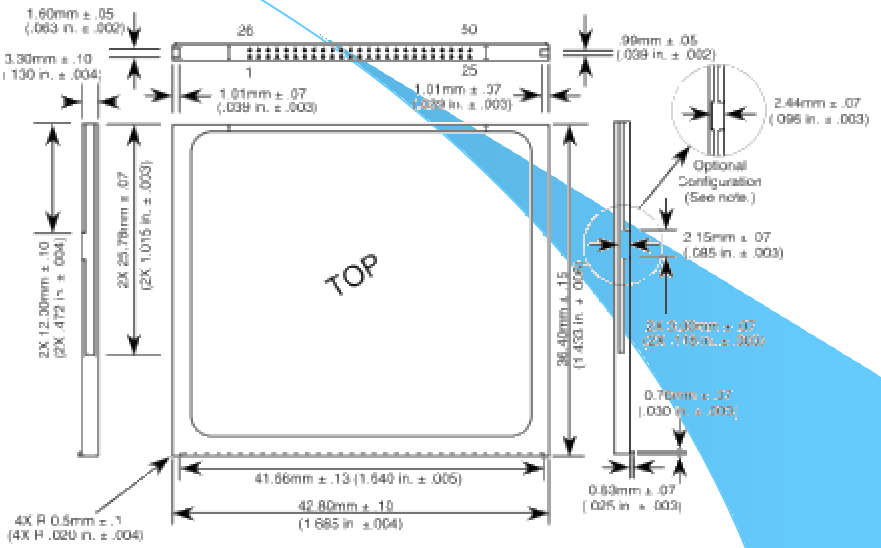
- PCB .4 mm
- Chips .5 mm
- Head, Disk & Cover 1.1 mm
- Motor & Base 1.3 mm

- Total 3.3 mm



Compact Flash Type 1



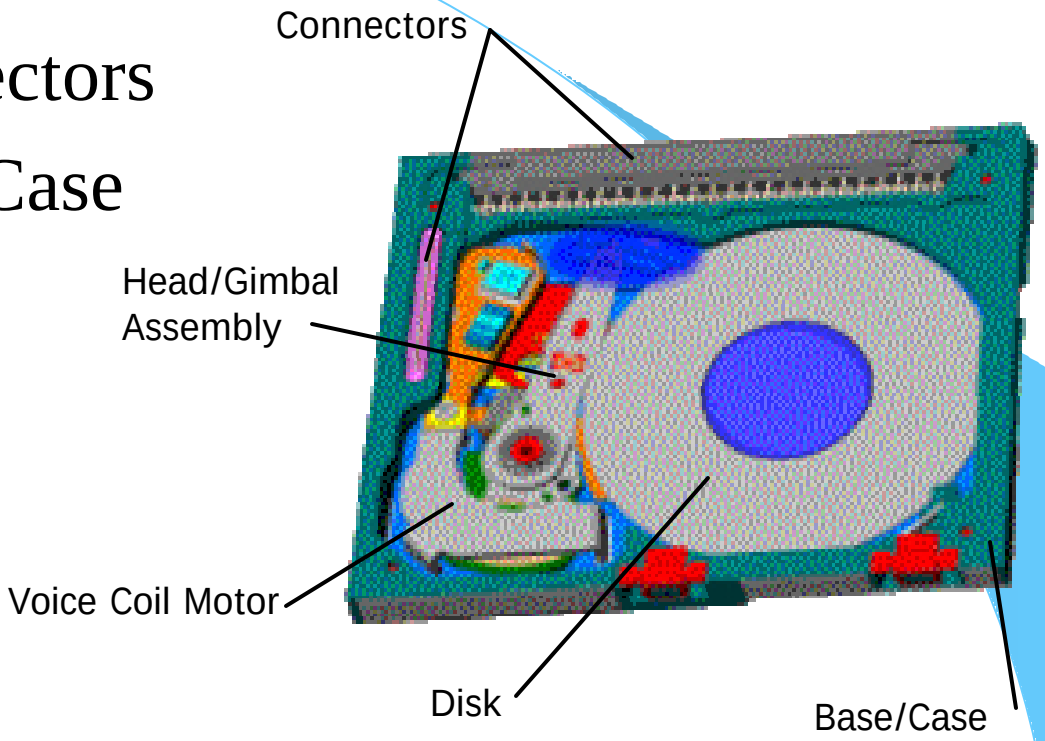


Note: The optional notched configuration was shown in the CF Specification Rev. 1.0. In specification Rev. 1.2, the notch was removed for ease of tooling. This optional configuration can be used but it is not recommended.

