An Historical Perspective of the Disk Drive Industry

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YESTERDAY’S DISK DRIVES
RAMAC Officially Announced

RAMAC Is First Major Achievement
Of Mushrooming IBM San Jose Plant

Conceived and developed in the IBM San Jose Research and Development Laboratories, the huge electronic data processing machine equipped with the "juke box" memory file, known as RAMAC for Random Access Memory Accounting, was announced by press, radio and television September 14.

Hailed by President Thomas J. Watson, Jr., as "providing one of the most significant advancements toward business control and operation by electronics thus far," RAMAC is the result of four years of intensive research and development by upwards of 200 San Jose IBM engineers and technicians. In addition, scores of Product Planning, Test, Customer Engineering, CE School, Manufacturing and Sales personnel have collaborated to make the RAMAC electronic "brain" a reality.

RAMAC has spearheaded a tremendous growth for the IBM plant here in San Jose with several thousand persons expected to be employed at the new plant by 1960. Upward of 3,000 will be employed in
The 1950’s

1956: IBM 350 RAMAC -- 5 MB

- First disk drive
- 50 24-inch disks
- Hydrostatic air bearing heads
- Demonstrated market and producibility
The 1960’s

1961: Bryant Computer 4240 -- 90 MB
• First disk drive with zoned recording
• 24 39-inch disks

• First drive with hydrodynamic air bearing heads
• 25 or 50 24-inch disks

1963: IBM 1311 “Low Cost File”--2.68 MB
• First drive with removable disk pack
• First production 14-inch disk drive
The 1960’s

1965: IBM 2310 “Ramkit” -- 1.024 MB
• First single disk cartridge drive
• First voice coil actuator

1966: IBM 2314 Storage Facility -- 29.17 MB
• Eight drives with single controller
• Removable disk pack (11 disks)
• First drive with ferrite core heads

1967: Memorex 630 -- 7.25 MB
• First IBM plug compatible disk drive
The 1970’s

1971: IBM 3330-1 “Merlin” -- 100 MB
  • First track-following servo system

1971: IBM 23FD “Minnow” -- 81 KB
  • First production flexible disk drive
  • 8-inch disks, read only

1973: IBM 3340 “Winchester” -- 35/70 MB
  • First disk drive with low mass heads, lubricated disks, sealed assembly
  • Removable 3348 Data Module
The 1970’s

1974: IBM 3330-11 “Iceberg” -- 200 MB
• IBM’s last disk pack drive

1975: IBM 62GV “Gulliver” -- 5/9 MB
• First drive with rotary actuator

1976: Shugart Associates SA400 -- 218 KB
• First 5.25-inch flexible disk drive
The 1970’s

1976: IBM 3350 “Madrid” -- 317.5 MB
  • Reintroduction of fixed disk media

1979: IBM 3370 “New File Project”--571 MB
  • First moving head drive with thin film heads, 2-7 encoding.

1979: IBM 3310 “Piccolo” -- 64.5 MB
  • First 8-inch rigid disk drive
The 1980’s

1980: Shugart Technology ST506 -- 5 MB
• First 5.25-inch rigid disk drive

1981: Sony OA-D30V -- 437.5 KB
• First 3.5-inch flexible disk drive

1983: Rodime RO 352 -- 10 MB
• First 3.5-inch rigid disk drive
The 1980’s

1983: Maxtor XT-1140 -- 126 MB
  • First 5.25-inch drive with in-hub motor

1986: Conner Peripherals CP340 -- 40 MB
  • First 3.5-inch disk drive with voice coil actuator

1988: PrairieTek 220 -- 20 MB
  • First 2.5-inch rigid disk drive
The 1990’s

1991: IBM 0663 “Corsair” -- 1,004 MB
  • First rigid disk drive with magnetoresistive heads

1991: Integral Peripherals 1820
  “Mustang” -- 21.4 MB
  • First 1.8-inch disk drive

