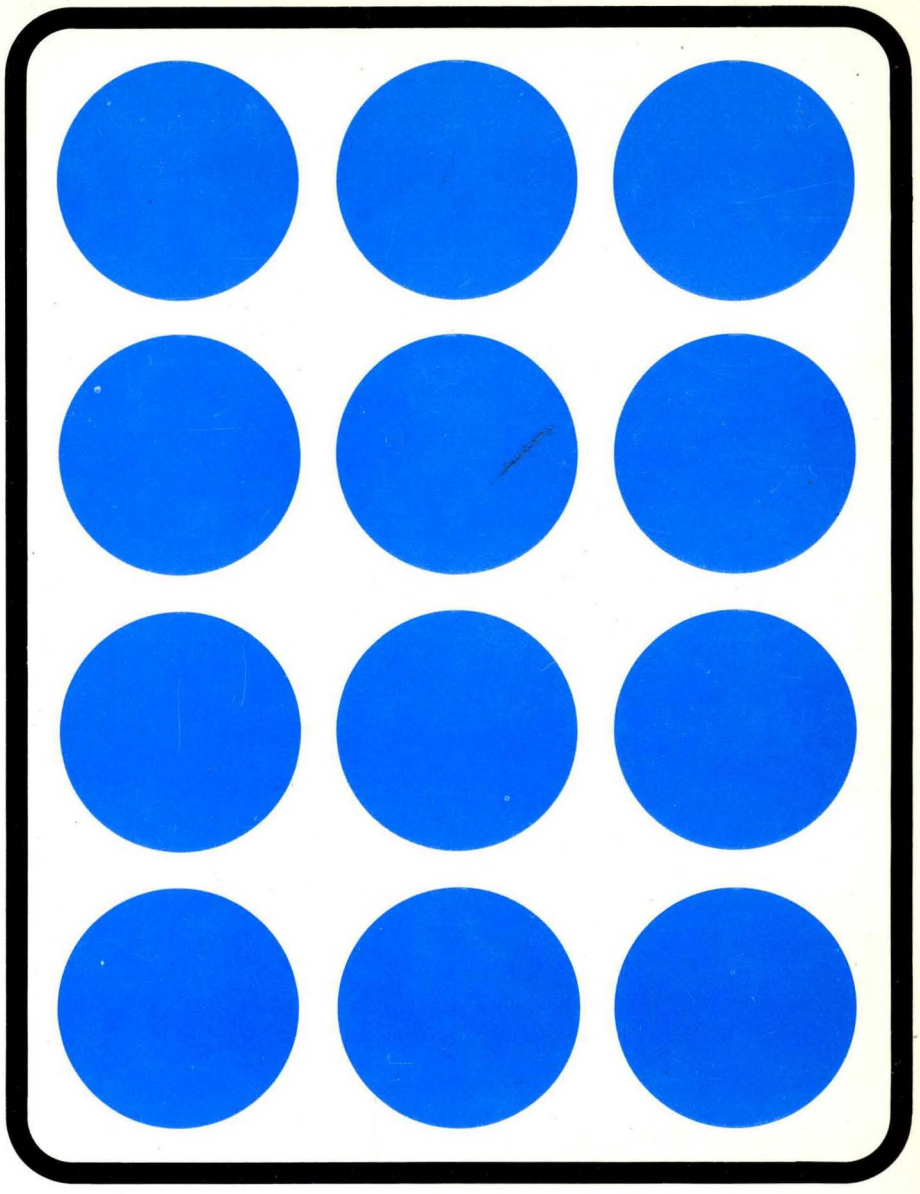
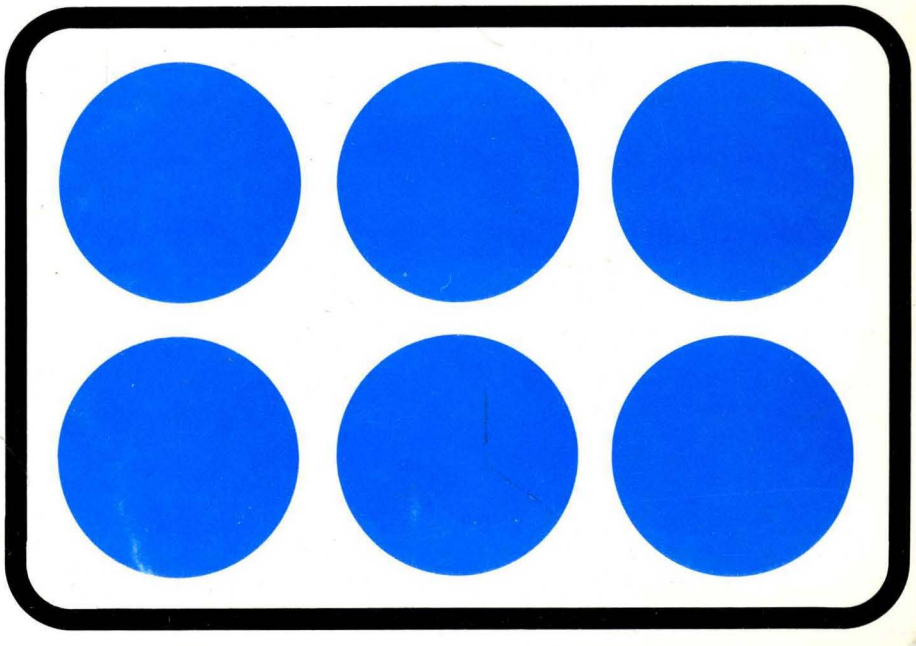


1979 DISK/TREND REPORT



RIGID
DISK
DRIVES

1979 DISK/TREND® REPORT

RIGID DISK DRIVES

July, 1979

James N. Porter
1224 Arbor Court
Mountain View, California 94040
415/961-6209

FOREWORD

In its third year the DISK/TREND Report is bigger than ever, mostly because the disk drive industry has more products, more companies, and more change than ever.

As in the past, this year's DISK/TREND Report is in two sections. This volume covers moving head rigid disk drives, and a separate report to be published in September will cover flexible disk drives.

Occasionally, most subscribers would like to have more detail on various aspects of the disk drive business, and I'm always willing to help when I can. Your inquiries are most welcome, and I will be happy to provide any non-proprietary information from my files which can be extracted without extensive research. Projects requiring more elaborate research and analysis can be addressed on a normal consulting basis if desired.

I solicit suggestions for any improvements to the DISK/TREND Report which would make it more useful to you. Quite a few user ideas are already incorporated into the report, and I'm confident that many future improvements will originate in the same way.

James N. Porter

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INTRODUCTION

Here are some changes to watch for

An effort has been made to keep the DISK/TREND Report's format as consistent as possible from year to year, so that regular users will find it simpler to use. That approach will continue, but a few changes have been made in 1979's report to improve clarity, and new information has also been added. Here are the principal changes:

* Unit shipments in each product group are now shown in much more detail, in a format similar to the revenue tables.

* Unit shipment data in two of the fixed disk drive groups are now supplemented with a breakdown of 14" vs. 8" disk drives.

* Non-captive market share information in each product group is now on a worldwide basis.

* Coverage of non-U.S. products and companies has been expanded.

* Page numbering is now organized by each of the report's sections, so you will be able to find reference data faster. Notice that numbering of product sections follows the DISK/TREND product group number sequence.

As usual, please note these key points

* Users can save time by familiarizing themselves with the definitions section. Industry nomenclature is rife with ambiguous meanings, and the DISK/TREND definitions should help clarify the language used in this report.

* All unit totals are given in spindles -- so a disk drive containing two spindles is counted in DISK/TREND statisics as two spindles.

* The value of all leased disk drives is given on an "if sold" basis in all DISK/TREND revenue estimates.

SUMMARY

Industry size

Moving head rigid disk drives generated estimated worldwide revenue totaling $3,457,400,000 in 1978, up 22.9% from 1977. Largest contributions to the increase came from the fixed disk drive product groups, plus storage module drives and disk pack drives over 100 MB.

The 1979 DISK/TREND estimate of 1978 worldwide revenues is 4.9% higher than the projection for 1978 in last year's report. The difference is attributable to a higher estimate for shipments by non-U.S. manufacturers. The 1979 DISK/TREND Report contains expanded coverage on non-U.S. disk drives and more accurate information on shipments by non-U.S. manufacturers than previous reports. Roughly similar differences for 1979 and 1980 have the same cause, with the 14.5% difference in 1981 created by the combination of larger non-U.S. shipments, plus growth of new fixed disk drives.

Continuation of total industry growth is projected through 1982, although individual product groups will produce uneven results. Worldwide average annual growth is expected to be 16.4% through 1982, when total industry revenues are projected at $6,337,000,000. During this period U.S. manufacturers' 83.7% share of worldwide revenues in 1978 is expected to fall to 76.6% in 1982.

The questionable condition of the U.S. economy in the last half of 1979 will probably not have a material negative impact on the product groups now growing rapidly, if the economic downturn lasts less than a year as generally assumed. It may be expected, however, to hasten the decline of older, less cost-effective disk drive formats.

TABLE 1

CONSOLIDATED WORLDWIDE SHIPMENTS

ALL EXISTING MOVING HEAD DISK DRIVE GROUPS

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1978 Shipments		Forecast							
	1979		1980		1981		1982			
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	709.1	1,132.7	526.2	822.3	650.9	1,010.2	874.0	1,369.2	1,047.6	1,613.6
Other U.S. Captive	641.6	1,024.0	881.0	1,385.2	1,011.0	1,606.9	1,159.6	1,831.0	1,261.5	1,983.7
TOTAL U.S. CAPTIVE	1,350.7	2,156.7	1,407.2	2,207.5	1,661.9	2,617.1	2,033.6	3,200.2	2,309.1	3,597.3
PCM	253.7	338.0	278.5	386.3	215.2	303.1	228.1	324.7	329.6	471.1
OEM	273.4	399.4	404.7	583.1	480.9	674.6	531.9	745.9	554.1	787.0
TOTAL U.S. NON-CAPTIVE	527.1	737.4	683.2	969.4	696.1	977.7	760.0	1,070.6	883.7	1,258.1
TOTAL U.S. SHIPMENTS	1,877.8	2,894.1	2,090.4	3,176.9	2,358.0	3,594.8	2,793.6	4,270.8	3,192.8	4,855.4
Non-U.S. Manufacturers										
Captive	--	428.4	--	537.1	13.4	705.0	40.1	915.0	72.5	1,134.1
PCM	13.4	61.0	22.0	68.5	17.7	70.1	22.2	77.5	40.4	126.0
OEM	.5	73.9	10.9	102.9	16.1	132.3	27.1	171.6	38.9	221.5
TOTAL NON-U.S. SHIPMENTS	13.9	563.3	32.9	708.5	47.2	907.4	89.4	1,164.1	151.8	1,481.6
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	1,891.7	3,457.4	2,123.3	3,885.4	2,405.2	4,502.2	2,883.0	5,434.9	3,344.6	6,337.0

Industry structure

Despite various acquisitions and mergers, the number of manufacturers with announced moving head disk drives in their product lines has now grown to 30 firms in the United States, 7 in Japan and 7 in Europe. Multi-national manufacturing activities by IBM, Siemens, Burroughs and others are counted as single operations.

As noted in previous DISK/TREND Reports, introduction of most disk drive formats has followed this pattern: (1) Introduction of an archetype drive by IBM, (2) delivery within a few years of PCM and/or OEM drives using the same technology with minor improvements, and (3) subsequent establishment of captive manufacturing programs by major system manufacturers of drives in various formats using the same technology.

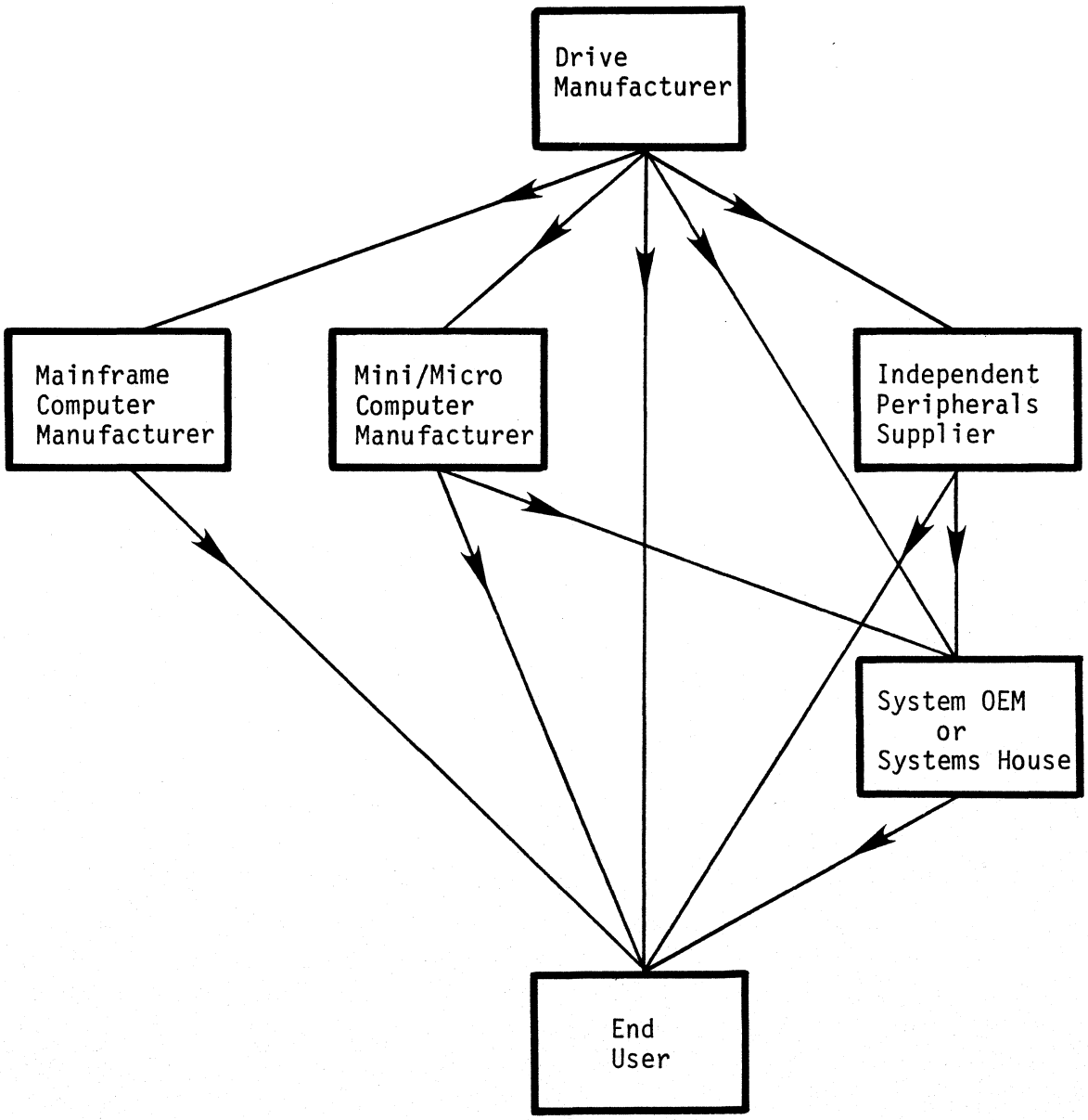
Since IBM's technology for heads, disks and other drive components has been widely copied, unofficial industry standards have evolved, which serve to promote multiple sources and competitive prices for essential disk drive components. For example, heads and disks similar to those introduced by IBM for the 2414, 3330, 3340 and 3350 drives are used with almost all of the disk drives in production today. In the same way, heads modeled after those on IBM's 3370 drive will certainly be available as soon after first delivery of the new drive as feasible. Because of independent component sources, small manufacturers find it possible to enter the disk drive market with comparatively modest resources.

Off-the-shelf technology also makes it possible for system manufacturers to initiate internal disk drive manufacturing programs efficiently. More captive manufacturing is expected, since the profit contribution can be attractive when reasonable annual quantities are required.

Figure 1

NON-CAPTIVE MARKETING STRUCTURE

Moving Head Disk Drives



Marketing channels

IBM's 32.8% share of worldwide disk drive revenues in 1978 is expected to sink to 21.2% in 1979, due to declining production of several products and the firm's two price cuts on 3350/3344 within a six month period. IBM worldwide disk drive revenues are forecast at $822,300,000 for 1979, but should increase at an average annual rate of 25.4% for the 1980-82 period. Most existing IBM disk products will phase out before 1982, but will be more than replaced by new products: The Piccolo family, 3370 and the yet-to-be-announced Whitney.

For the first time in 1979, IBM's disk drive revenue total will be exceeded by that of the combined total of other U.S. captive drive manufacturers. Adding in non-U.S. manufacturers the worldwide captive total is more than twice IBM's -- a sign of the growing maturity and product diversity of today's captive disk drive manufacturing operations. And these programs will surely grow. Average annual increase projected through 1982 is 21.3%. Today's product mix is predominantly in removable disk products, but the share held by fixed disk drives will continally grow through 1982.

Although not yet dead, PCM shipments of removable disk pack drives are rapidly expiring, with the end probably to occur in 1980. However, very high shipments of PCM 3350 drives in 1979 will help to make this the biggest revenue year yet for the PCM segment of the industry, despite drastically lower prices per spindle as a result of IBM's price cuts. After 1979, total PCM revenues will decrease for two years, along with 3350 shipments, until PCM 3370 shipments commence.

Worldwide OEM revenues are expected to rise every year through 1982, finally breaking $1 billion. Healthy increases are assured by the non-stop growth of the world's thousands of diverse system OEMs and systems houses.

TABLE 2

CONSOLIDATED WORLDWIDE SHIPMENTS

MARKET CLASS REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	1978 Shipments $M	1978 Shipments %	FORECAST 1979 $M	1979 %	1980 $M	1980 %	1981 $M	1981 %	1982 $M	1982 %
U.S. Manufacturers										
IBM	1,132.7	32.8	822.3	21.2	1,010.2	22.4	1,369.2	25.2	1,613.6	25.5
Other U.S. Captive	1,024.0	29.6	1,385.2	35.7	1,606.9	35.7	1,831.0	33.7	1,983.7	31.3
PCM	338.0	9.8	386.3	9.9	303.1	6.7	324.7	6.0	471.1	7.4
OEM	399.4	11.6	583.1	15.0	674.6	15.0	745.9	13.7	787.0	12.4
Total U.S. Mfgr's.	2,894.1	83.7	3,176.9	81.8	3,594.8	79.8	4,270.8	78.6	4,855.4	76.6
Non-U.S. Manufacturers										
Captive	428.4	12.4	537.1	13.8	705.0	15.7	915.0	16.8	1,134.1	17.9
PCM	61.0	1.8	68.5	1.8	70.1	1.6	77.5	1.4	126.0	2.0
OEM	73.9	2.1	102.9	2.6	132.3	2.9	171.6	3.2	221.5	3.5
Total Non-U.S. Mfgr's.	563.3	16.3	708.5	18.2	907.4	20.2	1,164.1	21.4	1,481.6	23.4
Worldwide Total	3,457.4	100.0	3,885.4	100.0	4,502.2	100.0	5,434.9	100.0	6,337.0	100.0

Product mix

Fixed disk drives will continue to increase their share of worldwide revenues through 1982, according to DISK/TREND projections. Fixed disk drives held 41.5% of worldwide revenues in 1978, and are expected to reach 66.0% in 1982. Of the other six product groups, only disk cartridge drives more than 12 MB are expected to consistently increase share of the total product mix each year through 1982, eventually reaching 11.6%. Storage module drives will maintain approximately the same share each year during this period, but all other product groups will be losers.

OEM market

It is expected that the OEM market will still receive two thirds of its worldwide revenues from removable disk drives in 1982, with the leadership held by large disk cartridge drives and storage module drives. Fixed disk drives are forecast at 29.8% of OEM worldwide revenues in 1982.

Control Data's share of 1978 OEM worldwide revenues was 42%, with the nearest competitor 33 percentage points lower. Control Data produced OEM revenue in seven out of the nine DISK/TREND product groups in 1978.

PCM market

As expected, Storage Technology moved into the lead in 1978 PCM revenues, on the strength of the firm's spectacular success in the 3350 market. STC's share of worldwide PCM revenues was 33.2%. Memorex held 23.9%, based on shipments of products in both the 3330 and 3350 product types.

Figure 2
CHANGING PRODUCT MIX
CONSOLIDATED WORLDWIDE DISK DRIVE SHIPMENTS

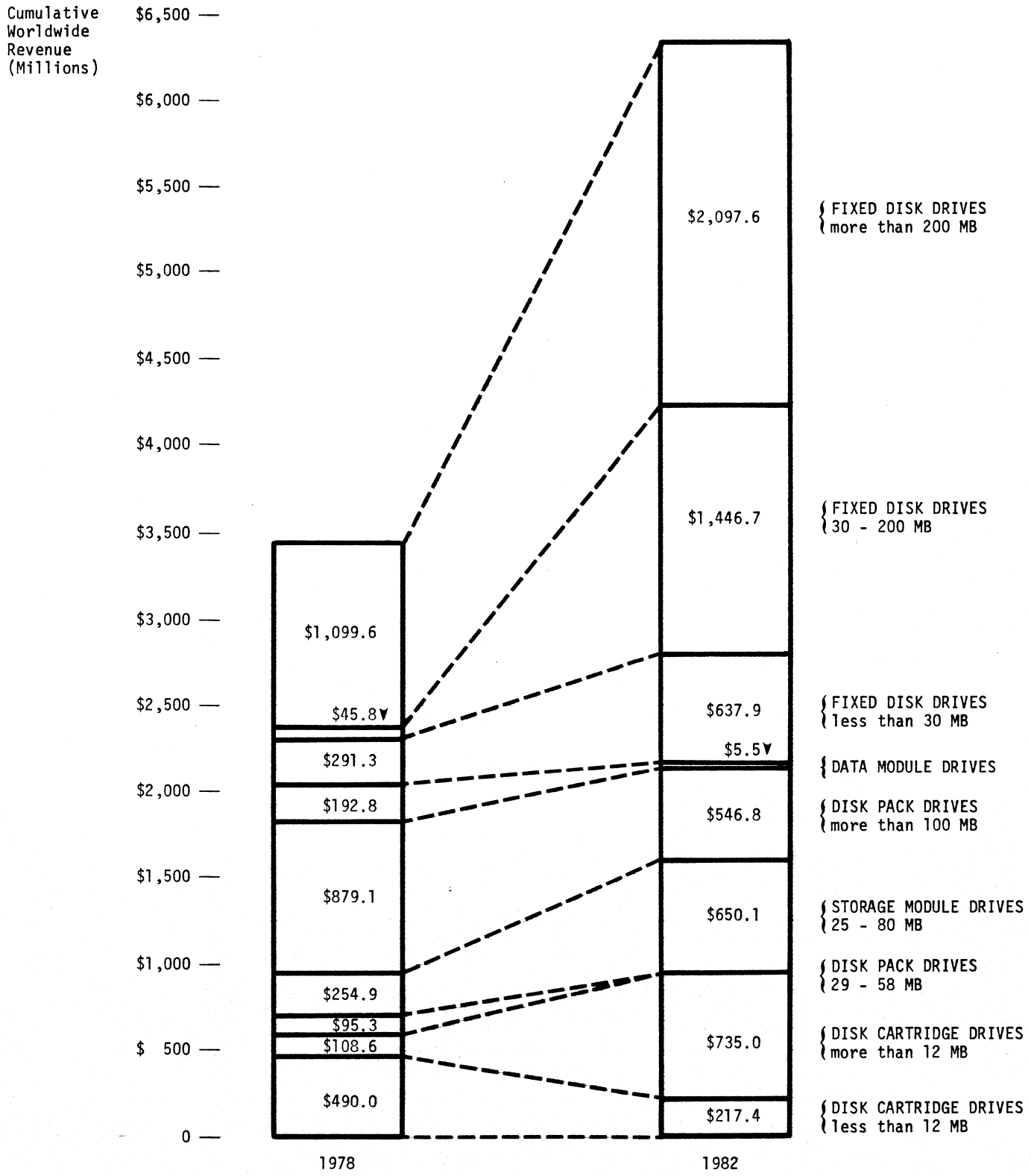


TABLE 3

WORLDWIDE SHIPMENTS

PRODUCT CATEGORY SUMMARY

ALL MANUFACTURERS

Units: Thousands Dollars: $ Million		1978 Shipments		FORECAST 1979		1980		1981		1982	
		Ship	%	Ship	%	Ship	%	Ship	%	Ship	%
8 Inch One Side	Units	533.7	+ 52.9	723.6	+ 35.6	791.2	+ 9.3	750.3	- 5.2	647.8	- 13.7
	$M	352.8	+ 38.6	408.6	+ 15.8	404.5	- 1.0	367.5	- 9.1	311.0	- 15.4
8 Inch Two Sides	Units	70.9	+382.3	236.4	+233.4	424.3	+ 79.5	798.6	+ 88.2	1,073.7	+ 34.4
	$M	100.2	+291.4	264.9	+164.4	445.9	+ 68.3	718.4	+ 61.1	906.9	+ 26.2
8 Inch Total	Units	604.6	+ 66.2	960.0	+ 58.8	1,215.5	+ 26.6	1,548.9	+ 27.5	1,721.5	+ 11.1
	$M	453.0	+ 61.7	673.5	+ 48.7	850.4	+ 26.3	1,085.9	+ 27.7	1,217.9	+ 12.2
5.25 Inch One Side	Units	127.6	+192.0	434.3	+240.4	725.2	+ 67.0	976.1	+ 34.6	1,204.7	+ 23.4
	$M	24.3	+158.5	76.8	+216.0	130.3	+ 69.7	196.5	+ 50.8	275.8	+ 40.4
5.25 Inch Two Sides	Units	.3	--	54.2	--	155.8	+187.5	482.4	+209.6	1,026.1	+112.7
	$M	.1	--	13.6	--	37.9	+178.7	124.1	+227.4	279.6	+125.3
5.25 Inch Total	Units	127.9	+192.7	488.5	+281.9	881.0	+ 80.3	1,458.5	+ 65.6	2,230.8	+ 53.0
	$M	24.4	+159.6	90.4	+270.5	168.2	+ 86.1	320.6	+ 90.6	555.4	+ 73.2
TOTAL ALL DRIVES	Units	732.5	+ 79.8	1,448.5	+ 97.7	2,096.5	+ 44.7	3,007.4	+ 43.4	3,952.3	+ 31.4
	$M	477.4	+ 64.8	763.9	+ 60.0	1,018.6	+ 33.3	1,406.5	+ 38.1	1,773.3	+ 26.1

