An Historical Perspective of the Disk Drive Industry

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Presented at the THIC Meeting at the Sony Auditorium,
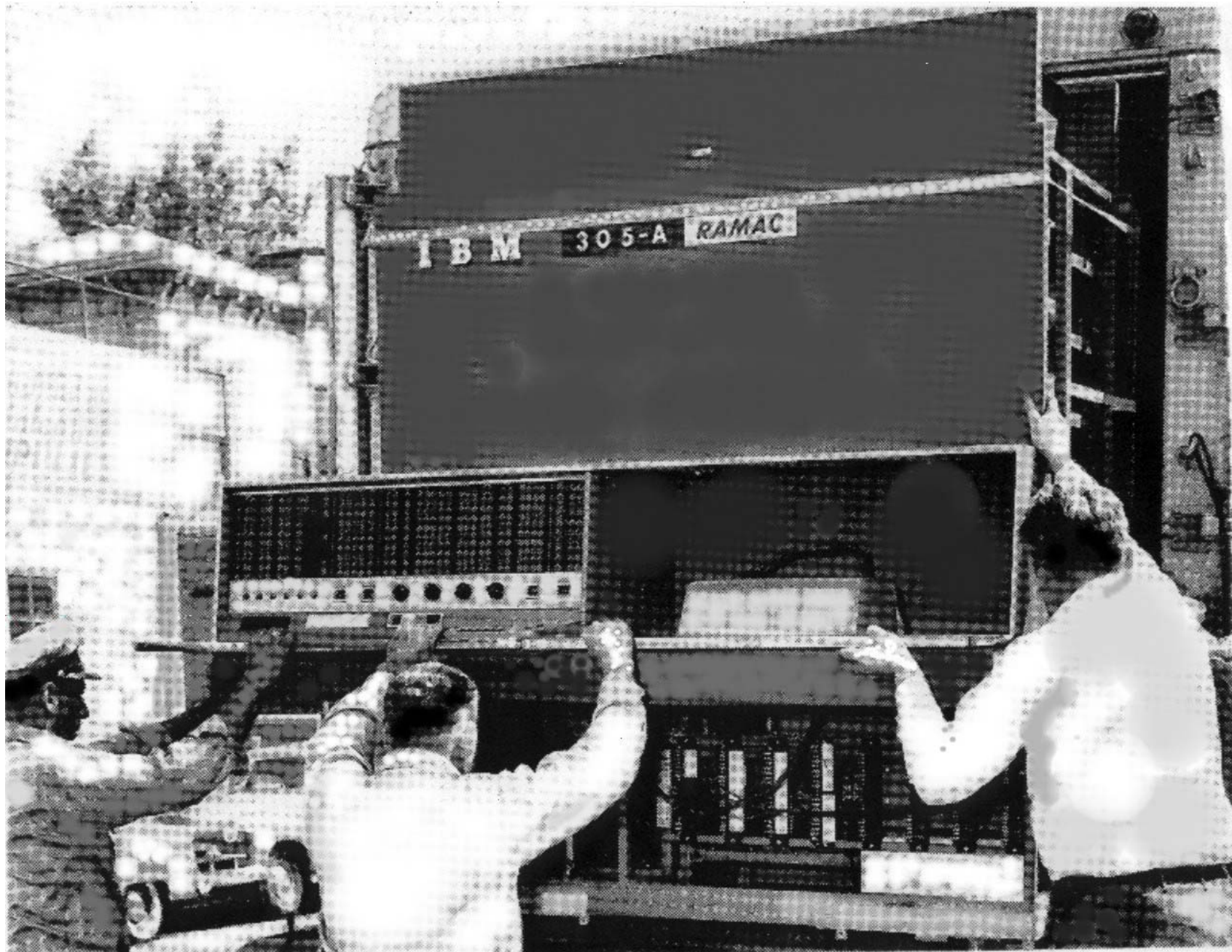3300 Zanker Rd, San Jose CA 95134-1940

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DISK/TREND

THIC Inc.