1993: Seagate Technology ST12550
  “Barracuda” -- 2,139 MB
  • First 7,200 RPM disk drive
The 1990’s

1997: IBM DTTA-351680 “Titan” -- 16.8 GB
    • First drive with giant magnetoresistive heads

1997: Seagate Technology ST19101
    “Cheetah 9” -- 9.1GB
    • First 10,000 RPM disk drive

1998: Seagate Technology ST118202
    “Cheetah 18” -- 18.2 GB
    • First 10,000 RPM drive with 3-inch disks
The 1990’s

1998: Hitachi DK3E1T-91 -- 9.2 GB
• First 12,000 RPM drive, using 2.5-inch disks

1999: IBM “Microdrive” -- 340 MB
• First 1-inch disk drive
• Compact Flash format, Type II
The 2000 millennium

2000: Seagate Technology ST318451 “Cheetah X15” -- 18.4 GB

• First 15,000 RPM drive, using 2.5-inch disks

2005: Toshiba drive, 3.3 x 24 x 32 mm

• First drives with .85 inch disk
TODAY’S DISK DRIVES
### DISK DRIVE MANUFACTURERS WORLDWIDE TOTAL

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<tbody>
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<td>RIGID</td>
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<td>75</td>
<td>65</td>
<td>68</td>
<td>63</td>
<td>59</td>
<td>57</td>
<td>47</td>
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<td>24</td>
<td>26</td>
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<td>FLEXIBLE</td>
<td>52</td>
<td>63</td>
<td>57</td>
<td>56</td>
<td>52</td>
<td>49</td>
<td>36</td>
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<td>28</td>
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<td>56</td>
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</table>
## Rigid Disk Drive Shipments Summary by Drive Capacity

<table>
<thead>
<tr>
<th>Worldwide Unit Shipments (000)</th>
<th>1998 Shipments</th>
<th>Forecast 1999</th>
<th>Forecast 2000</th>
</tr>
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<tbody>
<tr>
<td>Disk cartridge drives</td>
<td>1,290</td>
<td>970</td>
<td>1,120</td>
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<tr>
<td>FIXED DISK DRIVES</td>
<td></td>
<td></td>
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<tr>
<td>&lt;2 Gigabytes</td>
<td>2,014</td>
<td>376</td>
<td>250</td>
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<tr>
<td>2 - 3 Gigabytes</td>
<td>27,730</td>
<td>8,813</td>
<td>2,645</td>
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<tr>
<td>3 - 5 Gigabytes</td>
<td>70,968</td>
<td>48,772</td>
<td>13,140</td>
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<td>5 - 10 Gigabytes</td>
<td>36,109</td>
<td>67,034</td>
<td>52,695</td>
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<tr>
<td>10 - 20 Gigabytes</td>
<td>6,689</td>
<td>39,468</td>
<td>77,205</td>
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<tr>
<td>20 - 40 Gigabytes</td>
<td>58</td>
<td>2,733</td>
<td>42,830</td>
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<tr>
<td>40 - 80 Gigabytes</td>
<td>110</td>
<td>189</td>
<td>3,705</td>
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<tr>
<td>&gt;80 Gigabytes</td>
<td>0</td>
<td>0</td>
<td>230</td>
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<tr>
<td><strong>TOTAL SHIPMENTS</strong></td>
<td><strong>144,967</strong></td>
<td><strong>168,354</strong></td>
<td><strong>193,820</strong></td>
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<tr>
<td>Annual increase</td>
<td>11.1%</td>
<td>16.1%</td>
<td>15.1%</td>
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</table>
# 1999 Disk/Trend Report