TABLE 4

OEM WORLDWIDE SHIPMENTS
PRODUCT CATEGORY REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES ALL MANUFACTURERS	1978 Shipments $M	1978 Shipments %	FORECAST 1979 $M	1979 %	1980 $M	1980 %	1981 $M	1981 %	1982 $M	1982 %
Disk Cartridge Drives Less than 12 MB	188.3	39.8	229.7	33.5	176.2	21.8	123.4	13.4	84.1	8.3
Disk Cartridge Drives More than 12 MB	16.0	3.4	71.5	10.4	143.7	17.8	219.2	23.9	289.2	28.7
Disk Pack Drives 29-58 MB	50.7	10.7	39.7	5.8	17.5	2.2	7.2	.8	--	--
Storage Module Drives 25-80 MB	82.8	17.5	149.3	21.8	176.6	21.9	192.5	21.0	208.2	20.6
Disk Pack Drives More than 100 MB	104.1	22.0	111.6	16.3	119.7	14.8	125.9	13.7	129.3	12.8
Data Module Drives	4.3	.9	6.8	1.0	5.9	.7	4.2	.5	2.5	.2
Fixed Disk Drives Less than 30 MB	18.2	3.8	42.7	6.2	80.5	10.0	106.1	11.6	110.2	10.9
Fixed Disk Drives 30-200 MB	8.9	1.9	32.7	4.8	63.7	7.9	103.4	11.3	136.5	13.5
Fixed Disk Drives More than 200 MB	--	--	2.0	.3	23.1	2.9	35.6	3.9	48.5	4.8
Total Worldwide Revenue	473.3	100.0	686.0	100.0	806.9	100.0	917.5	100.0	1,008.5	100.0
% U.S. Mfg.	84.4%		85.0%		83.6%		81.3%		78.0%	
Annual Growth Rate			+44.9%		+17.6%		+13.7%		+9.9%	

TABLE 5

1978 ESTIMATED MARKET SHARES

WORLDWIDE SHIPMENTS OF ALL MOVING HEAD DISK DRIVES
(Value of non-U.S. currencies estimated at July, 1979, rates)

	CAPTIVE		PCM		OEM		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
Ampex	--	--	--	--	21.7	4.6	21.7	.6
Burroughs	304.5	11.8	--	--	--	--	304.5	8.8
Century Data Systems	--	--	--	--	29.1	6.1	29.1	.8
Control Data	220.6	8.5	48.1	12.1	198.8	42.0	467.5	13.5
Data General	69.2	2.7	--	--	--	--	69.2	2.0
Datapoint	14.2	.6	--	--	--	--	14.2	.4
Diablo	2.1	.1	--	--	40.3	8.5	42.4	1.2
Digital Equipment	140.6	5.4	--	--	--	--	140.6	4.1
Hewlett-Packard	78.7	3.1	--	--	--	--	78.7	2.3
IBM	1,132.7	43.8	--	--	--	--	1,132.7	32.8
ISS/Univac	135.2	5.2	61.8	15.5	1.1	.2	198.1	5.7
Memorex	--	--	95.4	23.9	35.1	7.4	130.5	3.8
Microdata	11.5	.4	--	--	.6	.1	12.1	.4
Northern Telecom	31.7	1.2	--	--	7.8	1.7	39.5	1.1
Perkin Elmer	4.2	.2	--	--	21.1	4.5	25.3	.7
Pertec	11.5	.4	--	--	16.9	3.6	28.4	.8
Storage Technology	--	--	132.7	33.2	--	--	132.7	3.9
Western Dynex	--	--	--	--	14.5	3.1	14.5	.4
Other U.S.	--	--	--	--	12.4	2.6	12.4	.4
U.S. Total	2,156.7	83.4	338.0	84.7	399.4	84.4	2,894.1	83.7
NON-U.S. MANUFACTURERS								
Data Recording Equipment	--	--	--	--	20.7	4.4	20.7	.6
Fujitsu	78.2	3.0	--	--	1.1	.2	79.3	2.3
Hitachi	79.1	3.1	--	--	5.0	1.1	84.1	2.4
Isotimpex	--	--	--	--	10.6	2.2	10.6	.3
Mitsubishi	14.1	.6	--	--	7.4	1.6	21.5	.6
Nippon Electric Company	58.7	2.3	--	--	11.9	2.5	70.6	2.0
Nippon Peripherals, Ltd.	19.1	.7	61.0	15.3	--	--	80.1	2.3
Philips	15.1	.6	--	--	--	--	15.1	.5
Siemens	85.5	3.3	--	--	--	--	85.5	2.5
Toshiba	59.3	2.3	--	--	.5	.1	59.8	1.7
Other Non-U.S.	19.3	.7	--	--	16.7	3.5	36.0	1.1
Non-U.S. Total	428.4	16.6	61.0	15.3	73.9	15.6	563.3	16.3
Worldwide Total	2,585.1	100.0	399.0	100.0	473.3	100.0	3,457.4	100.0

Note: Drives manufactured by ISS and NPL and resold by others in the PCM market are valued at PCM price levels above, to avoid distortion of total PCM market values.

Code: C = Captive
P = PCM
O = OEM

TABLE 6

CURRENT PRODUCT LINES

MANUFACTURERS OF MOVING HEAD DISK DRIVES

DISK/TREND PRODUCT GROUP:		1	2	3	4	5	6	7	8	9
U.S. Manufacturers	Type	Disk Cartridge Drives <12 MB	Disk Cartridge Drives >12 MB	Disk Pack Drives 29-58 MB	Storage Module Drives 25-80 MB	Disk Pack Drives >100 MB	Data Module Drives	Fixed Disk Drives <30 MB	Fixed Disk Drives 30-200 MB	Fixed Disk Drives >200 MB
Alpha Data	O							X		
Ampex	O			X	X	X			X	
Ball Computer	O				X	X				
Burroughs	C	X		X	X	X		X	X	X
Century Data Systems	O		X		X	X		X	X	
Control Data	C,P,O	X	X	X	X	X	X	X	X	X
Data General	C	X	X		X	X		X		
Datapoint	C	X	X							
Diablo	C, O	X								
Digital Equipment	C	X	X					X		
EMM	O	X	X					X		
Hewlett-Packard	C	X	X		X	X		X		
IBM	C	X		X		X	X	X	X	X
International Memories	O							X		
ISS/Univac	C,P,O		X	X	X	X			X	X
Kennedy	O							X	X	
Memorex	P,O					X		X	X	X
Microcomputer Systems	O							X	X	
Microdata	C,O	X						X	X	
Micropolis	O							X	X	
New World	C,O							X		
Northern Telecom	C,O	X						X	X	
Okidata	O							X	X	
Perkin-Elmer	C,O	X	X							
Pertec	C,O	X	X					X		
Priam	O							X	X	
Shugart	O							X		
Storage Technology	P,O								X	X
Vermont Research	O		X							
Western Dynex	O	X						X		
Japanese Manufacturers										
Fujitsu	C,O		X			X	X	X	X	X
Hitachi	C,O					X	X	X	X	X
Hokushin	O	X	X					X		
Mitsubishi	C,O	X	X		X	X		X	X	
Nippon Electric Company	C,O	X		X		X		X	X	X
Nippon Peripherals, Ltd.	C,O						X			X
Toshiba	C,O		X			X		X	X	
European Manufacturers										
BASF	P,O			X				X	X	
CII-Honeywell Bull	C,O	X	X						X	
Computer Peripherie Technik	O								X	
Data Recording Equipment	O	X								
Isotimpex	O	X		X						
Philips	C,O	X	X		X			X		
Siemens	C,O					X				X

TECHNICAL REVIEW

Competing technologies

As noted in previous DISK/TREND Reports, moving head disk drives are entrenched too deeply to be displaced by any competitive memory technology unless it possesses major advantages. An alternative storage device with only slight price or functional advantages is a poor bargain to a system OEM now using disk drives for auxiliary storage -- since the disk drive is a known quantity in terms of reliability, availability, price, interface requirements, and impact on system software. To these factors, captive disk drive manufacturers would add the problem of existing ownership of disk drive production facilities and an investment in skilled manpower.

Because they have such a big head start, disk drives seem destined to retain most of their markets well beyond the 1982 time horizon of this report. And they will continue to be the target for those advocating individual competitive technologies, as well as the performance and cost yardstick against which potential new storage devices are measured.

Two fundamental facts of life about computer storage devices cannot be ignored by anyone attempting to understand the potential future of would-be alternatives:

1. Disk drives have been a moving target for over twenty years, in both cost and functional improvements, and will continue to move forward at least through the 1980's.
2. Hardly any system designer takes a new storage device very

seriously until he can get his hands on it, thus proving that the concept really works, and that someone actually knows how to make one. Only then does real planning for system utilization begin.

Against the background, then, of a practical, skeptical computer industry, here is the current status of the alternative storage technologies most frequently mentioned as potential disk drive replacements:

* Optical memories: There are highly specialized optical memory systems in use with computer systems today -- but not very many. Small holographic memories have been used in such applications as credit verification systems, and the very large Unicom system produced by Precision Instruments several years ago has been used for scientific applications by NASA. These and other optical memories have so far been severely limited by the lack of a reversible storage medium. Thus the challenge has been to find the appropriate configuration and suitable applications for a read-only memory that potentially could store very large amounts of data at low cost per byte.

  The most aggressive development of optical memory programs underway today involves optical disk systems. Much of the technology used in optical disk digital memories is a by-product of programs originated to develop video disk players for the consumer market. Best known among companies active in the field today is Philips, which has introduced a home video disk system in selected U.S. markets already and has announced an intention to eventually produce optical disk recorders. Philips claims that the capacity of one side of a 12 inch disk is over 6,000 megabytes. Other major U.S. and Japanese companies are known to have active optical disk memory programs underway, but specific configurations for actual products are uncertain.

  Since optical disk memories would provide fast direct access to individual tracks, they are frequently mentioned as appropriate for use with infrequently updated large data bases, with the concept that updated data would merely be written on new tracks, leaving the old track unused in the future. Another application idea, perhaps with more potential, would be to use optical disk for backup of conventional magnetic disks. Thus, one optical disk could hold the contents of many magnetic disk files, at low cost, using much less storage space than magnetic tape. Since the backup medium needn't have an update capability, optical disk's non-reversible recording should not be a liability in such an application. In any event, optical disk memories may have a

future, probably several years in the future, if the right product planning decisions are made. And at this time, the feasible application areas are fundamentally complementary to magnetic disk files.

* Magnetic bubbles: Bubble memories are probably the most publicized memory technology in the history of the business, with actual deliveries still just a trickle. TI's 92 K-bit chip is now being used in portable terminals by TI and in a few limited applications by others, after extended delivery delays. However, the real potential for bubbles won't be approached until densities become much greater, so prices can fall much lower. In the last year several 256 K-bit chips were announced, then upstaged by Intel's announcement of a 1 M-bit chip to be available before the end of 1979. Other 1 M-bit chips are also expected to be available right behind Intel's, and eventual densities will be many times this level.

  Bubbles will earn a significant role in the memory market. The questions today concern identification of the market segments which will be most impacted by bubbles' presence, and the pace of their growth. It appears likely that the early successes will come in areas requiring reliability, small size and moderately fast access, such as IT's portable terminals, for example. Intel's 1 M-bit chip, designed as part of a system including controller and other auxiliary chips, will probably be used in a wide variety of microprocessor-based systems. Despite their expected commercial success, however, bubbles do not seem destined to impact the overall growth of the disk drive industry soon. When cost of complete bubble memory systems are considered, they won't be close to disk drives for many years, even using the optimistic predictions.

* Charge coupled devices: The glowing predictions of a few years ago for CCD's have been somewhat tarnished in 1979 -- not because of any functional failure, but because of availability problems. Both Storage Technology and Memorex announced disk-related CCD systems, and have been severely inconvenienced by failure of CCD suppliers to deliver. Both firms have now received enough chips to deliver, but shipments are far below the market available, due to limited CCD availability. The underlying problem appears to be that some CCD suppliers have come to the conclusion that CCD technology doesn't have the potential after all to achieve a large-enough cost advantage over RAMs, with the 64 K-bit RAM now available.

  So it now is unclear whether CCD's will really be the "gap-filler" they were promoted to be. Despite their volatility, CCD's could serve adequately as replacements for head-per-track disk drives and as cache memories. But unless these products are solidly backed by major semiconductor manufacturers, they will have a sharply limited future.

* Josephson junctions: Although some industry personnel have thought of the Josephson junction in terms of memory applications, its future really seems to be as a super processor -- which will require large amounts of auxiliary storage. Josephson devices are superconductors which must operate at 4° above absolute zero, but which could be made into processors operating at ten times the speed of today's fastest CPU. They are many years in the future, and configurations are uncertain -- except that large amounts of auxiliary storage will probably be required. Whatever the storage system, a system of buffering or cache will certainly be required to match the Josephson junction's timing requirements with the storage system.

* EBAM (Electron-beam accessed MOS storage): EBAM utilizes an electron beam, deflected as required, to store a charge in the oxide layer of an MOS target. Theoretically, it has the potential for high capacity, fast access and low cost. However, it probably is suitable only for very large systems with requirements for fast access, and would require a willingness to modify operating systems for optimum efficiency. At this time, EBAM doesn't seem likely to be developed into final product form.

Disk drive enhancements

IBM has announced use of higher recording densities for the new 3370, to be delivered for the first time in fourth quarter of 1979. It is expected that at least one other drive at even higher densities will follow the 3370 fairly soon. So another wave of technology enhancements is about to overtake the independent disk drive manufacturers, and the result will be the same as in the past: More function; lower price. Here are the key areas in which changes are occurring:

* Recording heads: Today's state-of-the-art disk drives use ferrite heads, typified by IBM's 3340 and 3350 heads, operating at up to 478 TPI and 6425 BPI. This year IBM introduced its 8" Piccolo drive, using heads similar in structure but increasing linear density to 8530 BPI. Most head design experts believe the practical limit for ferrite or similar heads is about 10,000 BPI. The Piccolo may represent the last stage in development of ferrite heads for disk recording.

  The next stage for disk recording heads appears to involve the so called "thin film" heads -- a general term used to describe varied head designs using deposition of thin films of magnetic and conductive materials, using methods borrowed from the semiconductor

industry. Eventual linear densities predicted for thin film heads are in the range of 24,000 to 50,000 BPI. Potential TPI also may be many times that of ferrite heads, and thin film heads have the other significant potential advantage of forming an array of many heads on a single slider, this enabling faster access by reducing head movements.

The industry has been waiting for some time to see thin film heads on a new drive from IBM -- and this may well be the year. Most of IBM's disk drive competitors and the independent head manufacturers expect the 3370 to use thin film heads. Such usage would set a new defacto design standard for disk recording heads -- a helpful service IBM routinely performs for the industry without even trying. Because the 3370 heads perform at over twice the recording density per square inch of 3350 heads, they will be widely used in the high performance disk drives designed by both captive and OEM manufacturers for several years in the future.

Of more immediate importance to the manufacturers of plug compatible drives, however, is establishment of a source for 3370 heads as early as possible after IBM's first 3370 delivery. Since every month's delay in shipment of independent 3370's is a month's lost business, PCM manufacturers are already working to develop thin film heads they believe will record at densities they think the 3370 utilizes. Independent head manufacturers wading in the same quicksand are also preparing thin film head designs, hoping for the best. It is believed that several of these organizations probably have the capability to produce appropriate heads, once the IBM heads are available for evaluation. So it may well be that availability of heads will not be the critical pacing factor in achieving first delivery of independent 3370's 18 months after IBM's first delivery, per the current DISK/TREND estimate.

* Recording disks: The industry keeps finding ways to stretch the life of coated disk technology. This year IBM demonstrated that oxide coating on Piccolo disks, an improvement on 3350 coating quality, was quite adequate for the purpose. For whatever it's worth, the collective industry guess regarding the 3370 disks also stays with coating techniques. Of course, the 3370 recording density is higher than Piccolo's, so it may be likely that the normal oxide magnetic particle will be replaced by a different magnetic particle, with higher resolution and coercivity.

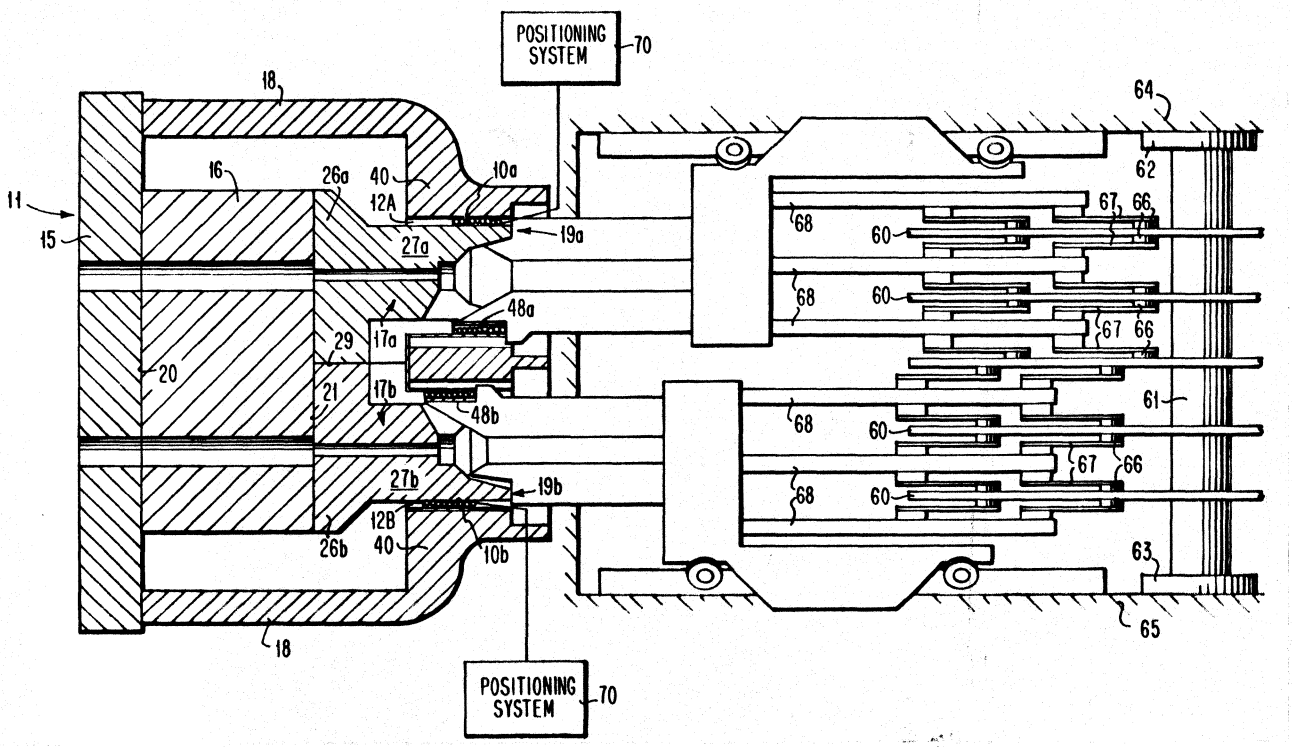
Coating techniques, even if used on the 3370, will reach their limit eventually. At that time thin magnetic films will have to be deposited directly onto disks, probably using either conventional plating methods or sputtering. Nickel cobalt plated disks are in wide use today with head-per-track disk drives, and have demonstrated satisfactory durability for continuous use. Sputtering equipment is widely available, but depositing a satisfactory surface on a disk as large as 14" in diameter may be difficult. Whatever manufacturing method may eventually become the industry standard, thin film disks will of necessity be used in the future, probably for the next increment of recording density after the 3370.

* Head positioning method: Many types of actuators are in use today with the several generations of disk drives still in daily operation. Even stepping motors have been used in the lowest cost designs. But today the high performance end of the spectrum is receiving considerable development attention, in order to facilitate faster access and to accurately position heads for ever-increasing track densities. Independent drives using linear motor actuators have been announced with track densities as high as 800 TPI. IBM has announced that the 3370 uses two actuators, and it is considered probable that the 3370's head positioning system is similar to the design illustrated below, from a patent issued to IBM earlier this year.

Figure 3

ILLUSTRATION FROM U.S. PATENT 4,136,293, January 23, 1979

IBM DESIGN FOR PARALLEL DUAL ACTUATOR



DEFINITIONS

Many basic terms have varying meanings within the computer industry, depending upon the role of the person speaking. In this report, such terms are used in the way most disk drive manufacturers use them.

Market class: Used here, arbitrarily, to differentiate captive, PCM and OEM disk drive marketing activities.

Captive: Disk drives manufactured internally or by a subsidiary of a computer manufacturer or system OEM, and sold or leased primarily for use with systems offered by the manufacturer. Note that the term is used to describe the products, not the manufacturer; drives sold to PCM or OEM market classes are classified accordingly. Most DISK/TREND statistics separate data between IBM and "other captive", but the term still pertains to the disk drives involved, not the manufacturer. Examples:

* Drives sold by DEC, Hewlett Packard or Burroughs are considered captive, if internally manufactured.

* In the case of a joint venture disk drive manufacturer such as Magnetic Peripherals, Inc., a joint venture of Control Data and Honeywell, MPI drives sold by Honeywell are included in captive, and MPI drives sold by CDC are included in captive, PCM or OEM groups, as appropriate.

Non-captive: Any public sale or lease by any disk drive manufacturer, except that sales or leases of internally manufactured drives by computer manufacturers or system OEMs primarily for use with their own systems are excluded. Both OEM and PCM shipments are included in the non-captive category. Examples:

* Shipments by ISS are non-captive, except for drives sold by its parent company or other subsidiaries.

* CDC disk drive sales to NCR are non-captive, in that NCR does not share in ownership of MPI, and are included in OEM totals.

PCM: Disk drives sold or leased by "plug compatible manufacturers" directly to end users; shipments of internally manufactured drives by computer manufacturers or system OEMs are not included unless supplied in plug compatible configurations for installation with systems supplied by other manufacturers. This category is not limited to plug compatible drives installed on IBM systems. It includes any drives which are suitably equipped to be connected without additional hardware to systems of all types, including minicomputers and small business systems. Examples:

* Storage module drives sold by Ball Computer to end users are included.

* On an arbitrary basis, drives manufactured by ISS, Nippon Peripherals or Hitachi and resold in the PCM market by other companies are included in PCM totals, in order to avoid distortion of total industry PCM activity.

OEM: Disk drives sold through any non-captive distribution channel except PCM. Drives are normally sold to OEMs to be included in complete systems or subsystems; such drives are included in OEM totals whether or not the OEM actually manufactures the remainder of the system or subsystem, or merely assembles components and adds software. Sales by a disk drive manufacturer to a second drive manufacturer for resale are included only in shipment totals for the originating drive manufacturer.