The Premier Advanced Recording Technology Forum

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. Up-
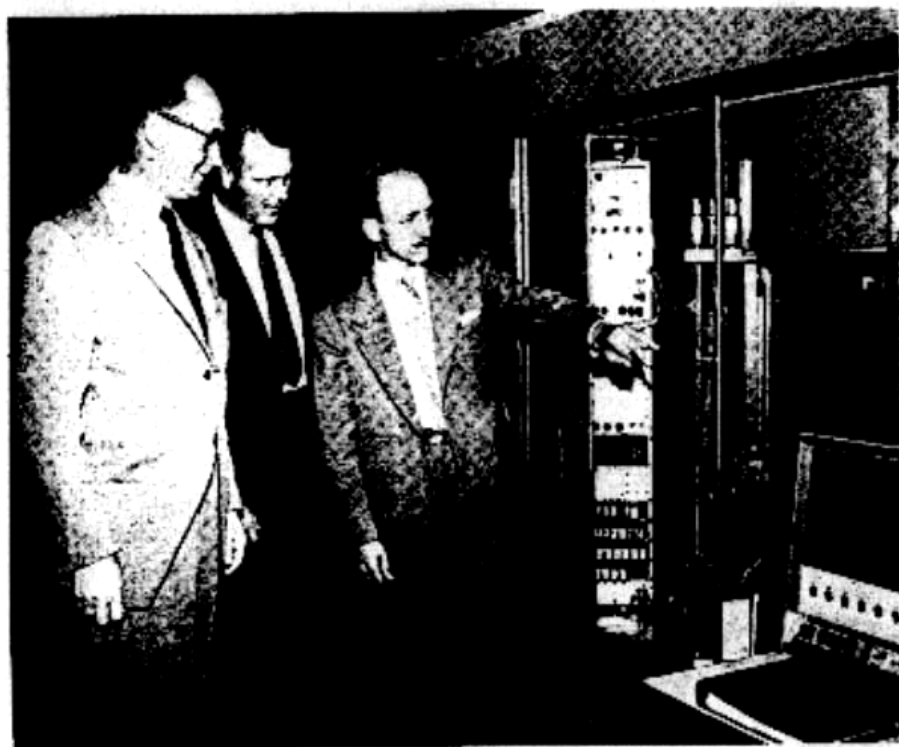
IBM's SAN JOSE BRAIN CHILD.— Watching the operation of the random "juke box" memory device of the San Jose-born RAMAC are Reynold B. Johnson, left, manager of the Research Laboratory, who with his associates originated the idea of the disk file; L. D. Stevens, manager of Development Engineering, and J. D. Fernbach, Engineering Laboratory manager, who were responsible for the development and engineering of the much-publicized

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

1962: IBM 1301 "Adv. Disk File" -- 28 MB
- 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

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RIGID	76	75	65	68	63	59	57	47	40	30	24	26	22	16	16
FLEXIBLE	52	63	57	56	52	49	36	26	21	19	19	19	17	16	13
OPTICAL	16	21	28	34	36	36	38	36	43	57	60	56	53	52	44

RIGID DISK DRIVE SHIPMENTS SUMMARY BY DRIVE CAPACITY

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

RIGID DISK DRIVES
CAPACITY AND PRICING HISTORY

Year	Worldwide drive sales ($ million)	÷	Total capacity shipped (Terabytes)	=	Overall average price per Megabyte	per Gigabyte
1988	20,424		1,770		$11.54	$11,540
1989	22,660		2,436		9.30	9,300
1990	25,578		3,727		6.86	6,860
1991	24,632		4,711		5.23	5,230
1992	24,550		8,180		3.00	3,000
1993	21,730		14,856		1.46	1,460
1994	23,231		32,933		.705	705
1995	26,633		80,677		.330	330
1996	28,819		160,623		.179	179
1997	31,736		338,061		.094	94
1998	30,077		694,340		.043	43
1999	32,400		1,393,435		.023	23

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:

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EFFECT:

- **Personal computer shipments will continue to increase, and they will all use disk drives.**

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EFFECT:

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

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EFFECT:

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

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EFFECT:

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

CAUSE:

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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:

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EFFECT:

- **Disk drives using new recording technolo- gies will become commercially important by the middle of the decade.**

CAUSE:

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EFFECT:

- **<u>Well-managed</u> 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.