Figure 3: Type I CompactFlash Storage Card and CF+ Card Dimensions

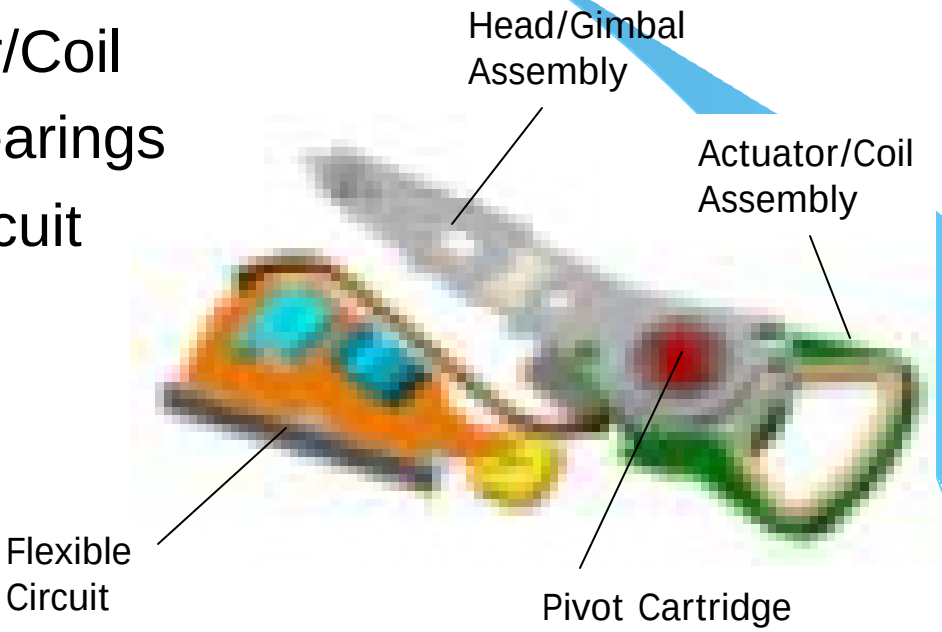
HDA Elements

- Connectors
- Base/Case
- VCM
- HGA
- Disk



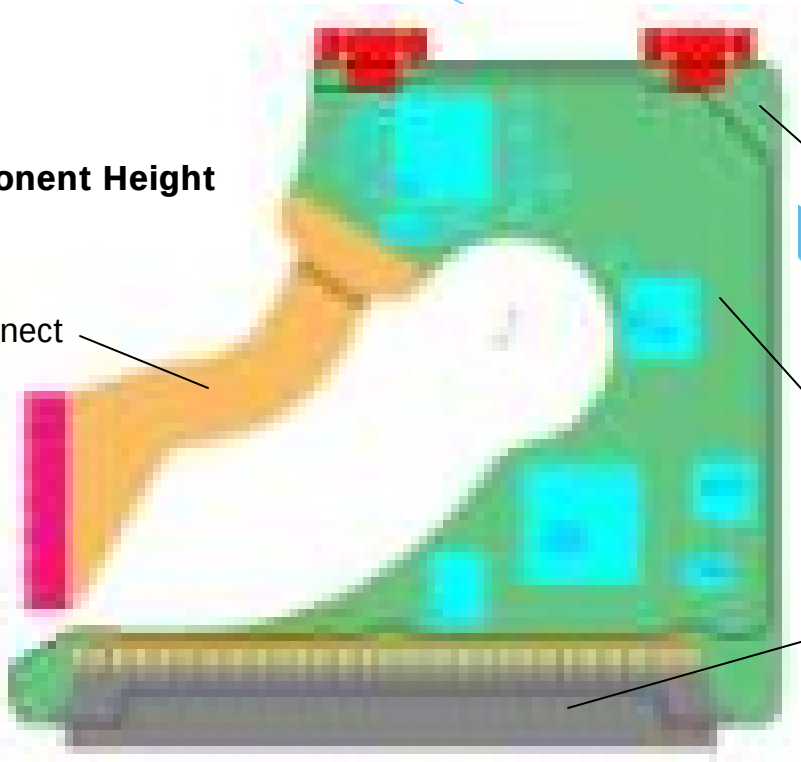
Head Stack / Pivot:

- HGA
- Actuator/Coil
- Pivot/Bearings
- Flex Circuit



PCBA

0.50mm
Max Component Height



Component
Keep-out

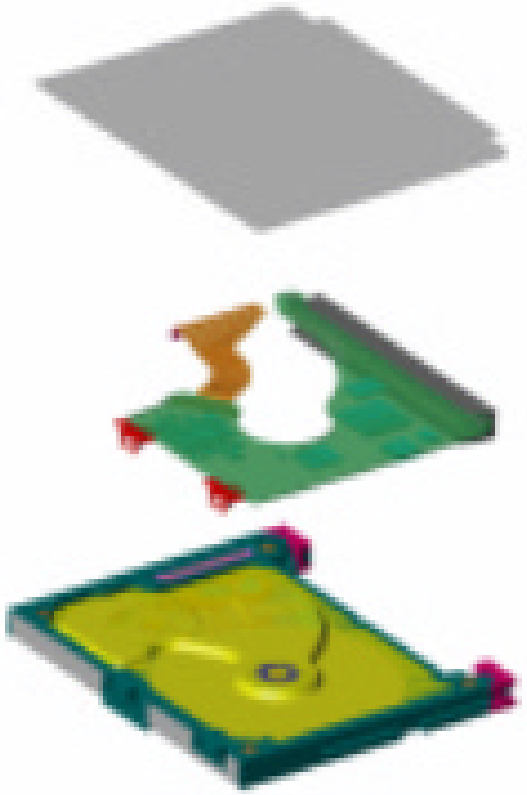
Flex Interconnect

Special
PCB Material

CF Connector

Drive Assembly:

- PCBA Mounting
- PCBA/HDA Interconnect
- Sealing
- Labeling



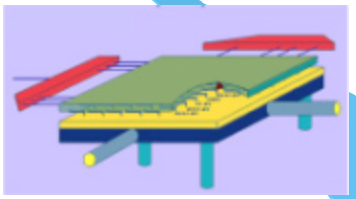
Other Small Form Factors

Flash Card	PC Card (PCMCIA)	CompactFlash	SmartMedia (SSFDC)	Secure Digital (SD)	Multi Media Card (MMC)	MemoryStick
Highest Capacities	Type I = N/A Type II = 1.2GB	Type I = 512MB Type II = 1GB	128MB	128MB	128MB	128MB
Size(s) mm	Type I = 3.3H Type II = 5.0H	42.8W x 36.4L Type I = 3.3H Type II = 5.0H	45.0W x 37L x0.76H	24W x 32L x 2.1H	24W x 32L x1.4H	21.5W x50L x2.8H
Max # of Flash Chips	Type I = 1 Type II = 28 Type III = 50	Type I = 4 at 1Gb/chip, 6 @ 256Mbit / chip Type II = 10	2	4	2	4
# of pins	68	50	22	9	7	10
Developer(s)	SanDisk Corp.	SanDisk Corp.('94)	TOSHIBA Corp.('95)	Matsushita, TOSHIBA, SanDisk Corp. ('00)	Siemens AG. SanDisk Corp. ('97)	Sony Corp.('98)