Independent: Any disk drive manufacturer other than IBM.

U.S./Worldwide: Shipments are classified U.S. or worldwide depending on the shipment destination of a drive's first public sale. Examples:

* An OEM shipment by a U.S. drive manufacturer to a European system manufacturer is included in worldwide totals.

* An OEM shipment by a Japanese drive manufacturer to a U.S. system manufacturer is included in U.S. totals.

* A Burroughs shipment of a drive manufactured in Europe to a U.S. end user is included in U.S. totals.

Revenue: Based on sale of disk drives alone, as normally sold by individual manufacturers, without controllers, formatters, or spare parts. When sold as an integral part of a system or subsystem, the value of the disk drive alone has been estimated for DISK/TREND purposes. Sale prices are estimated public sale transaction prices, whether at captive end user, PCM or OEM levels. Prices used for leased drives are on an "if sold" basis, at captive or PCM levels, as appropriate. All projected prices are in 1979 constant dollars.

Forecasts: Expected shipments and revenues for current or announced products in new production. Evolutionary improvements within existing formats are included, but completely new configurations or technologies are not included. Examples:

* Enhancements such as double density versions of existing configurations, revised encoding schemes and improved fixed head options are anticipated in DISK/TREND forecasts.

* Innovations such as disks in non-standard sizes or new physical configurations may require establishment of new DISK/TREND product categories.

Distribution channels: Shipments of non-captive drives are analysed by each of the following distribution channels:

Mainframe computer manufacturers: The major computer manufacturers, sometimes popularly known as "mainframers". In the U.S. this group consists of IBM, Sperry Univac, Honeywell, Burroughs, Control Data, and NCR.

Mini/micro computer manufacturers: Computer manufacturers primarily oriented to the minicomputer class, such as DEC, Hewlett Packard, etc., and the emerging manufacturers of microprocessor-based systems, such as Intel and National Semiconductor.

System OEMs/systems houses: (1) OEMs which manufacture a system requiring disk drives, such as Foxboro, Basic Four or Cromemco. (2) Systems houses, of any size, which combine finished components and custom software to offer users complete systems.

Independent peripherals suppliers: Specialized manufacturers which add controllers, interfaces and other equipment or software, and offer plug compatible subsystems to end users, system OEMs and systems houses. Examples are System Industries, Advanced Electronic Design, Microcomputer Systems, Diva and Telefile.

Direct to end user: Sales of plug compatible disk drives with any other necessary hardware directly to end users by disk drive manufacturers, whether or not title to the equipment is to be held by end users themselves or by lessors.

DISK CARTRIDGE DRIVES, LESS THAN 12 MB

1979 DISK/TREND REPORT

DISK CARTRIDGE DRIVES, LESS THAN 12 MB

Coverage

Examples of disk drives in this group include:

IBM	2310, 5444, 5447, 5022
Burroughs	9480-2, 9481-2, 9482-32
CII-Honeywell Bull	D 120
Control Data	9427H
Data General	6045, 6095
Datapoint	9360
Data Recording Equipment	3206, 3212, 4044B
Diablo Systems	31, 33, 43, 44, 44B
Digital Equipment	RK05J, RL01
EMM	203, 206, 303, 306
Hewlett-Packard	7900
Hokushin	CD 3300, CD 4400, CD5200S
Isotimpex	ISOT 1370
Microdata	2850, 9100, 7400
Mitsubishi	M 802F/S
Nippon Electric Company	N 7711, N 7715
Northern Telecom	3002, 3404, 3850
Perkin Elmer	SF/T 2212, SF/T 2222
Pertec	D3311, D3341, D3441
Philips	X1215, X1216
Western Dynex	DD-6121, DD-6222

This category includes all removable-only or fixed/removable disk drives with a total capacity per spindle of less than 12 MB. Each fixed/removable combination drive is counted as one spindle. Disk cartridges may be front loading (2315 type), top loading (5440 type) or a special design. At this time, all drives in the group use 14" disks, except the CII-Honeywell Bull D 120, which uses a 10.5" disk in a special cartridge.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1978	1979	1980	1981	1982
U.S. manufacturers	419.8	424.7	348.1	253.6	176.8
All manufacturers	490.0	507.2	415.4	306.3	217.4

Worldwide production of drives in this group increased by 12.8% in 1978, to 110,800 spindles -- thus continuing the role of the disk cartridge drive as the most popular rigid disk drive of all time. Furthermore, shipments are expected to increase again in 1979 to 122,000 spindles, up 10.1%. Significantly, however, total revenues for 1979 are projected to increase only 3.5%.

Total revenues for U.S. captive drives are actually decreasing in 1979, despite a 5.5% increase in unit shipments. This decline in average price has been caused primarily by DEC's aggressive introduction of its RL01 drive, at prices lower than those available for any other captive disk cartridge drive.

OEM drive shipments are the backbone of this category, and it is clear that shipments did not reach their peak in 1978, as expected. Worldwide OEM shipments for 1978 were 60,400 spindles, with 1979 projected at 73,400, an increase of 21.5%. The strong OEM showing for 1979 is a reflection of the excellent growth being achieved by most application areas for disk cartridge drives, especially small business systems. Low cost fixed disk drives will undoubtedly displace a large portion of these shipments in future years, but few OEMs have designed systems to use the new fixed drives yet -- so disk cartridge drives are receiving the benefit

of a period of exceptional growth. Disk cartridge drives over 12 MB capacity will also have a future negative effect on drives in this group, but 1979's impact has not very noticable.

Marketing trends

For the reasons mentioned above, 1979 is expected to be the shipment peak for this product group. System OEMs have now had the time required to design systems using small fixed Winchester drives, and numerous systems using such drives will be introduced in the next year -- diverting sales which would otherwise have gone to small disk cartridge drives. And a large number of system OEMs will also start to make use of higher capacity disk cartridge drives in 1980, providing an upward growth path for users who would have used 10 MB disk cartridge drives in multiple-spindle configurations for the same purpose in the past.

The decline in combined captive and OEM shipments is expected to average 25.2% annually, for the years 1980 through 1982. OEM average prices are expected to change very little during this period, as the product mix continues to shift predominantly to the high capacity end of the group. Captive drives will also evolve to higher average capacities, but DEC's very low price on the RL01 will contribute to a 5.2% average annual decline in price. The forecasted price decline would be greater, except for the expected introduction by DEC of a double density version of the same drive, the RL02, presumably at a somewhat higher price.

Technical trends

The 14" disk cartridge drives are a technically mature group of products, with few recent innovations expect DEC's use of an interspersed servo technique. However, it is possible that one or more of the following developments might affect the product group:

Smaller disk diameters: The CII-Honeywell Bull D 120, using 10.5" disks is now in production, with a few OEM sales already accomplished in the United States. 8" drives could have a larger impact eventually; fixed/removable 8" cartridge drives in the more than 12 MB product group are expected next year, and it is always possible that low-end versions could have a major impact in the less than 12 MB group.

High capacity floppies: Floppy drives in the 3 to 6 MB range seem inevitable, in both captive and OEM configurations. Impact upon existing products in this group by such a floppy drive would probably be negligible, however, since most of the 14" rigid disk drives will be at the upper end of the capacity range for the group by that time.

Magnetic bubbles: Through the early 1980's, magnetic bubbles will probably not be cost-effective competition against 10 MB disk cartridge drives, and will be at a distinct disadvantage on the disk cartridge's biggest feature: Removability.

Forecasting assumptions

1. The shipment peak for captive drives in this category will occur in 1979, with continuous decline thereafter, due to commitments to higher capacity cartridge drives, storage module drives and low cost fixed Winchester drives by mainframe and minicomputer manufacturers with internal manufacturing programs.

2. After 1979's shipment peak, OEM drives will be sharply impacted by low cost fixed disk drives, especially 8" Winchester drives, plus rapid migration of larger users to higher capacity disk cartridge drives.

3. OEM price levels will decline only slightly, due to continued increases in the average capacity of drives shipped.

4. Any potential impact by flexible disk drives on the rigid drives in this product group will be in the lower half of the capacity range, with no significant displacement of sales volume.

TABLE 7

DISK CARTRIDGE DRIVES, LESS THAN 12 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1978		Forecast							
	---Shipments---		------1979-----		------1980-----		------1981-----		------1982-----	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	11.0	18.3	--	--	--	--	--	--	--	--
Other U.S. Captive	161.5	253.3	159.3	249.2	136.7	213.7	102.7	160.8	73.1	114.1
TOTAL U.S. CAPTIVE	172.5	271.6	159.3	249.2	136.7	213.7	102.7	160.8	73.1	114.1
PCM	--	--	--	--	--	--	--	--	--	--
OEM	103.8	148.2	115.4	175.5	88.8	134.4	61.2	92.8	41.4	62.7
TOTAL U.S. NON-CAPTIVE	103.8	148.2	115.4	175.5	88.8	134.4	61.2	92.8	41.4	62.7
TOTAL U.S. SHIPMENTS	276.3	419.8	274.7	424.7	225.5	348.1	163.9	253.6	114.5	176.8
Non-U.S. Manufacturers										
Captive	--	30.1	--	28.3	--	25.5	--	22.1	--	19.2
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	40.1	5.8	54.2	--	41.8	--	30.6	--	21.4
TOTAL NON-U.S. SHIPMENTS	--	70.2	5.8	82.5	--	67.3	--	52.7	--	40.6
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	276.3	490.0	280.5	507.2	225.5	415.4	163.9	306.3	114.5	217.4
OEM Average Price ($000)	2.9	3.1	3.0	3.1	3.0	3.1	2.9	3.0	2.8	3.0

TABLE 8

DISK CARTRIDGE DRIVES, LESS THAN 12 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1978		Forecast							
	Shipments		1979		1980		1981		1982	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	1.5	2.5	(.9)	(1.5)	(1.8)	(3.0)	(3.0)	(5.0)	(3.3)	(5.5)
Other U.S. Captive	27.8	43.6	29.4	46.0	26.8	41.9	21.4	33.5	15.9	24.8
TOTAL U.S. CAPTIVE	29.3	46.1	28.5	44.5	25.0	38.9	18.4	28.5	12.6	19.3
PCM	--	--	--	--	--	--	--	--	--	--
OEM	35.3	50.4	39.0	59.3	29.6	44.8	21.1	32.0	14.8	22.4
TOTAL U.S. NON-CAPTIVE	35.3	50.4	39.0	59.3	29.6	44.8	21.1	32.0	14.8	22.4
TOTAL U.S. SHIPMENTS	64.6	96.5	67.5	103.8	54.6	83.7	39.5	60.5	27.4	41.7
Non-U.S. Manufacturers										
Captive	--	4.3	--	4.1	--	3.8	--	3.4	--	3.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	10.0	1.5	14.1	--	11.3	--	8.5	--	6.1
TOTAL NON-U.S. SHIPMENTS	--	14.3	1.5	18.2	--	15.1	--	11.9	--	9.1
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	64.6	110.8	69.0	122.0	54.6	98.8	39.5	72.4	27.4	50.8
Installed at Year End										
IBM	53.3	79.0	52.4	77.5	50.6	74.5	47.6	69.5	44.3	64.0
Non-IBM	283.3	461.7	353.2	585.2	409.6	687.0	452.1	764.4	482.8	820.7
WORLDWIDE TOTAL	336.6	540.7	405.6	662.7	460.2	761.5	499.7	833.9	527.1	884.7

TABLE 9

DISK CARTRIDGE DRIVES, LESS THAN 12 MB

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution Channel	1978 U.S. Net Shipments Units (000)	%	FORECAST 1979 %	1980 %	1981 %	1982 %
Mainframe computer manufacturers	2.5	7.1	6.3	5.1	4.0	2.5
Mini/micro computer manufacturers	13.3	37.7	35.4	33.6	32.7	32.3
System OEMs/systems houses	11.7	33.1	35.7	38.0	39.3	40.4
Independent peripherals suppliers	7.8	22.1	22.6	23.3	24.0	24.8
Direct to end user	--	--	--	--	--	--
TOTAL	35.3					

TABLE 10

DISK CARTRIDGE DRIVES, LESS THAN 12 MB

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1978 Net Shipments To United States Destinations Units (000)	%	Worldwide Units (000)	%
Control Data	10.2	28.9	17.0	28.1
Diablo	12.3	34.8	14.4	23.8
Data Recording Equipment	--	--	5.3	8.8
Western Dynex	2.0	5.7	5.0	8.3
Pertec	3.3	9.3	4.4	7.3
Perkin Elmer	2.5	7.1	4.2	7.0
Other U.S.	5.0	14.2	5.4	8.9
Other Non-U.S.	--	--	4.7	7.8
	35.3		60.4	

DISK CARTRIDGE DRIVES, MORE THAN 12 MB

1979 DISK/TREND REPORT

DISK CARTRIDGE DRIVES, MORE THAN 12 MB

Coverage

Examples of disk drives in this group include:

Century	H-32, H-64, H-96
CII-Honeywell Bull	D 140
Control Data	9448-32, 9448-64, 9448-96
Data General	6070
Datapoint	9374
Digital Equipment	RK06, RK07
EMM	312-25, 312-50, 312-76
Fujitsu	M-2201, M-2211
Hewlett-Packard	7905, 7906
Hokushin	CS-5400S, CD-5200
Mitsubishi	M803
Perkin Elmer	T-2422
Pertec	D3461, D3481
Philips	X1217
Toshiba	MK-200R
Vermont Research	5017

The common denominator among drives in this group is a removable cartridge, which is usually, but not always, combined with one or more fixed disk. Within the group, drives may be classified as follows:

Conventional fixed/removable cartridge format -- drives which are essentially the same physical configuration as lower capacity cartridge drives, but which use 10 MB removable cartridges combined with 10 MB fixed disks (Data General 6070, Perkin Elmer T-2422, Mitsubishi M803, Toshiba MK-200R)

High capacity fixed/removable -- drives using storage module (6000 BPI) technology to provide 16 MB removable cartridges, combined with up to 80 MB on fixed disks (Control Data 9448, Century Hunter).

Unique configurations -- drives such as Fujitsu's M-2201 (50 MB removable), CII-HB's D 140 (10 MB fixed/10 MB removable on 10.5" disks), DEC's RK06 and RK07 (up to 27.5 MB in a special two-disk removable cartridge), and Vermont Research's 5017 (26 MB fixed/26 MB removable, with embedded servo).

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1978	1979	1980	1981	1982
U.S. manufacturers	91.6	207.2	321.5	453.4	590.3
All manufacturers	108.6	231.7	373.8	551.9	735.0

In 1978, the captive manufacturing programs of DEC, Hewlett-Packard, and Datapoint provided two thirds of the total U.S. shipments of disk cartridge drives more than 12 MB. OEM shipments consisted mostly of the Perkin Elmer 10MB fixed/10 MB removable drive, plus smaller shipments by Pertec and Control Data.

The anticipated rapid growth expected for this product group has started in 1979, however, and worldwide shipments for the year are projected as 36,000 spindles, up 143.2% from the 1978 total of 14,800. During 1979, U.S. captive shipments are expected to climb 86.7% and U.S. OEM shipments are forecasted at a 316.2% increase. Control Data's "cartridge module drive," or CMD, accounts for the major part of the increase in OEM drive shipments.

The CMD, which went into production in 1977, bridges the capacity gap between traditional disk cartridge drives (up to 10 MB) and storage module drives (mostly at 80 MB). With a range of 32, 64 or 96 MB, the CMD provides the needed upward growth path from smaller disk cartridge drives and it is also an effective compromise between the opposing alternatives of all-fixed and all-removable disk storage. And since the CMD has been designed to use the same interfaces and controllers already in use with SMDs, early acceptance from the large existing SMD customer base has been excellent.

Marketing trends

Starting in 1980, OEM shipments of drives in this group are expected to exceed captive shipments. The predominant drive configuration will be the Control Data CMD and similar drives, such as Century Data System's Hunter and Ampex' DFR-932/964/996 (manufactured by Toshiba). Average annual growth in worldwide OEM shipments from 1980 through 1982 is projected at 59.5%, reaching 61,900 spindles in 1982 for the product group. This represents an increase over previous DISK/TREND projections, based on market reaction to the CMD. The average capacity of drives shipped in each year is expected to increase continually through 1982, with the result that OEM average prices will also increase each year during the same period.

Unique disk drive configurations will also share in the future growth of the OEM market for drives in this group, and that market penetration is assumed in this year's projections. Already the CII-Honeywell Bull D 140, a 10.5" disk in a fixed/removable drive, is available. Also available are the Fujitsu M-2201 and M-2211, offering up to 83.3 MB in a special removable cartridge with 14" disks. Widely anticipated in the industry is the Control Data Lark drive, which is expected to be introduced in the next year and to use 8" disks in a fixed/removable combination. It seems reasonable to expect that the Lark will provide tough price competition at the low capacity end of this category, and that it will eventually be produced in substantial quantities.

Non-U.S. manufacturers may also be expected to compete aggressively in the worldwide market for OEM high capacity disk cartridge drives. In addition to the Fujitsu and CII-HB drives, Hokushin has announced a fixed/

removable cartridge drive family with capacities up to 53 MB, and the CMD-type drive Toshiba is manufacturing for resale by Ampex will presumably show up in non-U.S. markets under the Toshiba label. OEM shipments by non-U.S. manufacturers were negligible in 1978, but are expected to reach 15,200 spindles in 1982.

Although U.S. captive production programs for disk cartridge drives in this group are currently in a sharp growth phase, shipments from 1980 through 1982 are expected to increase at a more modest 21% average annual rate. The 1979 growth spurt is being caused by new programs by Data General and Control Data/Honeywell (Magnetic Peripherals, Inc.), which can be expected to continue through the early 1980's, but at a more moderate rate of increase. The DEC RK06/RK07 cartridge drives do not appear to be growing in shipment volume, their market having been impacted by DEC's addition of Control Data's SMDs to its product line as resale products. Other captive programs, such as those by Hewlett-Packard and Datapoint, are expected to grow at rates similar to the overall average for captive drives.

Technical trends

Because this group is composed of several dissimilar disk drive configurations, interesting technical considerations may affect the reaction of prospective OEM customers to individual products:

Uniqueness: Drives such as the Fujitsu M-2201/M-2211, CII-Honeywell Bull D 140 and Vermont Research 5017 are one-of-a-kind designs, with no second-sourcing available. Since interfaces, controllers and physical enclosures must be designed for the individual drive, it is reasonable to expect OEMs with specialized requirements to be the most likely customers.

CDC vs. Century cartridge: Control Data's CMD uses a special single disk cartridge with unique hub and plastics, containing a disk with prerecorded servo on one side, data on the other. Century's Hunter cartridges use standard 5440-type hub and plastics, with data recorded at lower densities using both sides, without prerecorded servo tracks. Both sides claim advantages, but it's too early to determine whether either approach makes any difference in actual system operation.

8" disk cartridge drives: As noted above, introduction of 8" fixed/removable drives is expected. Use of Winchester technology is assumed for the fixed element in these drives, but the technique to be used for the removable cartridge is another matter. The essence of Winchester technology is a system permanently closed to the environment. So the configuration of the removable media package is an interesting problem, and one that has to be solved at reasonable cost if the product type is to prosper.

Forecasting assumptions

1. The CMD and similar drives will become dominant among OEM drives in this group during the next few years.
2. High capacity disk cartridge drives will secure a significant share of the disk storage requirements of small business systems and other minicomputer systems, in competition with storage module drives and fixed disk drives.
3. Due to the extended capacity range of the drives now available, and the continuing tendency toward higher capacity requirements, average OEM price per spindle will gradually increase through 1982.
4. Penetration of U.S. markets for disk drives in this group by non-U.S. manufacturers will be relatively small.

TABLE 11

DISK CARTRIDGE DRIVES, MORE THAN 12 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1978 Shipments		Forecast 1979		1980		1981		1982	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	48.3	77.6	94.5	145.6	131.5	202.6	183.7	282.2	247.0	380.2
TOTAL U.S. CAPTIVE	48.3	77.6	94.5	145.6	131.5	202.6	183.7	282.2	247.0	380.2
PCM	--	--	--	--	--	--	--	--	--	--
OEM	10.2	14.0	44.8	61.6	89.0	118.9	123.2	171.2	144.9	210.2
TOTAL U.S. NON-CAPTIVE	10.2	14.0	44.8	61.6	89.0	118.9	123.2	171.2	144.9	210.2
TOTAL U.S. SHIPMENTS	58.5	91.6	139.3	207.2	220.5	321.5	306.9	453.4	391.9	590.4
Non-U.S. Manufacturers										
Captive	--	15.0	--	14.6	--	27.5	--	50.5	--	65.6
PCM	--	--	--	--	--	--	--	--	--	--
OEM	.5	2.0	3.1	9.9	5.9	24.8	9.1	48.0	14.0	79.0
TOTAL NON-U.S. SHIPMENTS	.5	17.0	3.1	24.5	5.9	52.3	9.1	98.5	14.0	144.6
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	59.0	108.6	142.4	231.7	226.4	373.8	316.0	551.9	405.9	735.0
OEM Average Price ($000)	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7

TABLE 12

DISK CARTRIDGE DRIVES, MORE THAN 12 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1978		Forecast							
	Shipments		1979		1980		1981		1982	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	5.6	9.0	10.9	16.8	13.7	21.1	16.4	25.2	19.3	29.7
TOTAL U.S. CAPTIVE	5.6	9.0	10.9	16.8	13.7	21.1	16.4	25.2	19.3	29.7
PCM	--	--	--	--	--	--	--	--	--	--
OEM	2.7	3.7	11.2	15.4	21.2	28.3	28.0	38.9	32.2	46.7
TOTAL U.S. NON-CAPTIVE	2.7	3.7	11.2	15.4	21.2	28.3	28.0	38.9	32.2	46.7
TOTAL U.S. SHIPMENTS	8.3	12.7	22.1	32.2	34.9	49.4	44.4	64.1	51.5	76.4
Non-U.S. Manufacturers										
Captive	--	1.7	--	1.6	--	2.2	--	3.3	--	4.1
PCM	--	--	--	--	--	--	--	--	--	--
OEM	.1	.4	.7	2.2	1.3	5.5	1.9	10.0	2.7	15.2
TOTAL NON-U.S. SHIPMENTS	.1	2.1	.7	3.8	1.3	7.7	1.9	13.3	2.7	19.3
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	8.4	14.8	22.8	36.0	36.2	57.1	46.3	77.4	54.2	95.7
Installed at Year End										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	14.7	26.1	37.5	62.1	73.7	119.2	120.0	196.6	174.2	292.3
WORLDWIDE TOTAL	14.7	26.1	37.5	62.1	73.7	119.2	120.0	196.6	174.2	292.3

TABLE 13

DISK CARTRIDGE DRIVES, MORE THAN 12 MB

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution Channel	1978 U.S. Net Shipments Units (000)	1978 U.S. Net Shipments %	FORECAST 1979 %	1980 %	1981 %	1982 %
Mainframe computer manufacturers	.1	3.6	4.0	4.3	4.7	5.1
Mini/micro computer manufacturers	1.3	46.4	41.2	36.4	33.3	30.8
System OEMs/systems houses	1.2	42.9	41.7	45.0	46.9	48.1
Independent peripherals suppliers	.2	7.1	13.1	14.3	15.1	16.0
Direct to end user	--	--	--	--	--	--
TOTAL	2.8					

DISK PACK DRIVES, 29-58 MB

1979 DISK/TREND REPORT

DISK PACK DRIVES, 29-58 MB

Coverage

Examples of disk drives in this group include:

IBM	2314, 2319, 5445
Ampex	DM-323
Burroughs	9384-6, 9388-2
Control Data	9746, 9747
Isotimpex	EC 5061
ISS/Univac	715
Nippon Electric Company	DKU 300, DKU 310

All disk drives in this group utilize the same basic technology and physical configuation as IBM's 2314, which was introduced with System/360 in 1965. Most of the drives now in production are "double density" 58 MB drives, but some drives have been included because of physical similarity, even though outside of the nominal capacity range.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1978	1979	1980	1981	1982
U.S. manufacturers	51.8	37.2	10.9	4.8	--
All manufacturers	95.3	69.3	25.0	7.2	--

Worldwide net shipments of new drives in this group totaled 9,200 spindles in 1978. However, after deducting retirements of IBM and PCM drives, the worldwide net total for the year was 4,600. Captive and OEM production of 2314-type drives is still underway in Japan, Europe and the U.S.

All existing production programs for drives in this class are continuing to decline in 1979. This is expected to be the last year for U.S. captive shipments of new drives.

For many years the 2314 was the primary auxiliary storage device for the industry's mainframes and large minicomputers. Shipments have continued at high levels even after the availability of newer, more cost-effective drives, because few OEMs are willing to expend the resources necessary to provide for attachment of new disk drives to old computer systems. The continuing sales of many older systems on which 2314's are used, combined with the demand for add-on drives to be used with installed systems, has kept the product group in production much longer than many industry participants had expected.