## Rigid Disk Drives

### Capacity and Pricing History

<table>
<thead>
<tr>
<th>Year</th>
<th>Worldwide Drive Sales ($ million)</th>
<th>Total Capacity Shipped (Terabytes)</th>
<th>Overall Average Price per Megabyte</th>
<th>Overall Average Price per Gigabyte</th>
</tr>
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<tbody>
<tr>
<td>1988</td>
<td>20,424</td>
<td>1,770</td>
<td>$11.54</td>
<td>$11,540</td>
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<td>1989</td>
<td>22,660</td>
<td>2,436</td>
<td>9.30</td>
<td>9,300</td>
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<td>1990</td>
<td>25,578</td>
<td>3,727</td>
<td>6.86</td>
<td>6,860</td>
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<td>1991</td>
<td>24,632</td>
<td>4,711</td>
<td>5.23</td>
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<td>1992</td>
<td>24,550</td>
<td>8,180</td>
<td>3.00</td>
<td>3,000</td>
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<td>1993</td>
<td>21,730</td>
<td>14,856</td>
<td>1.46</td>
<td>1,460</td>
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<tr>
<td>1994</td>
<td>23,231</td>
<td>32,933</td>
<td>.705</td>
<td>705</td>
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<tr>
<td>1995</td>
<td>26,633</td>
<td>80,677</td>
<td>.330</td>
<td>330</td>
</tr>
<tr>
<td>1996</td>
<td>28,819</td>
<td>160,623</td>
<td>.179</td>
<td>179</td>
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<td>1997</td>
<td>31,736</td>
<td>338,061</td>
<td>.094</td>
<td>94</td>
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<tr>
<td>1998</td>
<td>30,077</td>
<td>694,340</td>
<td>.043</td>
<td>43</td>
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<tr>
<td>1999</td>
<td>32,400</td>
<td>1,393,435</td>
<td>.023</td>
<td>23</td>
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</table>
TOMORROW’S DISK DRIVES
The rapid rate of change in the disk drive industry will continue.

What are the *causes* for those changes? What will be the *effect* on the industry?
CAUSE:

• Most of the human race still does not have a personal computer.
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EFFECT:

• Personal computer shipments will continue to increase, and they will all use disk drives.
CAUSE:

- Demand by computer users to communicate with others, and to have access to a wide range of network applications, will continue to grow.
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EFFECT:

• The market for network storage will continue to grow, keeping the server drive market very healthy.
CAUSE:

- Demand for computer data storage will continue to grow rapidly, but at a lower rate than annual increases in areal density.
CAUSE:

- Demand for computer data storage will continue to grow rapidly, but at a lower rate than annual increases in areal density.

EFFECT:

- Expansion of the market for disk drive recording heads and disks will continue to be limited.
CAUSE:

- Patterns of mobile computing usage will evolve rapidly in this decade, with less weight, more capabilities, and lower prices.
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• Patterns of mobile computing usage will evolve rapidly in this decade, with less weight, more capabilities, and lower prices.

EFFECT:

• Fast growing markets for handheld devices, more applications, improved ease of use -- with sharp increases in the market for miniaturized disk drives.
CAUSE:

- New disk drive applications in consumer electronics will evolve into major markets.
**CAUSE:**

- New disk drive applications in consumer electronics will evolve into major markets.

**EFFECT:**

- Growth in consumer electronics markets will provide a major supplement to disk drive traditional markets and require production of disk drives with special specifications.
CAUSE:

- Annual increases in areal density for disk drives using conventional magnetic recording will be limited by the middle of the decade.
CAUSE:

• Annual increases in areal density for disk drives using conventional magnetic recording will be limited by the middle of the decade.

EFFECT:

• Disk drives using new recording technologies will become commercially important by the middle of the decade.
CAUSE:

• Disk drive markets will continue to grow, and products will adapt to new markets, with higher capacities, evolving interfaces, smaller physical size, and, of course, lower prices.
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• Disk drive markets will continue to grow, and products will adapt to new markets, with higher capacities, evolving interfaces, smaller physical size, and, of course, lower prices.

EFFECT:

• Well-managed disk drive manufacturers will survive.
The factors which shape the disk drive industry...

• The PRODUCTS
• The MARKETS
• The COMPETITION

...will continue to evolve at an exceptionally fast pace.