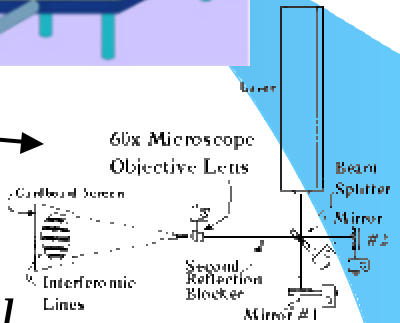
Possibly Competitive New Technologies

- Technologies
  - Flash

  - IBM Millipede™



  - Holographic

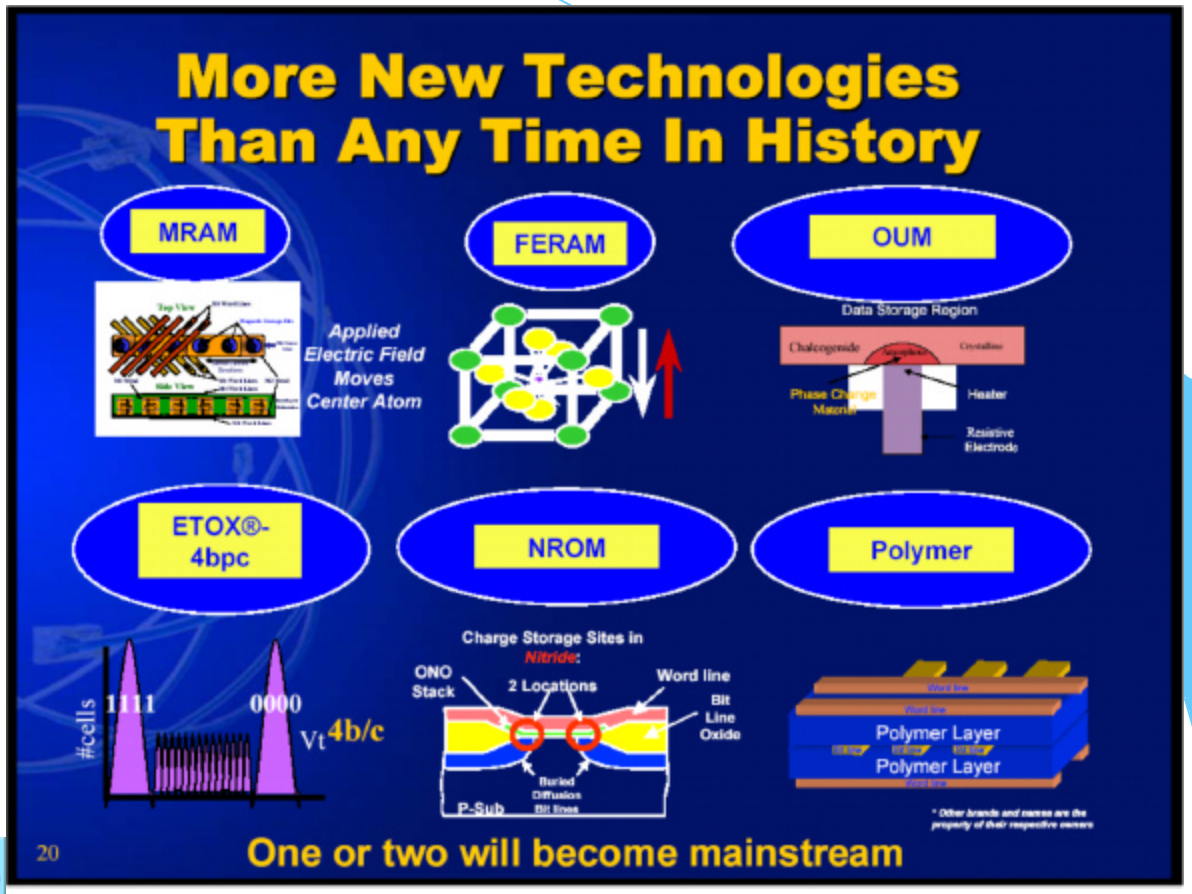


  - Advanced Optical
    - Spot Size Limited

$$D = \frac{l}{2NA}$$

  - Flash Successors/Others

Flash Successors



Slide from Stefan Lai
Intel Developer Forum
February 25-28, 2002

DISKCON Technical Symposium, Challenges of Small Form Factor Drive Design, Ron Dennison

New Technology Issues vs. Hard Drives

- Time to Market
- 10X Improvement
- Write Once
- Erase
- Optics, Electronics & Servos Required