Marketing trends

No new adoptions of drives in this group are expected for systems of any kind, with the possible exception of a few Eastern European countries. Production will continue to decrease in all market classes, with the last U.S. captive shipments this year, and the last Japanese captive shipments next year. 1981 should be the last year of production for OEM drives.

Retirements of drives will continue to climb, especially in the IBM and PCM groups, as new generations of IBM equipment are installed, and the old System/360 is displaced in larger numbers. Worldwide net shipments will be negative starting in 1980.

Technical trends

No further refinements of this format are expected.

Forecasting assumptions

1. Captive production will cease in the U.S. in 1979, elsewhere in 1980.

2. OEM production will end in 1980, with production levels before that time declining continually.

3. New system adoptions will be non-existent, with system designers preferring instead the newer high density cartridge drives, storage module drives or fixed disk drives to cover the same capacity requirements.

TABLE 14

DISK PACK DRIVES, 29-58 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1978		Forecast							
	---Shipments---		------1979-----		------1980-----		------1981-----		------1982-----	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	12.2	19.8	7.3	11.6	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	12.2	19.8	7.3	11.6	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	12.5	32.0	7.0	25.6	2.3	10.9	.8	4.8	--	--
TOTAL U.S. NON-CAPTIVE	12.5	32.0	7.0	25.6	2.3	10.9	.8	4.8	--	--
TOTAL U.S. SHIPMENTS	24.7	51.8	14.3	37.2	2.3	10.9	.8	4.8	--	--
Non-U.S. Manufacturers										
Captive	--	24.8	--	18.0	--	7.5	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	18.7	--	14.1	--	6.6	--	2.4	--	--
TOTAL NON-U.S. SHIPMENTS	--	43.5	--	32.1	--	14.1	--	2.4	--	--
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	24.7	95.3	14.3	69.3	2.3	25.0	.8	7.2	--	--
OEM Average Price ($000)	7.8	8.0	7.8	7.9	7.7	8.0	8.0	8.0	--	--

TABLE 15

DISK PACK DRIVES, 29-58 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1978		Forecast							
	Shipments		1979		1980		1981		1982	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	(2.2)	(3.5)	(1.7)	(2.8)	(1.3)	(2.1)	(1.0)	(1.6)	(1.1)	(1.8)
Other U.S. Captive	.8	1.3	.5	.8	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	(1.4)	(2.2)	(1.2)	(2.0)	(1.3)	(2.1)	(1.0)	(1.6)	(1.1)	(1.8)
PCM	(.9)	(1.1)	(.8)	(1.0)	(.7)	(.9)	(.6)	(.7)	(.6)	(.7)
OEM	1.6	4.1	.9	3.3	.3	1.4	.1	.6	--	--
TOTAL U.S. NON-CAPTIVE	.7	3.0	.1	2.3	(.4)	.5	(.5)	(.1)	(.6)	(.7)
TOTAL U.S. SHIPMENTS	(.7)	.8	(1.1)	.3	(1.7)	(1.6)	(1.5)	(1.7)	(1.7)	(2.5)
Non-U.S. Manufacturers										
Captive	--	1.6	--	1.2	--	.5	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	2.2	--	1.7	--	.8	--	.3	--	--
TOTAL NON-U.S. SHIPMENTS	--	3.8	--	2.9	--	1.3	--	.3	--	--
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	(.7)	4.6	(1.1)	3.2	(1.7)	(.3)	(1.5)	(1.4)	(1.7)	(2.5)
Installed at Year End										
IBM	24.3	41.7	22.6	38.9	21.3	36.8	20.3	35.2	19.2	33.4
Non-IBM	62.2	119.1	62.8	125.1	62.4	126.9	61.9	127.1	61.3	126.4
WORLDWIDE TOTAL	86.5	160.8	85.4	164.0	83.7	163.7	82.2	162.3	80.5	159.8

TABLE 16

DISK PACK DRIVES, 29-58 MB

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution Channel	1978 U.S. Net Shipments Units (000)	%	FORECAST 1979 %	1980 %	1981 %	1982 %
Mainframe computer manufacturers	.1	6.3	3.0	--	--	--
Mini/micro computer manufacturers	.3	18.7	15.9	12.3	8.1	3.9
System OEMs/systems houses	1.1	68.7	73.2	78.3	81.5	84.4
Independent peripherals suppliers	.1	6.3	7.9	9.4	10.4	11.7
Direct to end user	--	--	--	--	--	--
TOTAL	1.6					

TABLE 17

DISK PACK DRIVES, 29-58 MB

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1978 Net Shipments To United States Destinations Units (000)	%	Worldwide Units (000)	%
Control Data	.6	37.5	2.8	44.5
Other U.S.	1.0	62.5	1.3	20.6
Other Non-U.S.	--	--	2.2	34.9
	1.6		6.3	

Note: PCM net shipments, a negative value for 1978, have been eliminated from the two tables on this page to avoid distortion of OEM shipments.

STORAGE MODULE DRIVES, 25-80 MB

1979 DISK/TREND REPORT

STORAGE MODULE DRIVES, 25-80 MB

Coverage

Examples of disk drives in this group include:

Ampex	DM-940, DM-980
Ball	BD-50, BD-80
Burroughs	9484-2, 9484-5
Century	T-25, T-50, T-80
Control Data	9760, 9762, 270-10
Data General	6067
Hewlett-Packard	7920
ISS/Univac	8418
Mitsubishi	M2850, M2851F
Philips	X1237

"Storage module drive," or SMD, is the term used throughout the DISK/TREND Report as a generic description for disk drives using 3330-type technology at 4000 or 6000 BPI, employing small disk packs. All drives in the group currently use packs with five recording surfaces, except the Univac 8418 and the Philips X1237, with 7 and 8 surfaces, respectively. Among the five surface drives, all OEM and captive drives are designed to use disk packs meeting either the Control Data SMD or Century Trident standards, with only minor differences with some captive drives.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1978	1979	1980	1981	1982
U.S. manufacturers	252.5	379.5	459.6	524.4	587.1
All manufacturers	254.9	391.9	487.8	570.3	650.1

Growth of the OEM SMD market has continued at a faster pace than expected, and last year's DISK/TREND projections for the current period, although forecasting a vigorous increase, were too conservative. Worldwide OEM shipments were up 63.7% in 1978, to 16,700 spindles, and are estimated at an 89.8% increase in 1979, to 32,200 spindles. OEM average prices have decreased during the same period, a reflection of higher quantity purchases by individual system OEMs. Control Data continues to hold two thirds of the worldwide OEM market, based on 1978 shipment totals.

The SMD is in the right place at the right time. It is well positioned, in terms of capacity, price and availability, to capture the major share of current auxiliary storage requirements for minicomputers and small business systems, in the broad capacity range above 10 MB disk cartridge drives and below 19-surface disk pack drives. These markets are now booming, and other disk drive configurations which may eventually be expected to shrink the share available to SMDs, such as high capacity disk cartridge drives and fixed Winchester drives, have not yet been added to enough systems to seriously affect SMD shipments. Average capacity of SMDs continues to edge upward toward the popular 80 MB size.

The PCM market for SMDs is getting its start in 1979 with the first Control Data sales to the IBM Series/1 marketplace. No new U.S. captive manufacturers have emerged, and shipments by current U.S. manufacturers of captive drives are projected at 15,100 drives in 1979.

Worthy of note is the introduction of the first non-U.S. SMD designed to one of the U.S. pack/drive media standards. Mitsubishi is now shipping 50 and 80 MB Trident-type drives in the Japanese market, for both OEM and captive applications.

Marketing trends

Despite the high current annual growth of OEM SMDs, by 1981 annual growth is expected to settle down to levels well below 10% annually. Starting in 1980, high capacity disk cartridge drives and fixed disk drives will take more significant bites from the markets now dominated by SMDs. Indeed, it is assumed that in many multiple-spindle installations, which previously would have been 100% SMD, fixed disk drives will constitute a high proportion of the drives employed. And, obviously, many systems will be designed to use fixed disk drives exclusively, with only tape to meet the normal requirement for backup.

Despite the impact of other disk drive configurations, the SMD should not reach its production peak during the forecast period of this report, through 1982. It remains one of the most cost effective methods of storing moderate quantities of data on a completely removable basis, and no competitive removable disk drive with improved capability is in sight.

Non-U.S. manufacturing programs are projected to increase at a relatively modest rate through 1982, based primarily on known product lines. If other SMD programs are initiated by non-U.S. manufacturers, the size of the total market will probably not be changed materially, but the share available to U.S. manufacturers could decline.

DISK/TREND projections for the PCM market available to SMDs have been reduced this year, due to a combination of factors: (1) IBM's installation rate on the Series/1 has been slower than anticipated, (2) the 1979 start-up of PCM sales is slower than expected, and (3) the IBM Piccolo is providing very tough price competition. Nevertheless, it

is believed that a reasonable share of the Series/1 market will find removability desirable, and PCM sales should achieve gradual growth, providing IBM manages to find a successful formula in the minicomputer systems market.

U.S. captive production programs are expected to continue to grow at an average annual rate of 16.4% from 1980 through 1982, reaching 23,800 in that year. No new major captive programs are on the horizon, with one possible exception: DEC. DEC is understood to have acquired a manufacturing license to manufacture the Control Data SMDs it is now reselling as the RM02 and RM03. If DEC should undertake such a program, it would increase the DISK/TREND captive projections by a sizeable number, and decrease the OEM projections by the same number of spindles.

Technical trends

The question of whether the track density of the standard SMD, with five recording surfaces, can be doubled successfully is still open. Control Data, the industry leader, has not announced such a product, but Ampex has, the 160 MB DM-9160. The question is not whether an individual drive and pack can be made to operate at such densities -- they can -- but whether media interchangability can be achieved with a large population of drives and packs. The planned Ampex shipping date has slipped to mid-1979. Field performance of this drive may determine whether the 160 MB SMD has a future. Also of interest is the Ball BD-100, which increases track density 25%, to offer 100 MB.

If reliable performance is obtained, the market will surely respond to the opportunity to double capacity per spindle without significant

changes in controllers, enclosures or software. And price should also be extremely attractive, compared to the 19-surface disk pack alternative for equivalent capacity.

Shipments of these drives will not be included in this category, but will be forecasted with disk pack drives over 100 MB.

Forecasting assumptions

1. OEM sales momentum will continue, but with the growth rate declining through 1982, due to competition from high density cartridge drives and fixed disk drives.

2. Captive production will increase at a steady but moderate rate through 1982, due to availability of attractive storage alternatives.

3. Future OEM average unit prices will be subject to only a slight decline, because of continued growth in average capacity level and a reduced growth rate.

TABLE 18

STORAGE MODULE DRIVES, 25-80 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1978		Forecast							
	Shipments		1979		1980		1981		1982	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	101.1	170.4	135.9	228.0	163.5	271.5	186.3	309.9	211.6	352.2
TOTAL U.S. CAPTIVE	101.1	170.4	135.9	228.0	163.5	271.5	186.3	309.9	211.6	352.2
PCM	--	--	5.2	6.5	14.1	20.5	25.2	36.5	31.3	46.3
OEM	54.9	82.1	96.7	145.0	109.1	167.6	115.7	178.0	122.6	188.6
TOTAL U.S. NON-CAPTIVE	54.9	82.1	101.9	151.5	123.2	188.1	140.9	214.5	153.9	234.9
TOTAL U.S. SHIPMENTS	156.0	252.5	237.8	379.5	286.7	459.6	327.2	524.4	365.5	587.1
Non-U.S. Manufacturers										
Captive	--	1.7	--	8.1	--	19.2	--	31.4	--	43.4
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	.7	--	4.3	--	9.0	--	14.5	--	19.6
TOTAL NON-U.S. SHIPMENTS	--	2.4	--	12.4	--	28.2	--	45.9	--	63.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	156.0	254.9	237.8	391.9	286.7	487.8	327.2	570.3	365.5	650.1
OEM Average Price ($000)	4.9	5.0	4.6	4.6	4.4	4.5	4.3	4.4	4.2	4.3

TABLE 19

STORAGE MODULE DRIVES, 25-80 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1978		Forecast							
	---Shipments---		------1979-----		------1980-----		------1981-----		------1982-----	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	6.7	11.3	9.0	15.1	10.9	18.1	12.5	20.8	14.3	23.8
TOTAL U.S. CAPTIVE	6.7	11.3	9.0	15.1	10.9	18.1	12.5	20.8	14.3	23.8
PCM	--	--	.4	.5	1.1	1.6	2.0	2.9	2.5	3.7
OEM	11.1	16.6	21.0	31.5	24.8	38.1	26.9	41.4	29.2	44.9
TOTAL U.S. NON-CAPTIVE	11.1	16.6	21.4	32.0	25.9	39.7	28.9	44.3	31.7	48.6
TOTAL U.S. SHIPMENTS	17.8	27.9	30.4	47.1	36.8	57.8	41.4	65.1	46.0	72.4
Non-U.S. Manufacturers										
Captive	--	.1	--	.5	--	1.2	--	2.0	--	2.8
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	.1	--	.7	--	1.5	--	2.5	--	3.5
TOTAL NON-U.S. SHIPMENTS	--	.2	--	1.2	--	2.7	--	4.5	--	6.3
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	17.8	28.1	30.4	48.3	36.8	60.5	41.4	69.6	46.0	78.7
Installed at Year End										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	36.8	53.4	67.2	101.7	104.0	162.2	145.4	231.8	191.4	310.5
WORLDWIDE TOTAL	36.8	53.4	67.2	101.7	104.0	162.2	145.4	231.8	191.4	310.5

TABLE 20

STORAGE MODULE DRIVES, 25-80 MB

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution Channel	1978 U.S. Net Shipments Units (000)	%	FORECAST 1979 %	1980 %	1981 %	1982 %
Mainframe computer manufacturers	--	--	--	6.2	5.2	4.3
Mini/micro computer manufacturers	4.4	39.7	33.6	27.1	23.5	20.6
System OEMs/systems houses	3.8	34.2	40.6	41.8	45.9	49.8
Independent peripherals suppliers	2.9	26.1	25.8	24.9	25.4	25.3
Direct to end user	--	--	--	--	--	--
TOTAL	11.1					

TABLE 21

STORAGE MODULE DRIVES, 25-80 MB

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1978 Net Shipments To United States Destinations Units (000)	%	Worldwide Units (000)	%
Control Data	7.2	64.9	11.0	65.8
Century Data Systems	3.0	27.0	4.0	24.0
Other U.S.	.9	8.1	1.6	9.6
Other Non-U.S.	--	--	.1	.6
	11.1		16.7	

DISK PACK DRIVES, MORE THAN 100 MB

1979 DISK/TREND REPORT

DISK PACK DRIVES, MORE THAN 100 MB

Coverage

Examples of disk drives in this group include:

IBM	3330-1, 3330-11
Ampex	DM-9100, DM-9160, DM-9300, 331
Ball	BD-100
Burroughs	9383-16, 9484-8
Century	T-200, T-300, T-600, 225
Control Data	9764, 9766, 270-30, 9780, 33302
Data General	6060, 6061
Fujitsu	F478, F479
Hewlett-Packard	7925
Hitachi	H-8589-1, H-8589-11
ISS/Univac	733-10, 733-11, 733-12
Memorex	3670, 3675, 677
Mitsubishi	M2836A, M2837, M2838F
Nippon Electric	N276, N277
Siemens	PS5-3, PS5-5
Toshiba	DSU-450

This group covers disk drives similar to IBM's standard 3330-1 (100 MB) and 3330-11 (200 MB), plus a variety of other physical configurations and capacities. Many of the independent drives use technology essentially similar to the 3330-11, but refined to operate at higher densities. The most commercially significant of these are the 300 MB storage module drives by Control Data and the similar Century drive, the Trident -- all of which use the standard 19-surfaces.

Other variations include the Hewlett-Packard 2925 (120 MB on nine surfaces), Ball BD-100 (100 MB on five surfaces, Ampex DM-9160 (160 MB on five surfaces), Burroughs 9383-16 (174 MB on twenty surfaces), Siemens PS5-3 (146 MB on nine surfaces), and ISS 7330-12 (317.5 MB, the equivalent to IBM's 3350, on nineteen surfaces).

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1978	1979	1980	1981	1982
U.S. manufacturers	613.9	555.2	529.5	465.9	388.9
All manufacturers	879.1	777.5	726.5	641.5	546.8

1978 shipments for large disk pack drives went up in 1978 by a greater degree than expected. Worldwide shipments were up 10,000 spindles -- none of them from IBM, which is out of new production of 3330's. The biggest boost came from non-U.S. captive programs, which were 5,900 spindles higher than the previous DISK/TREND forecast for 1978, with a boost from U.S. captive and PCM shipments, which were also slightly higher than forecast.

In the U.S., neither independent captive nor OEM shipments have been impacted yet by large fixed disk drives, as they will be in the future. In 1979, U.S. captive and OEM shipments are running modestly ahead of 1978, but U.S. PCM and non-U.S. captive shipments are declining. 1979 worldwide shipments are estimated at 39,200 spindles, a drop of 6.2%.

PCM drives continue their fall, severely impacted by the current high installation rate of the more cost-effective IBM 3350 fixed disk drives and the PCM equivalents. OEM drives in this group continue a slight yearly increase in total shipments, as the mix of standard 3330 type drives steadily gives way to the 300 SMD type.

Control Data increased market share of non-captive drive shipments slightly in 1978, with a worldwide share of 42.4%. The Memorex share also held up well, at 34.6%, on the basis of its position as PCM leader and substantial OEM shipments to DEC.

Marketing trends

The basic trends in individual market classes of this product group are substantially unchanged from previous DISK/TREND projections. U.S. captive production should peak in 1980, with a steepening decline thereafter as large fixed disk drives find their way onto mainframes and large minicomputers. PCM production will probably die out in 1980. OEM production will be flat through 1982, but with various SMD configurations, from 160 MB to 600 MB, predominating by 1982. Worldwide total shipments will drop an average of 14.1% annually through 1982.

Technical trends

The Ampex DM-9160 and Century T-600 rely on 740-800 TPI recording densities. Whether removable disk pack drives operating at these densities can achieve reliable operation with unrestricted media interchange is a question which has not yet been answered by extensive field experience. If these and similar drives work without significant field problems, other OEM SMD manufacturers can be expected to follow quickly with their versions. Good market reaction can be expected, especially for the 160 MB drives, with lower costs than alternative products.

Forecasting assumptions

1. IBM's installed population of 3330 drives is now declining, and PCM drives will follow after 1980, due to the impact of IBM's 3350/3344 and successor drives.
2. IBM will not introduce any other large removable disk drive.
3. OEM drives will increase only slightly after 1980, but strength of various SMD configurations will prevent a shipment decline. OEM prices will increase slightly due to dominance of the 300 MB SMD.

TABLE 22

DISK PACK DRIVES, MORE THAN 100 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1978 Shipments		Forecast 1979		1980		1981		1982	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	250.5	409.9	237.0	391.9	233.1	386.3	206.4	344.0	157.5	262.5
TOTAL U.S. CAPTIVE	250.5	409.9	237.0	391.9	233.1	386.3	206.4	344.0	157.5	262.5
PCM	78.3	105.7	42.0	58.4	21.6	28.8	--	--	--	--
OEM	68.6	98.3	74.6	104.9	80.0	114.4	85.4	121.9	88.2	126.4
TOTAL U.S. NON-CAPTIVE	146.9	204.0	116.6	163.3	101.6	143.2	85.4	121.9	88.2	126.4
TOTAL U.S. SHIPMENTS	397.4	613.9	353.6	555.2	334.7	529.5	291.8	465.9	245.7	388.9
Non-U.S. Manufacturers										
Captive	--	259.4	--	215.6	--	191.7	--	171.6	--	155.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	5.8	--	6.7	--	5.3	--	4.0	--	2.9
TOTAL NON-U.S. SHIPMENTS	--	265.2	--	222.3	--	197.0	--	175.6	--	157.9
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	397.4	879.1	353.6	777.5	334.7	726.5	291.8	641.5	245.7	546.8
OEM Average Price ($000)	9.3	9.4	9.2	9.3	9.3	9.4	9.6	9.6	9.8	9.8

TABLE 23

DISK PACK DRIVES, MORE THAN 100 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1978		Forecast							
	---Shipments---		------1979-----		------1980-----		------1981-----		------1982-----	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	(.5)	(.9)	(2.0)	(3.6)	(3.0)	(5.6)	(2.3)	(3.8)
Other U.S. Captive	9.9	16.2	10.4	17.2	10.5	17.4	9.6	16.0	7.5	12.5
TOTAL U.S. CAPTIVE	9.9	16.2	9.9	16.3	8.5	13.8	6.6	10.4	5.2	8.7
PCM	4.0	5.4	2.3	3.2	1.2	1.6	(.8)	(1.1)	(2.3)	(3.3)
OEM	7.4	10.6	8.1	11.4	8.6	12.3	8.9	12.7	9.0	12.9
TOTAL U.S. NON-CAPTIVE	11.4	16.0	10.4	14.6	9.8	13.9	8.1	11.6	6.7	9.6
TOTAL U.S. SHIPMENTS	21.3	32.2	20.3	30.9	18.3	27.7	14.7	22.0	11.9	18.3
Non-U.S. Manufacturers										
Captive	--	9.1	--	7.7	--	7.1	--	6.6	--	6.2
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	.5	--	.6	--	.5	--	.4	--	.3
TOTAL NON-U.S. SHIPMENTS	--	9.6	--	8.3	--	7.6	--	7.0	--	6.5
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	21.3	41.8	20.3	39.2	18.3	35.3	14.7	29.0	11.9	24.8
Installed at Year End										
IBM	41.3	70.1	40.8	69.2	38.8	65.6	35.8	60.0	33.5	56.2
Non-IBM	82.6	148.5	103.4	188.6	123.7	227.5	141.4	262.1	155.6	290.7
WORLDWIDE TOTAL	123.9	218.6	144.2	257.8	162.5	293.1	177.2	322.1	189.1	346.9

TABLE 24

DISK PACK DRIVES, MORE THAN 100 MB

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution Channel	1978 U.S. Net Shipments Units (000)	%	FORECAST 1979 %	1980 %	1981 %	1982 %
Mainframe computer manufacturers	2.4	21.0	18.7	16.6	14.9	13.7
Mini/micro computer manufacturers	2.2	19.3	26.3	29.8	31.3	40.2
System OEMs/systems houses	1.5	13.2	21.2	29.5	41.7	33.9
Independent peripherals suppliers	1.3	11.4	11.7	11.9	12.1	12.2
Direct to end user*	4.0	35.1	22.1	12.2	--	--
TOTAL	11.4					

TABLE 25

DISK PACK DRIVES, MORE THAN 100 MB

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1978 Net Shipments To United States Destinations Units (000)	%	Worldwide Units (000)	%
Control Data	4.1	36.0	7.0	42.4
Memorex	4.5	39.5	5.7	34.6
ISS*	1.5	13.1	1.9	11.5
Other U.S.	1.3	11.4	1.4	8.5
Other Non-U.S.	--	--	.5	3.0
	11.4		16.5	

*Includes drives manufactured by ISS and resold by others in the PCM market.

DATA MODULE DRIVES, 35-70 MB

1979 DISK/TREND REPORT

DATA MODULE DRIVES, 35-70 MB

Coverage

Examples of disk drives in this group include:

IBM	3340
Control Data	9770
Nippon Peripherals, Ltd.	NP20

Each of the above drives is designed to provide media interchangability with standard IBM 3348 data modules, or independent equivalents, in the 35 MB, 70 MB or 70F MB versions.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1978	1979	1980	1981	1982
U.S. manufacturers	156.3	79.3	5.9	4.2	2.5
All manufacturers	192.8	112.4	27.4	15.5	5.5

IBM's 3340, the original "Winchester" disk drive, has been produced in substantial annual quantities since 1974. The DISK/TREND estimate of the IBM installed base for 3340's is expected to reach 65,000 in 1979, which is believed to be the last year in which IBM will keep the drive in new production. In IBM's strategy, the time for newer products has arrived, and the IBM market for the 3340's on large System/3's and small System/370's is now being replaced by the market for Piccolo fixed drives on System/34, System/38, 4331, etc.

The production availability of drives in this group by independent companies remains the same: Control Data and Nippon Peripherals, Ltd., are the only other manufacturers of such a drive. NCR is the primary OEM customer for Control Data's drive, and resells it as the NCR 6590. NPL is a joint venture subsidiary of Fujitsu and Hitachi, each of which market some of NPL's output, listed in the DISK/TREND estimates as captive shipments. NPL's shipments to Memorex for PCM distribution in the U.S. and to BASF for PCM distribution in Europe are, however, the larger part of NPL's shipments.

Marketing trends

Because the System/3 and System/370 markets for IBM's 3340 are being obliterated by new IBM products, the 3340's last year of new production appears to be 1979. As IBM's replacement systems hit high installation rates in 1981 and 1982, growing numbers of 3340's will probably be taken out of service.

NCR's purchases of the Control Data drive will probably continue through 1982, but going downhill after 1979. It's inevitable that NCR will add other, more cost-effective disk drives on its newer systems. Adoption of the 9770 by any other significant OEM is highly unlikely, since drives in this class compare unfavorably with other drive formats, in both hardware and media costs.

The Memorex and BASF PCM programs using NPL's drive will suffer the same fate as IBM's 3340, but will probably stay in production until 1981, as the independents pick up some add-on business that IBM doesn't actively solicit.

Technical trends

No further IBM product introductions are expected in this product area. Although employing technology related to the 3340 Winchester, IBM's newer fixed disk drives all employ head-disk assemblies designed to be removed only by customer engineers, not customers.

The previously announced NP22, a 140 MB double track version of the standard drive by NPL, apparently will not be ready for delivery until 1980. It remains difficult to predict any substantial market for this product, in view of the rapid shrinkage of the market for the standard 3340.

Forecasting assumptions

1. IBM will not extend the 3340 class of products with new introductions, and will cease new production of 3340's in 1979.

2. OEM markets for this drive will remain negligible, due to the lower drive and media costs for alternative disk drives. Attempts to develop the PCM market will achieve limited results due to market entry late in the product life cycle.

TABLE 26

DATA MODULE DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1978		Forecast							
	Shipments		1979		1980		1981		1982	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	98.3	152.0	46.8	72.5	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	98.3	152.0	46.8	72.5	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	4.3	4.3	6.8	6.8	5.9	5.9	4.2	4.2	2.5	2.5
TOTAL U.S. NON-CAPTIVE	4.3	4.3	6.8	6.8	5.9	5.9	4.2	4.2	2.5	2.5
TOTAL U.S. SHIPMENTS	102.6	156.3	53.6	79.3	5.9	5.9	4.2	4.2	2.5	2.5
Non-U.S. Manufacturers										
Captive	--	12.3	--	12.4	--	9.2	--	7.6	--	3.0
PCM	8.5	24.2	7.3	20.7	3.7	12.3	1.2	3.7	--	--
OEM	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	8.5	36.5	7.3	33.1	3.7	21.5	1.2	11.3	--	3.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	111.1	192.8	60.9	112.4	9.6	27.4	5.4	15.5	2.5	5.5
OEM Average Price ($000)	8.6	8.6	8.5	8.5	8.4	8.4	8.4	8.4	8.3	8.3

TABLE 27

DATA MODULE DRIVES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1978		Forecast							
	Shipments		1979		1980		1981		1982	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	6.6	10.2	3.1	4.8	--	--	(1.0)	(1.5)	(3.0)	(4.5)
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	6.6	10.2	3.1	4.8	--	--	(1.0)	(1.5)	(3.0)	(4.5)
PCM	--	--	--	--	--	--	--	--	--	--
OEM	.5	.5	.8	.8	.7	.7	.5	.5	.3	.3
TOTAL U.S. NON-CAPTIVE	.5	.5	.8	.8	.7	.7	.5	.5	.3	.3
TOTAL U.S. SHIPMENTS	7.1	10.7	3.9	5.6	.7	.7	(.5)	(1.0)	(2.7)	(4.2)
Non-U.S. Manufacturers										
Captive	--	.8	--	.8	--	.6	--	.5	--	.2
PCM	.7	2.0	.6	1.7	.3	1.0	.1	.3	--	--
OEM	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	.7	2.8	.6	2.5	.3	1.6	.1	.8	--	.2
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	7.8	13.5	4.5	8.1	1.0	2.3	(.4)	(.2)	(2.7)	(4.0)
Installed at Year End										
IBM	39.1	60.2	42.2	65.0	42.2	65.0	41.2	63.5	38.2	59.0
Non-IBM	2.0	6.9	3.4	10.2	4.4	12.5	5.0	13.8	5.3	14.3
WORLDWIDE TOTAL	41.1	67.1	45.6	75.2	46.6	77.5	46.2	77.3	43.5	73.3

TABLE 28

DATA MODULE DRIVES

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution Channel	1978 U.S. Net Shipments Units (000)	%	FORECAST 1979 %	1980 %	1981 %	1982 %
Mainframe computer manufacturers	.5	41.7	57.1	68.0	83.2	100.0
Mini/micro computer manufacturers	--	--	--	--	--	--
System OEMs/systems houses	--	--	--	--	--	--
Independent peripherals suppliers	--	--	--	--	--	--
Direct to end user	.7	58.3	42.9	32.0	16.8	--
TOTAL	1.2					

*Includes drives manufactured by NPL and resold by others in the PCM market.

FIXED DISK DRIVES, LESS THAN 30 MB

1979 DISK/TREND REPORT

FIXED DISK DRIVES, LESS THAN 30 MB

Coverage

Examples of disk drives in this group include:

14" disk diameter

IBM	System 32-34, 4962, 5448
Alpha Data	Atlas 210
BASF	6150-14
Burroughs	9493-9
Century	Marksman M-10, M-20
Control Data	9414, 9730-12, 230-20
Data General	6102, 6099
Digital Equipment	RK05F
EMM	103
Fujitsu	M 2251
Hewlett-Packard	7910
Hitachi	MFD 90/135, DK 62-20
Hokushin	CD-2800
Kennedy	5301-14
Memorex	601-25
Microdata	Reflex 7501
Mitsubishi	M 2883-10
Nippon Electric Company	N 7721, D 1210
Northern Telecom	4518, Iodisc 5200
Okidata	3301
Pertec	D1451
Philips	X1250
Shugart	SA 4004
Toshiba	MK-100F

8" disk diameter

IBM	4963-29, 8100 System
BASF	6171
International Memories	7710
Kennedy	7000
Memorex	101
Micropolis	1201-I
New World	Mikro-Disk 211
Pertec	D 8000
Priam	Diskos 2050

This group now includes both 14" and 8" fixed disk drives, which have been retained in a single DISK/TREND group, since both perform the same basic function, for the same application areas. The 14" drives include both Winchester technology, mostly 3340 level and drives designed with older 2314 and 3330 technologies. One 14" drive (Alpha Data) uses plated disks. IBM's "Piccolo" 8" drives use a refinement of Winchester technology, operating at 450 TPI, 8530 BPI. All of the 8" drives in this group from independent manufacturers announced to date, however, use variations of 3340 or 3350 Winchester technology.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1978	1979	1980	1981	1982
U.S. manufacturers	259.7	272.9	330.1	378.0	393.6
All manufacturers	291.3	320.2	426.7	562.5	637.9

IBM's "Gulliver" 14" drive, used with System/32, System/34, Series/1 and various terminals has been in large scale production since 1975. The Gulliver, a one-platter variation on 3340 Winchester technology, reached estimated production levels of over 20,000 spindles in both 1978 and 1979. Piccolo production started in 1979, but it is believed that 1979 shipments of the 3-disk 29 MB Piccolo will be relatively small.

To date the majority of U.S. independent shipments in this group are predominantly pre-Winchester technology drives. Captive drives by Burroughs and Northern Telecom (Sycor), and OEM drives by Control Data and Pertec all account for substantial quantities of non-Winchester drives shipped during 1978 and 1979. However, starting in 1979, low-cost 14" OEM drives from Shugart and Century are in production, as is the 8" Winchester drive by

International Memories. New low cost 14" Winchester drives are also being shipped by Hewlett-Packard and Data General. Because of the emergence of both captive and OEM low cost Winchester drives, 1979 U.S. non-IBM shipments are estimated at 31,200 spindles, up 118.2% from 1978. Control Data held 59.5% of the OEM shipments in 1978.

Non-U.S. shipments at this time, both captive and OEM, are predominantly Winchester technology drives, mostly 14". The 1979 non-U.S. total is estimated at 7,300 spindles, with the start-up BASF 8" drive accounting for the only shipments to U.S. destinations.

The driving force behind today's high activity level in this product group is the combination of high reliability and low cost available in newer Winchester technology drives. The early non-IBM Winchester drives of a few years ago promised improved reliability, but their prices were still close to the standard single disk cartridge drives -- so they achieved several system adoptions, but no landslide. Then the 1978 introductions of the Shugart 4000 and Century Marksman 14" drives lowered the price threshold significantly, paving the way for favorable decisions by a growing list of system OEMs. The current rush by drive manufacturers to introduce 8" drives reflects their confidence that the market is ready to react favorably to high reliability fixed drives at low cost. To this key combination add the important additional 8" drive advantages of small physical size, low power consumption and quiet operation.

Almost every system OEM except IBM has been concerned about the cost of providing appropriate backup for small fixed disk drives. Small business systems are the largest application requiring disk storage under 30 MB. These small systems are normally configured without the tape drives used for

backup and archival storage on larger computer systems. This consideration is continually becoming less of a deterrent to adoption of fixed drives, however, as time goes on. With the lower capacity fixed disk drives, usually in the 5-10 MB range, many OEMs have decided to use 1 MB floppies for backup. A few of these OEMs have refined their software to provide for backup only of files which change each day, in an attempt to hold down the number of diskettes to be handled. Many other OEMs have started to use high capacity versions of the 1/4 inch tape cartridge drive for backup of 10-30 MB disks, notably the Data Electronics 6400 BPI, 17 MB drive, which is being followed by a 34 MB version. As these backup alternatives prove practical in the marketplace, the proportion of system OEMs which insist on disk media removability is gradually shrinking.

Marketing trends

IBM's total production of drives in this capacity group is expected to remain stagnant through 1982, with only slight annual increases -- although the product mix will shift toward the Piccolo. At this time it is believed that IBM's larger Piccolo versions will be produced in much greater quantities than the below 30 MB types. This assumption is based on an analysis of the disk drive requirements for IBM's current systems and their probable extensions. If, however, IBM should greatly increase its product emphasis at the low end of the small business system market -- and it shows no signs of doing this -- considerably increased production of small fixed disk drives could be expected.

The big news for 1979 OEM disk drives has been the activity in 8" Winchester drives by a variety of U.S. companies. At least seven firms have

announced drives with capacities under 30 MB, with announcements still to come from Shugart, Control Data and others. Several non-U.S. companies are also expected to offer such drives soon. DISK/TREND projections for worldwide shipments of OEM 8" drives in this group anticipate a sharp growth from 4,100 spindles in 1979 to 63,800 spindles in 1982.

The DISK/TREND 1980 worldwide projection of 20,000 8" drive spindles to OEMs is probably lower than many participants in these programs think they will achieve. However, the time required by most system OEMs to design hardware and software for new systems, plus the time to evaluate disk drives and negotiate deals, is always painfully longer than anyone anticipates, when new disk drive configurations are introduced. In this case, the wide variety of design approaches and specifications offered with this generation of 8" disk drives will not help to shorten the design-in time, either.

Fortunately for the drive manufacturers, a new type of system OEM now exists, to welcome the low end 8" fixed drive: The manufacturers of micro-processor-based small business systems, many of which are frequently confused with the "computer hobby" market. These OEMs are already buying all the drives they can get from IMI, the only manufacturer of 8" OEM drives already in production. Their quick reaction time to new peripherals will be of great assistance to all of the other disk drive manufacturers going into production over the next six to nine months in establishing initial production levels.

It is probably helpful to think in terms of two distinct sub-groups within the major group of 8" drives less than 30 MB. The first sub-group consists of drives designed to be manufactured at the lowest possible cost per drive, usually with relatively low capacity, and mediocre access time.

These drives, typified by the Memorex 101 and the yet-to-be-announced Shugart 8" drive, are in great demand for use with the lowest priced systems available -- the microprocessor-based desktop small business systems. The second sub-group consists of drives designed to provide 10-30 MB capacity, with moderately fast access, at optimum cost for this combination of features. These drives, represented by the Micropolis 1202-I and BASF 6172, should be well received for applications requiring clusters of terminals -- mid-scale small business systems, distributed processing systems and shared logic word processing systems.

Not to be overlooked is the substantial current growth in shipments of OEM 14" drives, especially the low cost Winchester types. Worldwide shipments of OEM 14" drives are expected to reach 27,900 spindles in 1980, an increase of 47.6% over 1979. However, OEM 14" drives are forecasted for only a small increase in 1981, with a decline starting in 1982, as lower cost 8" drives divert shipments. Considering the changing mix of 14" vs 8" drives, combined with the usual experience curve pressure on prices, average OEM price levels for all fixed drives less than 30 MB are expected to drop from $2,200 in 1978 to $1,200 in 1982.

PCM shipments primarily to IBM Series/1 users, are projected at minimal levels, due to the great difficulty anticipated in selling low cost drives at decentralized user sites. PCM vendors will probably emphasize larger drives.

Captive manufacturing programs for low cost fixed drives just got underway in the U.S. this year; these and the several non-U.S. captive programs already started are expected to grow continually through 1982, reaching 52,400 spindles in that year. Although captive 8" drive programs

except for IBM will start later than OEM programs, worldwide captive shipments of 14" and 8" drives should be approximately equal in 1982.

Technical trends

Most of the technical questions which may influence the commercial success of products in this group do not involve sophisticated engineering breakthroughs, but practical considerations such as disk size and manufacturing cost:

Disk size: The IBM Piccolo uses a 210 mm disk, as do some independent drives, but several others use 200 mm disks. The inner diameter of each type also differs -- and one manufacturer (Memorex) is using the inner diameter from one standard and the outer diameter from the other. It is believed that both 200 mm and 210 mm disks will survive, and the unfortunate media manufacturers will have to make both, even at a slight cost penalty. The obvious remaining question is whether other sizes will emerge. The answer to that one is: Not unless a combined drive/media manufacturer decides to develop a drive with a disk smaller than 200 mm -- which is possible, but not probable in the near future.

Product cost: There will be great competition to develop the drive with the lowest possible unit price, for minimum-level systems. Considerable effort has been expended to simplify and cut costs for actuators, disk enclosures and electronics -- but the most important cost breakthrough may come when independent versions of the high density heads on IBM's 3370 (presumably thin film) become available, and are used on small 8" drives. Higher densities mean fewer heads and disks for equivalent capacity, thus cutting the largest cost area in most drives.

Forecasting assumptions

1. IBM's system requirements for fixed drives less than 30 MB will grow only slightly through 1982, due to a greater emphasis on applications requiring larger drives.

2. Other captive production will increase steadily through 1982, with 8" drives equaling 14" shipments in 1982.

3. Production of OEM drives will increase rapidly through 1982, with 8" drives passing up 14" in 1981, as the result of high demands for low cost fixed drives on small business systems, terminal clusters and other applications. Heavy initial demand for 8" drives will come from microprocessor-based small business systems. Non-U.S. manufacturing programs will also grow rapidly, with moderate penetration of U.S. domestic OEM drive markets.

4. PCM drives will grow at a minimal rate, due to high selling costs, effective competition from IBM and competition from independent drives in other configurations.

TABLE 29

FIXED DISK DRIVES, LESS THAN 30 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1978 Shipments		Forecast 1979		1980		1981		1982	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	128.1	177.2	99.9	140.6	105.9	152.1	119.0	172.2	120.7	176.1
Other U.S. Captive	46.4	68.3	65.2	95.6	72.0	110.4	83.1	121.3	89.6	133.3
TOTAL U.S. CAPTIVE	174.5	245.5	165.1	236.2	177.9	262.5	202.1	293.5	210.3	309.4
PCM	--	--	.8	.8	4.7	6.3	5.9	8.1	9.0	12.4
OEM	12.8	14.2	32.4	35.9	52.6	61.3	61.2	76.4	54.6	71.8
TOTAL U.S. NON-CAPTIVE	12.8	14.2	33.2	36.7	57.3	67.6	67.1	84.5	63.6	84.2
TOTAL U.S. SHIPMENTS	187.3	259.7	198.3	272.9	235.2	330.1	269.2	378.0	273.9	393.6
Non-U.S. Manufacturers										
Captive	--	27.6	--	40.5	--	77.4	16.2	154.8	33.8	205.9
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	4.0	.9	6.8	6.0	19.2	10.6	29.7	13.6	38.4
TOTAL NON-U.S. SHIPMENTS	--	31.6	.9	47.3	6.0	96.6	26.8	184.5	47.4	244.3
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	187.3	291.3	199.2	320.2	241.2	426.7	296.0	562.5	321.3	637.9
OEM Average Price ($000)	2.1	2.2	1.8	1.9	1.6	1.7	1.4	1.5	1.2	1.2

TABLE 30

FIXED DISK DRIVES, LESS THAN 30 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1978		Forecast							
	---Shipments---		------1979-----		------1980-----		------1981-----		------1982-----	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	18.0	24.9	15.2	21.4	15.8	22.7	17.0	24.6	17.0	24.8
Other U.S. Captive	5.1	7.5	7.5	11.0	9.0	13.8	12.4	18.1	16.0	23.8
TOTAL U.S. CAPTIVE	23.1	32.4	22.7	32.4	24.8	36.5	29.4	42.7	33.0	48.6
PCM	--	--	.1	.1	.6	.8	.8	1.1	1.3	1.8
OEM	6.1	6.8	18.1	20.1	32.9	38.3	43.7	54.6	49.6	65.3
TOTAL U.S. NON-CAPTIVE	6.1	6.8	18.2	20.2	33.5	39.1	44.5	55.7	50.9	67.1
TOTAL U.S. SHIPMENTS	29.2	39.2	40.9	52.6	58.3	75.6	73.9	98.4	83.9	115.7
Non-U.S. Manufacturers										
Captive	--	2.9	--	4.4	--	8.9	2.1	20.1	4.7	28.6
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	1.6	.4	2.9	3.0	9.6	5.9	16.5	8.5	24.0
TOTAL NON-U.S. SHIPMENTS	--	4.5	.4	7.3	3.0	18.5	8.0	36.6	13.2	52.6
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	29.2	43.7	41.3	59.9	61.3	94.1	81.9	135.0	97.1	168.3
Installed at Year End										
IBM	47.2	65.6	62.4	87.0	78.2	109.7	95.2	134.3	112.2	159.1
Non-IBM	18.4	30.6	44.5	69.1	90.0	140.5	154.9	250.9	235.0	394.4
WORLDWIDE TOTAL	65.6	96.2	106.9	156.1	168.2	250.2	250.1	385.2	347.2	553.5

TABLE 31

FIXED DISK DRIVES, LESS THAN 30 MB

WORLDWIDE SHIPMENTS

14" AND 8" DISK DIAMETERS

	DISK DRIVE SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1978 Shipments		Forecast 1979		1980		1981		1982	
	14"	8"	14"	8"	14"	8"	14"	8"	14"	8"
U.S. Manufacturers										
IBM	24.9	--	20.6	.8	17.3	5.4	12.7	11.9	10.0	14.8
Other U.S. Captive	7.5	--	11.0	--	13.5	.3	14.1	4.0	12.2	11.6
PCM	--	--	.1	--	.8	--	.7	.4	.5	1.3
OEM	6.8	--	16.3	3.8	22.1	16.2	23.0	31.6	17.0	48.3
TOTAL U.S. SHIPMENTS	39.2	--	48.0	4.6	53.7	21.9	50.5	47.9	39.7	76.0
Non-U.S. Manufacturers										
Captive	2.9	--	4.4	--	7.8	1.1	11.7	8.4	14.1	14.5
PCM	--	--	--	--	--	--	--	--	--	--
OEM	1.6	--	2.6	.3	5.8	3.8	7.8	8.7	8.5	15.5
TOTAL NON-U.S. SHIPMENTS	4.5	--	7.0	.3	13.6	4.9	19.5	17.1	22.6	30.0
TOTAL WORLDWIDE SHIPMENTS	43.7	--	55.0	4.9	67.3	26.8	70.0	65.0	62.3	106.0
14"/8" ANNUAL SHARE	100%	--	92%	8%	72%	28%	52%	48%	37%	63%

TABLE 32

FIXED DISK DRIVES, LESS THAN 30 MB

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution Channel	1978 U.S. Net Shipments Units (000)	1978 U.S. Net Shipments %	FORECAST 1979 %	1980 %	1981 %	1982 %
Mainframe computer manufacturers	2.0	32.8	16.4	14.2	13.7	13.1
Mini/micro computer manufacturers	.9	14.8	21.3	20.2	17.6	16.8
System OEMs/systems houses	2.6	42.6	51.5	55.0	56.9	57.8
Independent peripherals suppliers	.6	9.8	10.2	10.1	9.9	9.7
Direct to end user	--	--	.6	1.4	1.9	2.6
TOTAL	6.1					

TABLE 33

FIXED DISK DRIVES, LESS THAN 30 MB

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1978 Net Shipments To United States Destinations Units (000)	To United States Destinations %	Worldwide Units (000)	Worldwide %
Control Data	4.4	72.1	5.0	59.5
Other U.S.	1.7	27.9	1.8	21.4
Other Non-U.S.	--	--	1.6	19.1
	6.1		8.4	

FIXED DISK DRIVES, 30-200 MB

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Coverage

Examples of disk drives in this group include:

14" disk diameter

Ampex	DF-150
BASF	6150-42
Century	Marksman M-40
Control Data	9730-160, 230-30
Fujitsu	F436, M2284
Hitachi	DK 62-80
ISS/Univac	717
Kennedy	5303-70
Memorex	601-75
Microcomputer Systems	MSC-5925
Microdata	Reflex 7503, Reflex II-D
Mitsubishi	M 2883-60
Nippon Electric Company	N 7723, D 1240
Northern Telecom	Iodisc 5800
Okidata	3306
Priam	Diskos 3350
Toshiba	MK-300F
Storage Technology	2720

10.5" disk diameter

CII-Honeywell Bull	D 168

8" disk diameter

IBM	3310, 4963-64, System/34-38, 8100 System
Computer Peripherie Technik	HT 40
Microcomputer Systems	MSC-8000
Micropolis	1203-I

Each drive in this group uses either Piccolo technology (all IBM drives in the group use the same basic Piccolo drive) or variations on 3340 or 3350 Winchester technology. Most of the newer independent drives operate at 3350 densities. The CPT 8" drive is the only one using plated disks.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1978	1979	1980	1981	1982
U.S. manufacturers	9.4	234.8	508.5	779.8	1,021.4
All manufacturers	45.8	340.4	687.0	1,078.4	1,446.7

So far all independent production of drives in this group has consisted of 14" Winchester drives, with worldwide 1978 production at very low levels, for both captive and OEM drives. In 1979, however, U.S. OEM and non-U.S. captive shipments started to climb, and 16,900 non-IBM spindles were shipped worldwide.

In 1979, we are starting to see the kind of growth in mid-size OEM Winchester drives that drive manufacturers hoped for when several announced products in 1976. It's been a painful market development period, however, subject to the inevitable delays in OEM design decisions, plus drive manufacturing start-up problems. At this time, the number of system OEMs actually using such drives is still small.

For a good view of a rapid production start-up, watch what IBM does with the Piccolo this year. The Piccolo is used on five IBM systems, and it is believed that the preponderance of units shipped will be in the 30-200 MB DISK/TREND group. IBM's 1979 shipments are projected at 18,000 spindles, which should generate revenue of $176.4 million.

No independent plug compatible versions of the IBM Piccolo have yet been announced, and none are expected for the next year or more. Only a few OEM 8" drives have been announced to date, and, of these, only the Micropolis drives are expected to be available in the U.S. market in the near future.

Marketing trends

IBM shipments of Piccolo drives in this group are expected to grow steadily through 1982, reaching an awesome worldwide total of 54,800 spindles in that year. IBM has established a huge backlog for several of the new systems using Piccolo drives, and it seems to be destined to be the biggest single drive family of all time, in terms of spindles shipped. Enhanced versions of the current 64 MB drive are assumed in the current projections.

Other U.S. captive shipments, now very small, are expected to benefit from new drive introductions in 1980, and to increase to an impressive 52,500 spindles in 1982. 75% of the 1982 total will be 14" drives, reflecting an emphasis by captive manufacturers on higher capacities and a more conservative approach to product design. Non-U.S. captive shipments are expected to approach half of the worldwide total in 1982.

OEM shipments are expected to benefit from several new drives, some bringing additional capacity and some smaller physical size. Worldwide OEM shipments are projected at 51,900 spindles in 1982, reflecting an average annual increase of 80.3% from 1980 to 1982. Half of the 1982 total should be 8" drives. Average OEM prices are projected to fall from $3,600 in 1979 to $2,600 in 1982, reflecting the growing proportion of 8" shipments, despite increases in average capacity and a movement to add intelligence to some drive models.

PCM shipments, using 14" drives, are forecasted to start in 1980, with relatively modest success projected through 1982. 8" PCM drives are expected in 1981, accounting for most of the 1982 total. The basic reason behind the low expectation for PCM drives in this group is the cool reaction

so far among U.S. drive manufacturers to this market. Today's major PCM vendors are oriented to large IBM user sites, and they doubt their ability to efficiently sell and service the smaller, widely dispersed installations which will use Piccolo drives.

Technical trends

IBM's Piccolo will probably be increased in capacity by two or four times at some point in its future. The most likely initial enhancement is double track density, which would not change the transfer rate. The combination of thin film heads and thin film disks on 8" drives could eventually multiply capacity well above four times. It is possible IBM may feel the requirement to soon introduce double track density for System/38 or 8100 System versions not yet announced. In any event, independent manufacturers can be expected to explore use of thin film heads as soon as they are commerically available.

Backup for drives in this group is gradually becoming less of a concern to OEMs. High capacity 1/4" tape cartridge drives, such as the Data Electronics series, have proven reliable, and further development of this and other tape cartridge formats is expected.

Forecasting assumptions

1. IBM's massive backlog for systems using the Piccolo drive will necessitate extremely large production levels for this drive.
2. Other captive programs, now starting, will grow rapidly in the early 1980's, concentrating on 14" drives.
3. OEM shipments will continue the growth trend established in 1979, with significant 8" production starting in 1981.
4. PCM shipments will not achieve high success levels through 1982.

TABLE 34

FIXED DISK DRIVES, 30-200 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1978		Forecast							
	Shipments		1979		1980		1981		1982	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	128.4	176.4	223.7	322.6	289.5	421.1	340.4	504.2
Other U.S. Captive	3.1	3.1	28.3	31.5	89.9	137.8	168.0	259.0	242.5	372.8
TOTAL U.S. CAPTIVE	3.1	3.1	156.7	207.9	313.6	460.4	457.5	680.1	582.9	877.0
PCM	--	--	--	--	2.6	2.6	19.8	26.9	36.2	50.8
OEM	6.3	6.3	26.1	26.9	40.9	45.5	60.8	72.8	74.9	93.6
TOTAL U.S. NON-CAPTIVE	6.3	6.3	26.1	26.9	43.5	48.1	80.6	99.7	111.1	144.4
TOTAL U.S. SHIPMENTS	9.4	9.4	182.8	234.8	357.1	508.5	538.1	779.8	694.0	1,021.4
Non-U.S. Manufacturers										
Captive	--	33.8	--	99.8	13.4	160.3	23.9	251.2	38.7	351.6
PCM	--	--	--	--	--	--	9.6	16.8	16.6	30.8
OEM	--	2.6	--	5.8	--	18.2	1.5	30.6	3.2	42.9
TOTAL NON-U.S. SHIPMENTS	--	36.4	--	105.6	13.4	178.5	35.0	298.6	58.5	425.3
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	9.4	45.8	182.8	340.4	370.5	687.0	573.1	1,078.4	752.5	1,446.7
OEM Average Price ($000)	3.5	3.4	3.6	3.6	3.3	3.3	2.8	2.9	2.6	2.6

TABLE 35

FIXED DISK DRIVES, 30-200 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1978		Forecast							
	Shipments		1979		1980		1981		1982	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	13.1	18.0	23.3	33.6	30.8	44.8	37.0	54.8
Other U.S. Captive	.2	.2	1.8	2.0	6.2	9.5	12.0	18.5	18.8	28.9
TOTAL U.S. CAPTIVE	.2	.2	14.9	20.0	29.5	43.1	42.8	63.3	55.8	83.7
PCM	--	--	--	--	.3	.3	2.5	3.4	4.7	6.6
OEM	1.8	1.8	7.2	7.4	12.4	13.8	21.7	26.0	28.8	36.0
TOTAL U.S. NON-CAPTIVE	1.8	1.8	7.2	7.4	12.7	14.1	24.2	29.4	33.5	42.6
TOTAL U.S. SHIPMENTS	2.0	2.0	22.1	27.4	42.2	57.2	67.0	92.7	89.3	126.3
Non-U.S. Manufacturers										
Captive	--	1.9	--	5.7	.8	9.6	1.5	15.8	2.6	23.6
PCM	--	--	--	--	--	--	1.2	2.1	2.1	3.9
OEM	--	.8	--	1.8	--	5.7	.5	10.2	1.2	15.9
TOTAL NON-U.S. SHIPMENTS	--	2.7	--	7.5	.8	15.3	3.2	28.1	5.9	43.4
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	2.0	4.7	22.1	34.9	43.0	72.5	70.2	120.8	95.2	169.7
Installed at Year End										
IBM	--	--	13.1	18.0	36.4	51.6	67.2	96.4	104.2	151.2
Non-IBM	2.6	5.8	11.6	22.7	31.3	61.6	70.7	137.6	128.9	252.5
WORLDWIDE TOTAL	2.6	5.8	24.7	40.7	67.7	113.2	137.9	234.0	233.1	403.7

TABLE 36

FIXED DISK DRIVES 30-200 MB

WORLDWIDE SHIPMENTS

14" AND 8" DISK DIAMETERS

	DISK DRIVE SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1978		Forecast							
	Shipments		1979		1980		1981		1982	
	14"	8"	14"	8"	14"	8"	14"	8"	14"	8"
U.S. Manufacturers										
IBM	--	--	--	18.0	--	33.6	--	44.8	--	54.8
Other U.S. Captive	.2	--	2.0	--	9.5	--	18.5	--	22.0	6.9
PCM	--	--	--	--	.3	--	1.2	2.2	1.2	5.4
OEM	1.8	--	7.4	--	13.0	.8	17.0	9.0	19.0	17.0
TOTAL U.S. SHIPMENTS	2.0	--	9.4	18.0	22.8	34.4	36.7	56.0	42.2	84.1
Non-U.S. Manufacturers										
Captive	1.9	--	5.7	--	9.3	.3	14.5	1.3	17.6	6.0
PCM	--	--	--	--	--	--	--	2.1	--	3.9
OEM	.8	--	1.8	--	5.3	.4	6.5	3.7	7.2	8.7
TOTAL NON-U.S. SHIPMENTS	2.7	--	7.5	--	14.6	.7	21.0	7.1	24.8	18.6
TOTAL WORLDWIDE SHIPMENTS	4.7	--	16.9	18.0	37.4	35.1	57.7	63.1	67.0	102.7
14"/8" ANNUAL SHARE	100%	--	48%	52%	52%	48%	48%	52%	39%	61%

TABLE 37

FIXED DISK DRIVES, 30-200 MB

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution Channel	1978 U.S. Net Shipments Units (000)	1978 U.S. Net Shipments %	FORECAST 1979 %	1980 %	1981 %	1982 %
Mainframe computer manufacturers	--	--	--	3.0	4.6	5.2
Mini/micro computer manufacturers	--	--	12.5	13.4	12.3	12.0
System OEMs/systems houses	1.7	94.4	78.8	70.1	55.8	49.7
Independent peripherals suppliers	.1	5.6	8.7	11.1	13.0	14.6
Direct to end user	--	--	--	2.4	14.3	18.5
TOTAL	1.8					

FIXED DISK DRIVES, MORE THAN 200 MB

1979 DISK/TREND REPORT

FIXED DISK DRIVES, MORE THAN 200 MB

Coverage

Examples of disk drives in this category include:

IBM	3350, 3344, 3370
Burroughs	9494-2, 9494-4
Control Data	9790, 9776, 819-21, 33801, 33502
Fujitsu	F493, F496
Hitachi	H-8594, H-8595, H-8597
ISS/Univac	735, 7350, 8470
Memorex	3644, 3650, 3652
Nippon Electric Company	D1510, N7751
Nippon Peripherals, Ltd.	NP24, NP25
Siemens	PS5-7
Storage Technology	8400, 8800, 8350, 8650

IBM's "Madrid," the 3350, provided the model for many of the independent drives in this group. Even the majority of the new PCM double density versions of the 3350 are the same basic 15-surface configuration, except for double track density. Among the other approaches are Storage Technology's older drive, the 8800 Super Disk (4 spindles accessed by a single rotary actuator), Burroughs' only large fixed drives (201 MB on 8 surfaces), Control Data's several 22-surface drives, and Univac's new 8470 (16 surfaces). The most significant new drive, of course, is the IBM 3370, for which IBM has not yet released detailed specifications.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1978	1979	1980	1981	1982
U.S. manufacturers	1,039.1	986.1	1,080.7	1,406.7	1,694.7
All manufacturers	1,099.6	1,134.8	1,332.6	1,701.3	2,097.6

The last twelve months have witnessed two dramatic developments in the big-stakes market for 3350-type drives on IBM systems: (1) A large increase in shipments of PCM 3350 drives and (2) Two 20% decreases in purchase prices by IBM, only six months apart. There is no concensus among industry participants as to the underlying reasons for IBM's price changes. The market demand is strong, and IBM knew as well as the rest of the industry that the independents would immediately drop prices an equivalent amount in order to maintain their sales momentum, even at lower margins.

The real answer may lie in a combination of motives: An IBM desire to position the 3350 appropriately against the new PCM double density drives (assuming no intention to introduce such a drive by IBM), a desire to reduce the leased population of 3350 drives (since the purchase prices were reduced more than the lease prices), and a general philosophy against making the plug compatible disk drive business any more attractive than necessary. Whatever IBM's motives, PCM 3350 shipments are up (higher than last year's DISK/TREND forecast), even though profits are down. DISK/TREND estimates of 1979 PCM worldwide shipments are 21,800 spindles -- slightly above IBM's shipments -- compared with the 1978 PCM total of 11,300.

In 1978, Storage Technology consolidated its early lead in PCM shipments, by securing 49.6% of the worldwide PCM market, based on the company's total of 5,600 spindles. Memorex, which led the pack at the height of the PCM 3330 era, held 21.2% of the 1978 PCM shipments in this product group.

Captive shipments from other manufacturers also started-up on a serious basis in 1979, from both U.S. and non-U.S. manufacturers. The worldwide total for 1979 is estimated at 10,800 spindles, up from early efforts in 1978, at 1,400 spindles.

No significant OEM shipments have yet occurred. It seems that the world's mainframers are the primary market for large fixed disk drives at this time, and with few exceptions, they have internal disk drive sources. The large minicomputers tied to growing databases will eventually constitute another market, but not today.

Marketing trends

The future for the IBM and PCM segments of the large fixed disk drive market will be governed by the character and timing of IBM's product introductions. The first milestone in this sequence is the 3370, due for first shipment in fourth quarter of 1979, for use with the 4331, 4341 and System/38 -- and probably with other systems eventually. The 571 MB 3370, has several advanced features, offers the usual improvement in cost per megabyte, does not attach to older IBM systems, and will take time to copy. After IBM's first shipment, a delay of 18 months or more is expected before PCM shipments start.

The second milestone will be IBM's eventual introduction of the "Whitney" disk file. This drive is generally expected to offer twice the capacity of the 3370, with at least as many advanced features, and further improvements in cost per megabyte. The introduction will probably occur in connection with announcement of the so-called "H" series of computers, to replace the high end of the 370 family, and is popularly forecasted for the first half of 1980. The Whitney is reputed to be designed for outstanding reliability, in addition to offering extremely high recording densities, so the delay after first IBM shipment until PCM shipments start may well exceed the usual 18 months.

The DISK/TREND interpretation of the effect of IBM's product actions is: (1) Only a slight increase in total IBM shipments in 1980, while the 3350 winds down and the 3370 scales up, followed by sharp increases in shipment levels in 1981 and 1982. (2) A decline in PCM 3350 shipments in 1980 and 1981, first independent 3370 shipments in mid 1981, and an increase of total shipment levels in 1982. The results should be continuous revenue growth for IBM, but total revenue isn't forecasted to reach 1978 pre-price cut levels until after 1981. PCM drive manufacturers can expect two so-so years after the 1979 peak, until 3370 revenues produce a new peak in 1982.

Other captive production by the world's mainframers with internal disk drive manufacturing facilities is destined to grow by an average 43.1% during 1980 and 1981, to the 22,000 spindle level in 1981. Almost no growth is forecast for 1982, with the expectation that this group of manufacturers will be transitioning into 3370 technology levels during that period.

OEM shipments are projected at relatively low levels, reaching a worldwide total of 4,500 spindles in 1982. The supermini market and the eventual emergence of plug compatible versions of IBM's new generation of computers will help to create the limited OEM market foreseen by 1982.

Technical trends

The 3350 operates at a recording density per square inch (BPI x TPI) slightly higher than 3 million bits. It is known that the 3370 records at 7.5 million bits per square inch, but IBM won't reveal technical details until the first shipment in fourth quarter of this year. All of the current manufacturers of PCM 3350 drives are expected to push through 3370 programs, and all of them have spent considerable time in deciding which of their

guesses are good enough to justify proceeding with various parts of their programs before IBM's first shipment.

The majority of industry guesses on 3370 specifications are along these lines: Thin film heads, particulate coated disks, about 11,800 BPI, about 635 TPI, probably ten data surfaces and two servo surfaces, and a parallel dual actuator using a common magnetic field. There's nothing close to an industry consensus on the Whitney's specifications -- except that it is undoubtedly bigger, better and an even tougher act to follow.

Despite advance preparations by PCM drive manufacturers, independent head manufacturers and others, it seems unlikely that less than 18 months will elapse before independent 3370's are shipped. Individual manufacturers may be ready in selected areas -- heads, disks, actuators, electronics -- but the total package is too sophisticated to expect early delivery.

Forecasting assumptions

1. IBM first commercial shipment of 3370 in fourth quarter of 1979, as announced. First commercial shipment of Whitney in fourth quarter, 1980. Continuing reduction in production of 3350/3344, with last new production in 1981. No IBM attachment of 3370 or Whitney to old systems. No significant price reductions through 1982.

2. First commercial shipment of PCM 3370's in mid-1981; Whitney, mid-1982. PCM shipments of standard and double density 3350 remain significant through 1981.

3. Steady growth in worldwide captive production, until 1982, when some mainframers start conversion to 3370 technology.

4. OEM shipments remain minor through 1982.

TABLE 38

FIXED DISK DRIVES, MORE THAN 200 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1978		Forecast							
	Shipments		1979		1980		1981		1982	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	471.7	785.2	251.1	432.8	321.3	535.5	465.5	775.9	586.5	933.3
Other U.S. Captive	18.5	21.6	153.5	231.8	184.3	284.6	229.4	353.8	240.2	368.6
TOTAL U.S. CAPTIVE	490.2	806.8	404.6	664.6	505.6	820.1	694.9	1,129.7	826.7	1,301.9
PCM	175.4	232.3	230.5	320.6	172.2	244.9	177.2	253.2	253.1	361.6
OEM	--	--	.9	.9	12.3	15.7	19.4	23.8	25.0	31.2
TOTAL U.S. NON-CAPTIVE	175.4	232.3	231.4	321.5	184.5	260.6	196.6	277.0	278.1	392.8
TOTAL U.S. SHIPMENTS	665.6	1,039.1	636.0	986.1	690.1	1,080.7	891.5	1,406.7	1,104.8	1,694.7
Non-U.S. Manufacturers										
Captive	--	23.7	--	99.8	--	186.7	--	225.8	--	290.4
PCM	4.9	36.8	14.7	47.8	14.0	57.8	11.4	57.0	23.8	95.2
OEM	--	--	1.1	1.1	4.2	7.4	5.9	11.8	8.1	17.3
TOTAL NON-U.S. SHIPMENTS	4.9	60.5	15.8	148.7	18.2	251.9	17.3	294.6	31.9	402.9
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	670.5	1,099.6	651.8	1,134.8	708.3	1,332.6	908.8	1,701.3	1,136.7	2,097.6
OEM Average Price ($000)	--	--	10.0	10.0	11.0	11.0	11.0	11.1	10.7	10.8

TABLE 39

FIXED DISK DRIVES, MORE THAN 200 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1978		Forecast							
	Shipments		1979		1980		1981		1982	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	16.1	26.8	12.3	21.2	13.5	22.5	17.7	29.5	23.0	36.6
Other U.S. Captive	.6	.7	5.1	7.7	6.8	10.5	9.4	14.5	8.8	13.5
TOTAL U.S. CAPTIVE	16.7	27.5	17.4	28.9	20.3	33.0	27.1	44.0	31.8	50.1
PCM	7.4	9.8	13.8	19.2	10.9	15.5	8.4	12.0	11.2	16.0
OEM	--	--	.1	.1	1.1	1.4	1.8	2.2	2.4	3.0
TOTAL U.S. NON-CAPTIVE	7.4	9.8	13.9	19.3	12.0	16.9	10.2	14.2	13.6	19.0
TOTAL U.S. SHIPMENTS	24.1	37.3	31.3	48.2	32.3	49.9	37.3	58.2	45.4	69.1
Non-U.S. Manufacturers										
Captive	--	.7	--	3.1	--	6.1	--	7.5	--	8.8
PCM	.2	1.5	.8	2.6	.8	3.3	.5	2.5	1.0	4.0
OEM	--	--	.1	.1	.4	.7	.5	1.0	.7	1.5
TOTAL NON-U.S. SHIPMENTS	.2	2.2	.9	5.8	1.2	10.1	1.0	11.0	1.7	14.3
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	24.3	39.5	32.2	54.0	33.5	60.0	38.3	69.2	47.1	83.4
Installed at Year End										
IBM	37.4	62.3	49.7	83.5	63.2	106.0	80.9	135.5	103.9	172.1
Non-IBM	9.4	14.5	29.3	47.3	49.3	84.8	69.9	124.5	94.0	171.3
WORLDWIDE TOTAL	46.8	76.8	79.0	130.8	112.5	190.8	150.8	260.0	197.9	343.4

TABLE 40

FIXED DISK DRIVES, MORE THAN 200 MB

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution Channel	1978 U.S. Net Shipments Units (000)	%	FORECAST 1979 %	1980 %	1981 %	1982 %
Mainframe computer manufacturers	--	--	--	3.0	3.2	3.5
Mini/micro computer manufacturers	--	--	.8	5.3	8.5	5.5
System OEMs/systems houses	--	--	--	3.1	7.3	8.6
Independent peripherals suppliers	--	--	--	--	1.5	2.7
Direct to end user*	7.6	100.0	99.2	88.6	79.5	79.7
TOTAL	7.6					

TABLE 41

FIXED DISK DRIVES, MORE THAN 200 MB

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1978 Net Shipments To United States Destinations Units (000)	%	Worldwide Units (000)	%
Storage Technology	4.6	60.6	5.6	49.6
Memorex	1.4	18.4	2.4	21.2
Other U.S.*	1.4	18.4	1.8	15.9
Other Non-U.S.*	.2	2.6	1.5	13.3
	7.6		11.3	

*Includes drives manufactured by ISS and NPL and resold by others in the PCM market.

DISK DRIVE SPECIFICATIONS

1979 DISK/TREND REPORT

DISK DRIVE SPECIFICATIONS

Coverage

This listing includes most disk drives now in new production or announced. Also included are a number of IBM drives no longer in new production, but listed for reference.

Generally, no attempt has been made to include specifications on drive models sold by computer system manufacturers but purchased on an OEM basis from others. Also not listed in most cases are captive drives which are similar to OEM models made by the same manufacturer. In some cases, drives made by one drive manufacturer and resold by another drive manufacturer have been included for identification purposes.

DISK/TREND categories

Most category assignments for individual drives are clear, but a few arbitrary decisions have been made, mostly in connection with Group 3, disk pack drives, 29-58 MB. Some drives with capacities above and below the nominal range have been included, because they are similar in most respects to other drives included in the Group.

Generic type

In most cases IBM drive and media model numbers are used to describe the general physical form of drives and media, since IBM's designations are well known throughout the industry. However, usage of an IBM model number is not meant to imply interchangability. Individual drives may require media with a variety of special characteristics, such as non-standard recording disks, sectors, initialization, etc.

Technology type

The IBM drive model numbers used are intended as a general guide to the type of heads and recording disks employed. This identification is based on a much broader interpretation than the original IBM specifications, since other drives frequently use greater densities.

The term "Gulliver" is used to describe IBM's family of single disk fixed 14" disk drives using essentially 3340 technology, and "Picollo" identifies the 8530 BPI, 450 TPI technology used with IBM's new 210 mm drives.

Capacities

Capacities are listed as "U" for unformatted or "F" for formatted.

Accuracy

All information has been cross-checked for accuracy. However, it is anticipated that some errors may be included, since many manufacturers' published specifications do not cover all of the items listed, and numerous verbal inquiries were necessary. Your corrections will be most welcome and will be included in the next edition.

DISK/TREND disk drive groups

Removable media:
1. Disk cartridge drives, less than 12 MB
2. Disk cartridge drives, more than 12 MB
3. Disk pack drives, 29-58 MB
4. Storage module drives, 25-80 MB
5. Disk pack drives, more than 100 MB
6. Data module drives

Fixed media:
7. Fixed disk drives, less than 30 MB
8. Fixed disk drives, 30 MB - 200 MB
9. Fixed disk drives, more than 200 MB

MANUFACTURER	Alpha Data	Alpha Data	Alpha Data	Alpha Data	Ampex	Ampex	Ampex
DRIVE	Atlas 210	Atlas 215	Atlas 220	Atlas 225	DM-440	DM-441	DM-442
DISK/TREND GROUP	7	7	7	7	1	1	1
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	2315	2315	2315
TECHNOLOGY TYPE, DRIVE	Special Plated Disks	Special Plated Disks	Special Plated Disks	Special Plated Disks	2314	2314	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE		0.256 MB Fixed Heads		0.512 MB Fixed Heads			
Total capacity (MBytes) FIXED	F: 10.5	F: 10.25	F: 21.0	F: 20.5	--	U: 3.125	--
REMOVABLE	--	--	--	--	U: 3.125	U: 3.125	U: 6.25
Capacity per track (Bytes)	U: 18,750	U: 18,750	U: 18,750	U: 18,750	U: 7,812	U: 7,812	U: 7,812
Data surfaces per spindle	2	2	4	4	2	4	2
Heads per data surface	4	4	4	4	1	1	1
Tracks per surface	320	320	320	320	200	200	400
TPI	128	128	128	128	100	100	200
BPI	7000	7000	7000	7000	2200	2200	2200
RPM	1800	1800	1800	1800	1500/2400	1500/2400	1500/2400
Average positioning time (msec)	38	38	38	38	35	35	35
Average rotational delay (msec)	16	16	16	16	20/12.5	20/12.5	20/12.5
Average access time (msec)	54	54	54	54	55/37.5	55/37.5	55/37.5
Data transfer rate (KBytes/sec)	525	525	525	525	195/312.5	195/312.5	195/312.5
FIRST CUSTOMER SHIPMENT	4Q79	4Q79	4Q79	4Q79	1975	1975	1975
COMMENTS	Rotary Actuator	Rotary Actuator	Rotary Actuator	Rotary Actuator	Mfg. by Western Dynex	Mfg. by Western Dynex	Mfg. by Western Dynex

ALPHA DATA

AMPEX

MANUFACTURER	Ampex	Ampex	Ampex	Ampex	Ampex	Ampex	Ampex
DRIVE	DM-443	DM-445	DM-446	DM-447	DM-448	DFR-932	DFR-964
DISK/TREND GROUP	1	1	1	1	1	2	2
MEDIA: Manufacturer's number	--	--	--	--	--	CDC 91204	CDC 91204
Generic type	2315	5440	5440	5440	5440	CMD	CMD
TECHNOLOGY TYPE, DRIVE	2314	2314	2314	2314	2314	SMD	SMD
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 6.25	--	U: 3.125	--	U: 6.25	U: 16.289	U: 48.868
REMOVABLE	U: 6.25	U: 3.125	U: 3.125	U: 6.25	U: 6.25	U: 16.289	U: 16.289
Capacity per track (Bytes)	U: 7,812	U: 7,812	U: 7,812	U: 7,812	U: 7,812	U: 20,160	U: 20,160
Data surfaces per spindle	4	2	4	2	4	1 Fixed 1 Removable	3 Fixed 1 Removable
Heads per data surface	1	1	1	1	1	2 Fixed 1 Removable	2 Fixed 1 Removable
Tracks per surface	400	200	200	400	400	823	823
TPI	200	100	100	200	200	384	384
BPI	2200	2200	2200	2200	2200	6038	6038
RPM	1500/2400	1500/2400	1500/2400	1500/2400	1500/2400	3600	3600
Average positioning time (msec)	35	35	35	35	35	30	30
Average rotational delay (msec)	20/12.5	20/12.5	20/12.5	20/12.5	20/12.5	8.3	8.3
Average access time (msec)	55/37.5	55/37.5	55/37.5	55/37.5	55/37.5	38.3	38.3
Data transfer rate (KBytes/sec)	195/312.5	195/312.5	195/312.5	195/312.5	195/312.5	1209	1209
FIRST CUSTOMER SHIPMENT	1975	1975	1975	1975	1975	4Q79	4Q79
COMMENTS	Mfg. by Western Dynex	Mfg. by Western Dynex	Mfg. by Western Dynex	Mfg. by Western Dynex	Mfg. by Western Dynex	Mfg. by Toshiba	Mfg. by Toshiba

MANUFACTURER	Ampex	Ampex	Ampex	Ampex	Ampex	Ampex	Ampex
DRIVE	DFR-996	DM-323	DM-940	DM-980	DM-9100	DM-9160	DM-9200
DISK/TREND GROUP	2	3	4	4	5	5	5
MEDIA: Manufacturer's number	CDC 91204	--	--	--	--	--	--
Generic type	CMD	2316	SMD	SMD	3336-1	3336-11	3336-11
TECHNOLOGY TYPE, DRIVE	SMD	2314	3330-11	3330-11	3330-1	3330-11	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 81.446	--	--	--	--	--	--
REMOVABLE	U: 16.289	F: 58.4	U: 41.4	U: 82.8	U: 103.17	U: 165.8	U: 206.3
Capacity per track (Bytes)	U: 20,160	F: 7,294	U: 20,160	U: 20,160	U: 13,440	U: 20,160	U: 13,440
Data surfaces per spindle	5 Fixed 1 Removable	20	5	5	19	5	19
Heads per data surface	2 Fixed 1 Removable	1	1	1	1	1	1
Tracks per surface	823	406	411	822	411	1645	815
TPI	384	200	192	384	192	800	370
BPI	6038	2200	6038	6038	4040	6038	4040
RPM	3600	2400	3600	3600	3600	3600	3600
Average positioning time (msec)	30	32	30	30	28	28	28
Average rotational delay (msec)	8.3	12.5	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	44.5	38.3	38.3	36.3	36.3	36.3
Data transfer rate (KBytes/sec)	1209	312.5	1209	1209	806	1209	806
FIRST CUSTOMER SHIPMENT	4Q79	1973	10/75	1/76	11/75	2Q79	11/75
COMMENTS	Mfg. by Toshiba						

MANUFACTURER	Ampex	Ampex	Ampex	Ampex	Ampex	Ampex	Ampex
DRIVE	DM-9300	DM-331	PTD-930X Parallel Transfer Drive	DM-401	DM-402	DM-403	DM-404
DISK/TREND GROUP	5	5	5	7	7	7	7
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	3336-11	3336-11	3336-11	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3330-11	3330-11	3330-11	2314	2314	2314	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	--	U: 3.13	U: 6.25	U: 6.25	U: 12.5
REMOVABLE	U: 309.5	U: 206.3	U: 312.177	--	--	--	--
Capacity per track (Bytes)	U: 20,160	U: 13,440	U: 20,160	U: 7,812	U: 7,812	U: 7,812	U: 7,812
Data surfaces per spindle	19	19	19	2	4	2	4
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	815	815	815	203	203	406	406
TPI	370	370	384	100	100	200	200
BPI	6038	4040	6038	2200	2200	2200	2200
RPM	3600	3600	3600	1500/2400	1500/2400	1500/2400	1500/2400
Average positioning time (msec)	28	28	28	70	70	70	70
Average rotational delay (msec)	8.3	8.3	8.3	20/12.5	20/12.5	20/12.5	20/12.5
Average access time (msec)	36.3	36.3	36.3	90/82.5	90/82.5	90/82.5	90/82.5
Data transfer rate (KBytes/sec)	1209	806	1209	195/312.5	195/312.5	195/312.5	195/312.5
FIRST CUSTOMER SHIPMENT	5/76	11/74	11/78	1979	1979	1979	1979
COMMENTS			4, 6, or 9 track parallel data transfer	Mfg. by Western Dynex	Mfg. by Western Dynex	Mfg. by Western Dynex	Mfg. by Western Dynex

MANUFACTURER	Ampex	Ampex	Ball Computer Products	Ball Computer Products	Ball Computer Products	BASF	BASF
DRIVE	DF 980	DF 150	BD-50	BD-80	BD-100	6240 6242	6243
DISK/TREND GROUP	8	8	4	4	5	6	6
MEDIA: Manufacturer's number	--	--	--	--	--	1370	1370
Generic type	Fixed	Fixed	Trident	Trident	Trident	3348	3348
TECHNOLOGY TYPE, DRIVE	3350	3350	3330-11	3330-11	3330-11	3340	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE	.96 MB Fixed Head Option	.96 MB Fixed Head Option					
Total capacity (MBytes) FIXED	U: 82.9	U: 158.3	--	--	--	--	--
REMOVABLE	--	--	U: 54.7	U: 82.1	U: 103.2	F: 35/70	F: 50.6
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 13,440	U: 20,160	U: 20,160	F: 16,736	F: 16,736
Data surfaces per spindle	5	7	5	5	5	3/6	6
Heads per data surface	2	2	1	1	1	2	2
Tracks per surface	823	1122	815	815	1024	348/696	696
TPI	478	478	370	370	465	300	300
BPI	6370	6370	4040	6060	6060	5636	5636
RPM	3600	3600	3600	3600	3600	2964	2964
Average positioning time (msec)	30	30	30	30	30	20	20
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3	10.1	10.1
Average access time (msec)	38.3	38.3	38.3	38.3	38.3	30.1	30.1
Data transfer rate (KBytes/sec)	1209	1209	806	1209	1209	885	885
FIRST CUSTOMER SHIPMENT	4Q79	4Q79	8/76	4/77	3Q79	1977	1979
COMMENTS	SMD Interface	SMD Interface				PCM 3340 Mfg. by Nippon Peripherals, Ltd.	PCM 3340 Mfg. by Nippon Peripherals, Ltd.

AMPEX BALL BASF

MANUFACTURER	BASF	BASF	BASF	BASF	BASF	BASF	BASF
DRIVE	6171	6172	6150-14	6150-28	6150-42	6244	6250 6252 6253
DISK/TREND GROUP	7	7	7	7	8	9	9
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3350	3350	3340	3340	3340	3350	3350
NOMINAL DISK DIAMETER	210mm	210mm	14"	14"	14"	14"	14"
PERFORMANCE						1.004 MB Fixed Head Option	1.144 MB Fixed Head Option
Total capacity (MBytes) FIXED	U: 8.0	U: 24.0	U: 14.1	U: 28.2	U: 42.3	F: 279.558	F: 317.5
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 13,344	U: 13,344	U: 20,160	U: 20,160	U: 20,160	F: 16,736	F: 19,069
Data surfaces per spindle	1	3	1	2	3	15	15
Heads per data surface	1	1	2	2	2	2	2
Tracks per surface	600	600	700	700	700	1114	1110
TPI	500	500	300	300	300	480	480
BPI	6542	6542	6380	6380	6380	5636	6425
RPM	3600	3600	2976	2976	2976	2964	3600
Average positioning time (msec)	36	36	40	40	40	20	20
Average rotational delay (msec)	8.3	8.3	10.1	10.1	10.1	10.1	8.3
Average access time (msec)	44.3	44.3	50.1	50.1	50.1	30.1	28.3
Data transfer rate (KBytes/sec)	800.6	800.6	1000	1000	1000	885	1198
FIRST CUSTOMER SHIPMENT	8/79	8/79	1979	1979	1979	1978	1978
COMMENTS	Linear Motor Actuator	Linear Motor Actuator				PCM 3344 Mfg. by Nippon Peripherals, Ltd.	PCM 3350 Mfg. by Nippon Peripherals, Ltd.

MANUFACTURER	Burroughs	Burroughs	Burroughs	Burroughs	Burroughs	Burroughs	Burroughs
DRIVE	9480-2 9480-12	9481-2 9481-12	9482-32	9384-6 9384-7 9384-8 9388-2	9383-6 9383-7 9383-8 9386-4	9383-16 9383-17 9383-18 9484-8	9484-2
DISK/TREND GROUP	1	1	1	3	3	5	4
MEDIA: Manufacturer's number	9985-3	9985	9985	9974-4	9974-4	9974-4	
Generic type	2315	2315	2315	2316	2316	2316	Trident
TECHNOLOGY TYPE, DRIVE	2314	3330-1	3330-1	2314	2314	3330-11	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	--	--	--	--	--
REMOVABLE	F: 2.3	F: 4.68	F: 9.3	F: 64.8	F: 87.2	F: 174.4	F: 32.6
Capacity per track (Bytes)	F: 5,760	F: 11,520	F: 11,520	F: 10,800	F: 10,800	F: 10,800	F: 16,200
Data surfaces per spindle	2	2	2	20	20	20	5
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	203	203	404	300	404	808	407
TPI	100	100	200	200	200	400	370
BPI	2200	4400	4400	4400	4400	4400	6039
RPM	1500	1500	1500	2400	2400	2400	3672
Average positioning time (msec)	60	60	35	30	30	30	25
Average rotational delay (msec)	20	20	20	12.5	12.5	12.5	8.3
Average access time (msec)	80	80	55	42.5	42.5	42.5	33.3
Data transfer rate (KBytes/sec)	193	193	387.5	625	625	625	1210
FIRST CUSTOMER SHIPMENT			7/76	1974	1974	1976	1977
COMMENTS						Embedded Servo	

MANUFACTURER	Burroughs	Burroughs	Burroughs	Burroughs	Burroughs	Burroughs	Burroughs
DRIVE	9484-5	9493-9	9493-18	9493-28	9493-37	9494-2	9494-4
DISK/TREND GROUP	4	7	7	7	8	9	9
MEDIA: Manufacturer's number	9974-5	--	--	--	--	--	--
Generic type	Trident	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3330-11	3330-1	3330-1	3330-1	3330-1	3330-11	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE				Drive consists of 2 spindles	Drive consists of 2 spindles		Drive consists of 2 spindles
Total capacity (MBytes) FIXED	--	F: 9.4	F: 18.8	F: 28.2	F: 37.6	F: 201	F: 402
REMOVABLE	F: 65.2	--	--	--	--	--	--
Capacity per track (Bytes)	F: 16,200	F: 11,520	F: 11,520	F: 11,520	F: 11,520		
Data surfaces per spindle	5	2	4	2	4	8	8
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	815	400	400	400	400	1564	1564
TPI	370	200	200	200	200	714	714
BPI	6039	4000	4000	4000	4000	6551	6551
RPM	3672	1500	1500	1500	1500	3672	3672
Average positioning time (msec)	25	35	35	35	35	28	28
Average rotational delay (msec)	8.3	20	20	20	20	8	8
Average access time (msec)	33.3	55	55	55	55	36	36
Data transfer rate (KBytes/sec)	1210	348	348	348	348	1300	1300
FIRST CUSTOMER SHIPMENT	1977	1/77	1/77	1/77	1/77	4Q78	4Q78
COMMENTS						B1800-B7800	B1800-B7800

MANUFACTURER	Century Data Systems	Century Data Systems	Century Data Systems	Century Data Systems	Century Data Systems	Century Data Systems	Century Data Systems
DRIVE	Hunter H-32	Hunter H-64	Hunter H-96	213 215	Trident T-25	Trident T-50	Trident T-80 T-82 882
DISK/TREND GROUP	2	2	2	3	4	4	4
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	5440	5440	5440	2316	Trident	Trident	Trident
TECHNOLOGY TYPE, DRIVE	3330-11	3330-11	3330-11	2314	3330-11	3330-11	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 16.7	U: 50.3	U: 83.9	--	--	--	--
REMOVABLE	U: 16.7	U: 16.7	U: 16.7	F: 58.35	U: 27.3	U: 54.7	U: 82.1
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 20,160	F: 7,294	U: 13,440	U: 13,440	U: 20,160
Data surfaces per spindle	1 Fixed 2 Removable	3 Fixed 2 Removable	5 Fixed 2 Removable	20	5	5	5
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	833 Fixed 412 Removable	833 Fixed 412 Removable	833 Fixed 412 Removable	406	408	815	815
TPI	384 Fixed 192 Removable	384 Fixed 192 Removable	384 Fixed 192 Removable	200	185	370	370
BPI	6060	6060	6060	2200	4040	4040	6060
RPM	3600	3600	3600	2400	3600	3600	3600
Average positioning time (msec)	30	30	30	35	30	30	30
Average rotational delay (msec)	8.3	8.3	8.3	12.5	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	38.3	47.5	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	1209	1209	1209	312.5	806	806	1209
FIRST CUSTOMER SHIPMENT	4Q79	4Q79	4Q79		8/75	5/75	8/75
COMMENTS							

CENTURY

MANUFACTURER	Century Data Systems	Century Data Systems	Century Data Systems	Century Data Systems	Century Data Systems	Century Data Systems	Century Data Systems
DRIVE	Trident T-200 T-202	Trident T-300 T-302 832 833	Trident T-600 T-602	225	Marksman M-10	Marksman M-20	Marksman M-40
DISK/TREND GROUP	5	5	5	5	7	7	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	3336-11	3336-11	3336-11	2316	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3330-11	3330-11	3330-11	2314	3350	3350	3350
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	--	--	U: 10.08	U: 20.16	U: 40.32
REMOVABLE	U: 208.1	U: 312.1	U: 624.2	U: 125	--	--	--
Capacity per track (Bytes)	U: 13,440	U: 20,160	U: 20,160	U: 15,625	U: 24,000	U: 24,000	U: 24,000
Data surfaces per spindle	19	19	19	20	1	2	4
Heads per data surface	1	1	1	1	2	2	2
Tracks per surface	815	815	1646	406	420	420	420
TPI	370	370	740	200	182	182	182
BPI	4040	6060	6060	4400	7545	7545	7545
RPM	3600	3600	3600	2400	2400	2400	2400
Average positioning time (msec)	30	30	30	35	43	43	43
Average rotational delay (msec)	8.3	8.3	8.3	12.5	12.5	12.5	12.5
Average access time (msec)	38.3	38.3	38.3	47.5	55.5	55.5	55.5
Data transfer rate (KBytes/sec)	806	1209	1209	625	960	960	960
FIRST CUSTOMER SHIPMENT	6/76	8/76	4Q79		3Q78	3Q78	1Q78
COMMENTS					Stepping Motor Actuator	Stepping Motor Actuator	Stepping Motor Actuator

MANUFACTURER	CII-Honeywell Bull	CII-Honeywell Bull	CII-Honeywell Bull	CII-Honeywell Bull	CII-Honeywell Bull	Computer Peripherie Technik GmbH.	Control Data
DRIVE	D120	D140	D164	D166	D168	HT 40	9427H
DISK/TREND GROUP	1	2	8	8	8	8	1
MEDIA: Manufacturer's number	M4120	M4120	--	--	--	--	9847 (100 TPI) 9848 (200 TPI)
Generic type	Special Cartridge	Special Cartridge	Fixed	Fixed	Fixed	Fixed	5440
TECHNOLOGY TYPE, DRIVE	3330-11	3330-11	Special	Special	Special	Special - Plated Disks	2314
NOMINAL DISK DIAMETER	10.5"	10.5"	10.5"	10.5"	10.5"	200mm	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	F: 10.0	F: 60.2	F: 90.3	F: 120.4	U: 41.4288	U: 6.25
REMOVABLE	F: 10.0	F: 10.0	--	--	--	--	U: 6.25
Capacity per track (Bytes)	F: 12,800	F: 12,800	F: 19,200	F: 19,200	F: 19,200	U: 20,160	U: 7,812
Data surfaces per spindle	2	4	4	6	8	5	4
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	392	392	784	784	784	411	406
TPI	500	500	600	600	600	295	200
BPI	4750	4750	7300	7300	7300	10,300	2200
RPM	3600	3600	2400	2400	2400	3600	2400/1500
Average positioning time (msec)	75	75	40	40	40	15	35
Average rotational delay (msec)	8.3	8.3	12.5	12.5	12.5	8.3	12.5/20
Average access time (msec)	83.3	83.3	52.5	52.5	52.5	23.3	47.5/55
Data transfer rate (KBytes/sec)	920	920	920	920	920	1209	312.5/195
FIRST CUSTOMER SHIPMENT	7/78	4Q79	1Q80	1Q80	1Q80	1Q80	8/74
COMMENTS	Embedded Servo	Embedded Servo	Embedded Servo Thin Film Heads	Embedded Servo Thin Film Heads	Embedded Servo Thin Film Heads	Plated Disks; Winchester Heads Rotary Actuator; SMD Interface	OEM

MANUFACTURER	Control Data	Control Data	Control Data	Control Data	Control Data	Control Data	Control Data
DRIVE	9448-32	9448-64	9448-96	9746 9747	9760	9762	270-10
DISK/TREND GROUP	2	2	2	3	4	4	4
MEDIA: Manufacturer's number	91204	91204	91204	9873	9876	9877	877
Generic type	CMD	CMD	CMD	2316	SMD	SMD	SMD
TECHNOLOGY TYPE, DRIVE	SMD	SMD	SMD	2314	3330-11	3330-11	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 16.289	U: 48.869	U: 81.446	--	--	--	--
REMOVABLE	U: 16.289	U: 16.289	U: 16.289	U: 62.5	U: 40.7	U: 81.5	F: 63
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 20,160	U: 7,812	U: 20,160	U: 20,160	F: 15,360
Data surfaces per spindle	1 Fixed 1 Removable	3 Fixed 1 Removable	5 Fixed 1 Removable	20	5	5	5
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	823	823	823	406	411	823	823
TPI	384	384	384	200	192	384	384
BPI	6038	6038	6038	2220	6038	6038	6038
RPM	3600	3600	3600	2400	3600	3600	3600
Average positioning time (msec)	30	30	30	35	30	30	30
Average rotational delay (msec)	8.3	8.3	8.3	12.5	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	38.3	47.5	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	1209	1209	1209	312.5	1209	1209	1209
FIRST CUSTOMER SHIPMENT	9/78	9/78	9/78	1974	3/74	3/75	1978
COMMENTS	OEM Separate Servo Surface For Fixed and Removable Disks	OEM Separate Servo Surface For Fixed and Removable Disks	OEM Separate Servo Surface For Fixed and Removable Disks	OEM	OEM	OEM	Series/1 Interface

CONTROL DATA

MANUFACTURER	Control Data	Control Data	Control Data	Control Data	Control Data	Control Data	Control Data
DRIVE	9764	9766	270-30	9754 9756	9780	9784 9786	9770
DISK/TREND GROUP	5	5	5	5	5	5	6
MEDIA: Manufacturer's number	9883-91	9883-91	883-91	9879	9883	9882	9778
Generic type	3336-11	3336-11	3336-11	3336-1	3336-11	3336-11	3348
TECHNOLOGY TYPE, DRIVE	3330-11	3330-11	3330-11	3330-1	3330-11	3330-11	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	--	--	--	--	--
REMOVABLE	U: 154.8	U: 309.5	F: 240	F: 100	F: 200	F: 200	F: 35/70
Capacity per track (Bytes)	U: 20,160	U: 20,160	F: 15,360	F: 13,030	F: 13,030	F: 13,030	F: 16,736
Data surfaces per spindle	19	19	19	19	19	19	3/6
Heads per data surface	1	1	1	1	1	1	2
Tracks per surface	411	823	823	411	822	822	696/2
TPI	192	384	384	192	384	384	300
BPI	6038	6038	6038	4040	4040	4040	5636
RPM	3600	3600	3600	3600	3600	3600	2964
Average positioning time (msec)	30	30	30	30	30	30	25
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3	8.3	10.1
Average access time (msec)	38.3	38.3	38.3	38.3	38.3	38.3	35.1
Data transfer rate (KBytes/sec)	1209	1209	1209	806	806	806	885
FIRST CUSTOMER SHIPMENT	3/76	3/76	1978				1976
COMMENTS	OEM	OEM	Series/1 Interface	OEM Drive; PCM Version 33301	OEM Drive; PCM Version 33302	OEM	OEM

CONTROL DATA

MANUFACTURER	Control Data	Control Data	Control Data	Control Data	Control Data	Control Data	Control Data
DRIVE	9414	9730-12	9730-24	230-10 240-10*	230-20 240-20*	230-23 240-23*	230-26 240-26*
DISK/TREND GROUP	7	7	7	7	7	8	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	2314	3350	3350	3350	3350	3350	3350
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE		.96 MB Fixed Head Option	.96 MB Fixed Head Option	.74 or 1.48 MB F. Head Option	.74 or 1.48 MB F. Head Option	.74 or 1.48 MB F. Head Option	.74 or 1.48 MB F. Head Option
Total capacity (MBytes) FIXED	U: 12.5/6.25	U: 12.9	U: 25.8	F: 9.3	F: 25.3	F: 37.9	F: 50.6
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 7,812	U: 20,160	U: 20,160	F: 15,360	F: 15,360	F: 15,360	F: 15,360
Data surfaces per spindle	4/2	1	2	1	2	3	4
Heads per data surface	1	2	2	2	2	2	2
Tracks per surface	408	640	640	606	823	823	823
TPI	200/100	296	296	296	340	340	340
BPI	2200	6220	6220	6220	6220	6220	6220
RPM	2400/1500	3600	3600	3600	3600	3600	3600
Average positioning time (msec)	65	40	40	30	30	30	30
Average rotational delay (msec)	12.5/20	8.3	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	77.5/85	48.3	48.3	38.3	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	312.5/195	1209	1209	1209	1209	1209	1209
FIRST CUSTOMER SHIPMENT	9/76	5/77	5/77	1Q79	2Q79	2Q79	2Q79
COMMENTS	OEM	OEM	OEM	Series/1 Interface	Series/1 Interface	Series/1 Interface	Series/1 Interface

*240 Series includes a flexible disk drive

CONTROL DATA

MANUFACTURER	Control Data	Control Data	Control Data	Control Data	Control Data	Control Data	Control Data
DRIVE	230-30 240-30*	9730-80	9730-160	33801-A2 33801-B2 33801-C2 (3330 Format)	33801-A2 33801-B2 33801-C2 (3350 Format)	9776-A2 9776-B2 9776-C2	9790
DISK/TREND GROUP	8	8	8	9	9	9	9
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3350	3350	3350	*	*	*	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE	.74 or 1.48 MB F. Head Option	.96 or 1.93 MB F. Head Option	.96 or 1.93 MB F. Head Option	1.24 MB Fixed Head Option	1.72 MB Fixed Head Option	1.24 MB Fixed Head Option	
Total capacity (MBytes) FIXED	F: 63.2	U: 82.9	U: 165.9	F: 400	F: 317.5	F: 400	U: 325.8
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 15,360	U: 20,160	U: 20,160	*	*	*	U: 20,160
Data surfaces per spindle	5	5	5	20	20	20	40
Heads per data surface	2	2	2	2	2	2	1
Tracks per surface	823	823	1646	*	*	*	411
TPI	340	340	680	*	*	*	192
BPI	6220	6220	6220	*	*	6038	6000
RPM	3600	3600	3600	3600	3600	3600	3600
Average positioning time (msec)	30	30	30	25	25	25	50
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	38.3	33.3	33.3	33.3	58.3
Data transfer rate (KBytes/sec)	1209	1209	1209	1198	1198	1198	4840
FIRST CUSTOMER SHIPMENT	2Q79	1Q79	2Q79	1978	1978	1Q79	1975
COMMENTS	Series/1 Interface	OEM	OEM	PCM *Not yet announced	PCM *Not yet announced	OEM *Not yet announced	OEM

CONTROL DATA

MANUFACTURER	Control Data	Control Data	Control Data	Data General	Data General	Data General	Data General
DRIVE	33502	819-11	819-21	6045 6046 6047 6048	6095	6070	6067
DISK/TREND GROUP	9	9	9	1	1	2	4
MEDIA: Manufacturer's number	--	--	--	--	--	1145	1143
Generic type	Fixed	Fixed	Fixed	5440	5440	5440	SMD
TECHNOLOGY TYPE, DRIVE	*	3330-11	3330-11	2314	2314	3330-1	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE	1.72 MB Fixed Head Option						
Total capacity (MBytes) FIXED	F: 635	U: 325.8	U: 651.6	F: 5.014	F: 5.014	F: 10.027	--
REMOVABLE	--	--	--	F: 5.014	F: 5.014	F: 10.027	F: 50.074
Capacity per track (Bytes)	*	U: 20,160	U: 20,160	F: 6,144	F: 6,144	F: 12,288	F: 12,288
Data surfaces per spindle	20	40	40	4	4	4	5
Heads per data surface	2	1	1	1	1	1	1
Tracks per surface	*	411	823	408	408	408	815
TPI	*	192	384	200	200	200	370
BPI	*	6000	6000	2200	2200	4040	4040
RPM	3600	3600	3600	2400	2400	2400	3600
Average positioning time (msec)	25	50	50	38	38	38	35
Average rotational delay (msec)	8.3	8.3	8.3	12.5	12.5	12.5	8.3
Average access time (msec)	33.3	58.3	58.3	50.5	50.5	50.5	43.3
Data transfer rate (KBytes/sec)	1198	4840	4840	312.5	312.5	625	806
FIRST CUSTOMER SHIPMENT	1978	1978	1978	1976			
COMMENTS	PCM *Not yet announced (CDC Model 885)						

CONTROL DATA

DATA GENERAL

MANUFACTURER	Data General	Data General	Data General	Datapoint	Datapoint	Datapoint	Data Recording Equipment, Ltd.
DRIVE	6060	6061	6102 6099	9350	9360	9374	312
DISK/TREND GROUP	5	5	7	1	1	2	1
MEDIA: Manufacturer's number	--	--	--	80362	80362	80428	--
Generic type	3336-1	3336-11	Fixed	2315	2315	5440	2315
TECHNOLOGY TYPE, DRIVE	3330-1	3330-11	3340	2314	2314	3330-1	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	F: 12.582912	--	F: 2.49	F: 10.027	--
REMOVABLE	F: 95.957	F: 190.280	--	F: 2.49	F: 2.49	F: 10.029	U: 3.0
Capacity per track (Bytes)	F: 12,288	F: 12,288	F: 16,384	F: 6,144	F: 6,144	F: 12,288	U: 7,500
Data surfaces per spindle	19	19	2	2	4	4	2
Heads per data surface	1	1	2	1	1	1	1
Tracks per surface	411	815	384	203	203	408	203
TPI	192	370	166	100	100	200	100
BPI	4040	4040	5760	2200	2200	4400	2200
RPM	3600	3600	2964	1500	1500	2400	1500
Average positioning time (msec)	35	35	60	70	70	35	70
Average rotational delay (msec)	8.3	8.3	10.1	20	20	12.5	20
Average access time (msec)	43.3	43.3	70.1	90	90	47.5	90
Data transfer rate (KBytes/sec)	806	806	910.6	195	195	625	195.25
FIRST CUSTOMER SHIPMENT	1976	1976	3Q79	1978	1978	1978	1970
COMMENTS			6102-Micronova System 6099-Nova and Eclipse System Stepping Motor Actuator				

DATA GENERAL DATAPOINT DRE

MANUFACTURER	Data Recording Equipment, Ltd.	Data Recording Equipment, Ltd.	Data Recording Equipment, Ltd.	Data Recording Equipment, Ltd.	Data Recording Equipment, Ltd.	Data Recording Equipment, Ltd.	Data Recording Equipment, Ltd.
DRIVE	3206	3208	3212	4041B	4042B	4043B	4044B
DISK/TREND GROUP	1	1	1	1	1	1	1
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	2315	2315	2315	5440	5440	5440	5440
TECHNOLOGY TYPE, DRIVE	2314	2314	3330-1	2314	2314	2314	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	--	--	--	U: 3.125	U: 6.25
REMOVABLE	U: 6.0	U: 6.0	U: 12.0	U: 3.125	U: 6.25	U: 3.125	U: 6.25
Capacity per track (Bytes)	U: 7,500	U: 7,500	U: 15,000	U: 7,812	U: 7,812	U: 7,812	U: 7,812
Data surfaces per spindle	2	2	2	2	2	4	4
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	406	406	406	204	408	204	408
TPI	200	200	200	100	200	100	200
BPI	2200	2200	4400	2200	2200	2200	2200
RPM	1500	1500	1500	2400	2400	2400	2400
Average positioning time (msec)	70	60	70	38	38	38	38
Average rotational delay (msec)	20	20	20	12.5	12.5	12.5	12.5
Average access time (msec)	90	80	90	50.5	50.5	50.5	50.5
Data transfer rate (KBytes/sec)	195.25	195.25	390.5	312.5	312.5	312.5	312.5
FIRST CUSTOMER SHIPMENT	1976	1976	1978	6/77	6/77	6/77	6/77
COMMENTS							

DRE

MANUFACTURER	Diablo Systems	Diablo Systems	Diablo Systems	Diablo Systems	Diablo Systems	Diablo Systems	Digital Equipment Corporation
DRIVE	31	33	43	44	44B	33F	RK05J
DISK/TREND GROUP	1	1	1	1	1	7	1
MEDIA: Manufacturer's number	--	--	--	--	--	--	RK05K
Generic type	2315	2315	5440	5440	5440	Fixed	2315
TECHNOLOGY TYPE, DRIVE	2314	2314	2314	2314	2314	2314	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	U: 1.5/3.0	U: 3.125	U: 6.25	U: 6.25	U: 3.0/6.0	--
REMOVABLE	U: 1.5/3.0	U: 1.5/3.0	U: 3.125	U: 6.25	U: 6.25	--	F: 2.49
Capacity per track (Bytes)	U: 3,750/7,500	U: 3,750/7,500	U: 7,812	U: 7,812	U: 7,812	U: 3,700/7,500	F: 6,144
Data surfaces per spindle	2	4	4	4	4	4	2
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	203	203	204	408	408	203	203
TPI	100	100	100	200	200	100	100
BPI	1100/2200	1100/2200	2200	2200	2200	1100/2200	2040
RPM	1500	1500	2400	2400	2400	1500	1500
Average positioning time (msec)	70	70	38	38	38	70	50
Average rotational delay (msec)	20	20	12.5	12.5	12.5	20	20
Average access time (msec)	90	90	50.5	50.5	50.5	90	70
Data transfer rate (KBytes/sec)	97.5/195	97.5/195	312.5	312.5	312.5	97.5/195	180
FIRST CUSTOMER SHIPMENT	8/70	8/70	3/72	10/72	3Q76		1975
COMMENTS							Original RK05 FCS 1972

DIABLO

DEC

MANUFACTURER	Digital Equipment Corporation	Digital Equipment Corporation	Digital Equipment Corporation	Digital Equipment Corporation	Digital Equipment Corporation	Digital Equipment Corporation	Electronic Memories & Magnetics Corp.
DRIVE	RL01	RK06	RK07	RM02	RM03	RK05F	203-1
DISK/TREND GROUP	1	2	2	4	4	7	1
MEDIA: Manufacturer's number	RL01K	RK06K	RK07K	--	--	--	--
Generic type	5440	Special Cartridge	Special Cartridge	SMD	SMD	Fixed	2315
TECHNOLOGY TYPE, DRIVE	3330-1	3330-1	3330-11	3330-11	3330-11	2314	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	--	--	--	F: 4.99	--
REMOVABLE	F: 5.24	F: 13.89	F: 27.54	F: 67.42	F: 67.42	--	U: 3.0
Capacity per track (Bytes)	F: 10,240	F: 11,264	F: 11,264	F: 16,384	F: 16,384	F: 6,144	U: 7,500
Data surfaces per spindle	2	3	3	5	5	2	2
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	256	411	815	823	823	406	204
TPI	125	192.3	384.6	384	384	200	100
BPI	3725	4040	4040	6038	6038	2040	2200
RPM	2400	2400	2400	2400	3600	1500	1500
Average positioning time (msec)	55	38	36.5	30	30	56	40
Average rotational delay (msec)	12.5	12.5	12.5	12.5	8.3	20	20
Average access time (msec)	67.5	50.5	49	42.5	38.3	76	60
Data transfer rate (KBytes/sec)	512.5	538	538	806	1209	180	199
FIRST CUSTOMER SHIPMENT	4/78	12/76	4/78	4/78	1977	7/76	1/72
COMMENTS	Embedded Servo			Manufactured by CDC	Manufactured by CDC		2400 RPM Optional

DEC

EMM

MANUFACTURER	Electronic Memories & Magnetics Corp.	Electronic Memories & Magnetics Corp.	Electronic Memories & Magnetics Corp.	Electronic Memories & Magnetics Corp.	Electronic Memories & Magnetics Corp.	Electronic Memories & Magnetics Corp.	Electronic Memories & Magnetics Corp.
DRIVE	203-2	206-1	206-2	303-1	303-2	306-1	306-2
DISK/TREND GROUP	1	1	1	1	1	1	1
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	2315	2315	2315	5440	5440	5440	5440
TECHNOLOGY TYPE, DRIVE	2314	2314	2314	2314	2314	2314	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 3.0	--	U: 6.0	--	U: 3.0	--	U: 6.0
REMOVABLE	U: 3.0	U: 6.0	U: 6.0	U: 3.0	U: 3.0	U: 6.0	U: 6.0
Capacity per track (Bytes)	U: 7,500	U: 7,500	U: 7,500	U: 7,500	U: 7,500	U: 7,500	U: 7,500
Data surfaces per spindle	4	2	4	2	4	2	4
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	204	408	408	204	204	408	408
TPI	100	200	200	100	100	200	200
BPI	2200	2200	2200	2200	2200	2200	2200
RPM	1500	1500	1500	1500	1500	1500	1500
Average positioning time (msec)	40	40	40	40	40	40	40
Average rotational delay (msec)	20	20	20	20	20	20	20
Average access time (msec)	60	60	60	60	60	60	60
Data transfer rate (KBytes/sec)	199	199	199	199	199	199	199
FIRST CUSTOMER SHIPMENT	5/72	1/74	1/74	1/74	1/74	1/74	1/74
COMMENTS	2400 RPM Optional	2400 RPM Optional	2400 RPM Optional	2400 RPM Optional	2400 RPM Optional	2400 RPM Optional	2400 RPM Optional

EMM

MANUFACTURER	Electronic Memories & Magnetics Corp.	Electronic Memories & Magnetics Corp.	Electronic Memories & Magnetics Corp.	Electronic Memories & Magnetics Corp.	Fujitsu, Ltd.	Fujitsu Ltd.	Fujitsu, Ltd.
DRIVE	312-25	312-50	312-76	103	M2201	F451	F452
DISK/TREND GROUP	2	2	2	7	2	2	2
MEDIA: Manufacturer's number	5440	5440	5440	--	M2951	F922P	F922P
Generic type	5440	5440	5440	Fixed	Special Cartridge	Special Cartridge	Special Cartridge
TECHNOLOGY TYPE, DRIVE	3330-11	3030-11	3030-11	2314	3330-11	3330-11	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 12.73	U: 38.19	U: 63.68	U: 3.0	--	--	--
REMOVABLE	U: 12.73	U: 12.73	U: 12.73	--	U: 50	F: 19.86	F: 39.7
Capacity per track (Bytes)	U: 15,625	U: 15,625	U: 15,625	U: 7,500	U: 20,480	F: 16,384	F: 16,384
Data surfaces per spindle	1 Fixed 1 Removable	3 Fixed 1 Removable	5 Fixed 1 Removable	2	3	3	3
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	815	815	815	204	815	404	808
TPI	370	370	370	100	370	370	370
BPI	4680	4680	4680	2200	6135	6135	6135
RPM	2400	2400	2400	1500	2400	2400	2400
Average positioning time (msec)	45	45	45	75	30	30	30
Average rotational delay (msec)	12.5	12.5	12.5	20	12.5	12.5	12.5
Average access time (msec)	57.5	57.5	57.5	95	42.5	42.5	42.5
Data transfer rate (KBytes/sec)	625	625	625	199	819	819	819
FIRST CUSTOMER SHIPMENT	1979	1979	1979	1/73	4Q77	3Q77	3Q77
COMMENTS	Separate servo surfaces for fixed and removable disks	Separate servo surfaces for fixed and removable disks	Separate servo surfaces for fixed and removable disks		OEM		

EMM

FUJITSU

MANUFACTURER	Fujitsu, Ltd.	Fujitsu, Ltd.	Fujitsu, Ltd.	Fujitsu, Ltd.	Fujitsu, Ltd.	Fujitsu, Ltd.	Fujitsu, Ltd.
DRIVE	M2211	F6417	F478	F479	F467	M2251	M2252
DISK/TREND GROUP	2	2	5	5	6	7	8
MEDIA: Manufacturer's number	M2952	F924P	F945P	F949P		--	--
Generic type	Special Cartridge	Special Cartridge	3336-1	3336-11	3348-35/70	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3330-11	3330-11	3330-1	3330-11	3340	3340	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE						.3277 or .6554 F. Head Option	.3277 or .6554 F. Head Option
Total capacity (MBytes) FIXED	--	--	--	--	--	U: 12.7	U: 25.4
REMOVABLE	U: 83.3	F: 67.6	F: 100	F: 200	F: 35/70	--	--
Capacity per track (Bytes)	U: 20,480	F: 16,736	F: 13,030	F: 13,030	F: 16,736	U: 20,480	U: 20,480
Data surfaces per spindle	5	5	19	19	3/6	1	2
Heads per data surface	1	1	1	1	2	2	2
Tracks per surface	815	808	413	815	696/2	630	630
TPI	370	370	192	370	300	300	300
BPI	6135	5636	4040	4040	5636	6230	6230
RPM	2400	2400	3600	3600	2964	2400	2400
Average positioning time (msec)	30	30	25	25	20	40	40
Average rotational delay (msec)	12.5	12.5	8.4	8.4	10.1	12.5	12.5
Average access time (msec)	42.5	42.5	33.4	33.4	30.1	52.5	52.5
Data transfer rate (KBytes/sec)	819	717	806	806	885	819	819
FIRST CUSTOMER SHIPMENT	4Q79	4Q79	4Q73	3Q75	1976	2Q78	2Q78
COMMENTS	OEM					OEM SMD interface	OEM SMD interface

FUJITSU

MANUFACTURER	Fujitsu, Ltd.	Fujitsu, Ltd.	Fujitsu, Ltd.	Fujitsu, Ltd.	Fujitsu, Ltd.	Fujitsu, Ltd.	Fujitsu, Ltd.
DRIVE	M2253	M2282	M2283	M2284	F436	F6411	F493
DISK/TREND GROUP	8	8	8	8	8	8	9
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3340	3350	3350	3350	3350	3350	3350
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE	.3277 or .6554 F. Head Option	.6554 Fixed Head Option	.6554 Fixed Head Option	.6554 Fixed Head Option			
Total capacity (MBytes) FIXED	U: 50.8	U: 66.2	U: 132.5	U: 165.4	F: 100	F: 135	F: 317.5
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 20,480	U: 20,480	U: 20,480	U: 20,480		F: 16,736	F: 19,069
Data surfaces per spindle	4	2	4	5	5	5	15
Heads per data surface	2	2	2	2	2	2	2
Tracks per surface	630	1630	1630	1630	1630	1630	1110
TPI	300	668	668	668	668	668	480
BPI	6230	6580	6580	6580	6580	5694	6362
RPM	2400	2964	2964	2964	2400	2964	3600
Average positioning time (msec)	40	27	27	27	27	27	20
Average rotational delay (msec)	12.5	10.1	10.1	10.1	12.5	10.1	8.4
Average access time (msec)	52.5	37.1	37.1	37.1	39.5	37.1	28.4
Data transfer rate (KBytes/sec)	819	1011	1011	1011	819	885	1198
FIRST CUSTOMER SHIPMENT	2Q78	4Q79	4Q79	4Q79	4Q79	4Q79	4Q79
COMMENTS	OEM SMD interface	OEM SMD interface	OEM SMD interface	OEM SMD interface			

FUJITSU

MANUFACTURER	Fujitsu, Ltd.	Hewlett Packard	Hewlett Packard	Hewlett Packard	Hewlett Packard	Hewlett Packard	Hewlett Packard
DRIVE	F496	7900	7905	7906	7920	7925	7910
DISK/TREND GROUP	9	1	2	2	4	5	7
MEDIA: Manufacturer's number	--	12869A	12940A	12940A	13394A	13356A	--
Generic type	Fixed	2315	2315	2315	Special SMD	Special Pack	Fixed
TECHNOLOGY TYPE, DRIVE	2 x 3350	2314	3330-1	3330-1	3330-11	3330-11	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	F: 635	F: 2.5	U: 6.34	U: 12.68	--	--	F: 12.09
REMOVABLE	--	F: 2.5	U: 12.68	U: 12.68	U: 63.67	F: 120.18	--
Capacity per track (Bytes)	F: 19,069	F: 6,144	U: 15,625	U: 15,625	U: 15,625	F: 16,384	F: 8,192
Data surfaces per spindle	20	4	3	3	5	9	2
Heads per data surface	2	1	1	1	1	1	1
Tracks per surface	1660	200	406	F-812 R-406	815	815	738
TPI	668	100	192	F-384 R-192	384	384	300
BPI	6426	2200	4680	4680	4680	6250	3225
RPM	3600	2400	3600	3600	3600	2700	3000
Average positioning time (msec)	20	30	25	25	25	25	70
Average rotational delay (msec)	8.4	12.5	8.3	8.3	8.33	11.1	10
Average access time (msec)	28.4	42.5	33.3	33.3	33.33	36.1	80
Data transfer rate (KBytes/sec)	1198	312.5	937.5	937.5	937.5	937.5	526
FIRST CUSTOMER SHIPMENT	2Q80			3/78	3/77	6/78	1Q79
COMMENTS				Replaces 7905			

FUJITSU HEWLETT-PACKARD

MANUFACTURER	Hitachi, Ltd.	Hitachi, Ltd.	Hitachi, Ltd.	Hitachi, Ltd.	Hitachi, Ltd.	Hitachi, Ltd.	Hitachi, Ltd.
DRIVE	H-8593	H-8589-1	H-8589-11	H-8586-12 H-8586-22	MFD 90-1	MFD 90-2	MFD 90-F
DISK/TREND GROUP	5	5	5	6	7	7	7
MEDIA: Manufacturer's number	H-8583	H-8581-1	H-8581-11	H-8584-35/70	--	--	--
Generic type	Special Disk Pack	3336-1	3336-11	3348-35/70	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3330-11	3330-1	3330-11	3340	3340	3340	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							0.061 MB Fixed Head Option
Total capacity (MBytes) FIXED	--	--	--	--	F: 1.3	F: 2.6	F: 1.95
REMOVABLE	F: 100	F: 100	F: 200	F: 35/70	--	--	--
Capacity per track (Bytes)	F: 13,030	F: 13,030	F: 13,030	F: 16,736	F: 10,200	F: 10,200	F: 10,200
Data surfaces per spindle	12	19	19	3/6	1	2	2
Heads per data surface	1	1	1	2	2	2	2/1
Tracks per surface	815	411	815	696/2	129	129	129/65
TPI	370	192	370	300	48	48	48
BPI	4040	4040	4040	5636	3706	3706	3706
RPM	3600	3600	3600	2964	3425	3425	3425
Average positioning time (msec)	30	30	25	20	190	190	190
Average rotational delay (msec)	8.3	8.3	8.3	10.1	8.8	8.8	8.8
Average access time (msec)	38.3	38.3	33.3	30.1	198.8	198.8	198.8
Data transfer rate (KBytes/sec)	806	806	806	1976	618	618	618
FIRST CUSTOMER SHIPMENT	1979			1976	1976	1976	1976
COMMENTS	Two 50 MB Disk Packs on Single Spindle				OEM	OEM	OEM

MANUFACTURER	Hitachi, Ltd.	Hitachi, Ltd.	Hitachi, Ltd.	Hitachi, Ltd.	Hitachi, Ltd.	Hitachi, Ltd.	Hitachi, Ltd.
DRIVE	MFD 90-F2	MFD 135-4	MFD 135-8	MDF 135-F	DK 62-10	DK 62-20	DK 62-40
DISK/TREND GROUP	7	7	7	7	7	7	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3340	3340	3340	3340	3340	3340	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE	0.143 MB Fixed Head Option			0.21 MB Fixed Head Option	0.144 MB Fixed Head Option	0.144 MB Fixed Head Option	0.144 MB Fixed Head Option
Total capacity (MBytes) FIXED	F: 1.95	F: 3.7	F: 7.4	F: 6.5	U: 10.8 F: 9.2	U: 21.7 F: 18.5	U: 43.3 F: 36.9
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 10,200	F: 14,500	F: 14,500	F: 14,500	F: 15,360	F: 15,360	F: 15,360
Data surfaces per spindle	2	2	4	4	1	2	4
Heads per data surface	2/1	2	2	2/2/2/1	2	2	2
Tracks per surface	129/65	129/128	129/128	129/128	604	604	604
TPI	48	48	48	48	300	300	300
BPI	3706	5241	5241	5241	5570	5570	5570
RPM	3425	3450	3450	3450	2964	2964	2964
Average positioning time (msec)	190	100	100	100	40	40	37
Average rotational delay (msec)	8.8	8.7	8.7	8.7	10.1	10.1	10.1
Average access time (msec)	198.8	108.7	108.8	108.7	50.1	50.1	47.1
Data transfer rate (KBytes/sec)	618	875	875	875	889	889	889
FIRST CUSTOMER SHIPMENT	1976	1979	1979	1979	1977	1977	1979
COMMENTS	OEM	OEM	OEM	OEM	OEM	OEM	OEM

HITACHI

MANUFACTURER	Hitachi, Ltd.	Hitachi, Ltd.	Hitachi, Ltd.	Hokushin Electric Works, Ltd.	Hokushin Electric Works, Ltd.	Hokushin Electric Works, Ltd.	Hokushin Electric Works, Ltd.
DRIVE	DK 62-80	H-8594-22	H-8595-12 H-8595-22 H-8595-32	CD-3100	CD-3100H	CD-3300	CD-4300
DISK/TREND GROUP	8	9	9	1	1	1	1
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	2315	2315	2315	5440
TECHNOLOGY TYPE, DRIVE	3340	3344	3350	2314	2314	2314	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE	0.144 MB Fixed Head Option	1.004 MB Fixed Head Option	1.144 MB Fixed Head Option				
Total capacity (MBytes) FIXED	U: 86.6 F: 73.9	F:280	F: 317.5	--	--	U: 3.0	U: 3.0
REMOVABLE	--	--	--	U: 1.5	U: 3.0	U: 3.0	U: 3.0
Capacity per track (Bytes)	F: 15,360	F: 16,736	F: 19,069	U: 3,750	U: 7,500	U: 7,500	U: 7,500
Data surfaces per spindle	8	15	15	2	2	4	4
Heads per data surface	2	2	2	1	1	1	1
Tracks per surface	604	1114	1110	203	203	203	204
TPI	300	478	478	100	100	100	100
BPI	5570	5636	6425	1100	2200	2200	2200
RPM	2964	2964	3600	1500	1500	1500	1500/2400
Average positioning time (msec)	37	20	20	70	70	70	38
Average rotational delay (msec)	10.1	10.1	8.4	20	20	20	20/12.5
Average access time (msec)	47.1	30.1	28.4	90	90	90	58/50.5
Data transfer rate (KBytes/sec)	889	885	1198	97.5	195	195	195/312.5
FIRST CUSTOMER SHIPMENT	1979	1979	1979	1972	1972	1972	1974
COMMENTS	OEM						

HITACHI

HOKUSHIN

MANUFACTURER	Hokushin Electric Works, Ltd.	Hokushin Electric Works, Ltd.	Hokushin Electric Works, Ltd.	Hokushin Electric Works, Ltd.	Hokushin Electric Works, Ltd.	Hokushin Electric Works, Ltd.	Hokushin Electric Works, Ltd.
DRIVE	CD-4400	CD-5200S	CD-5400S	CD-5100	CD-5200	CD-5300	CD-5400
DISK/TREND GROUP	1	1	2	2	2	2	2
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	5440	5440	5440	5440	5440	5440	5440
TECHNOLOGY TYPE, DRIVE	2314	2314	2314	3330-11	3330-11	3300-11	3300-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 6.0	U: 6.0	U: 18.0	--	U: 13.26	U: 26.52	U: 39.78
REMOVABLE	U: 6.0	U: 6.0	U: 6.0	U: 13.26	U: 13.26	U: 13.26	U: 13.26
Capacity per track (Bytes)	U: 7,500	U: 7,500	U: 7,500	U: 16,250	U: 16,250	U: 16,250	U: 16,250
Data surfaces per spindle	4	4	4	2	4	6	8
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	408	408	408	408	408	408	408
TPI	200	200	200	200	200	200	200
BPI	2200	2200	2200	4580	4580	4580	4580
RPM	2400	2400	2400	2400	2400	2400	2400
Average positioning time (msec)	38	40	40	40	40	40	40
Average rotational delay (msec)	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Average access time (msec)	50.5	52.5	52.5	52.5	52.5	52.5	52.5
Data transfer rate (KBytes/sec)	312.5	312.5	312.5	650	650	650	650
FIRST CUSTOMER SHIPMENT	1975	1979	1979	1979	1979	1979	1979
COMMENTS							

MANUFACTURER	Hokushin Electric Works, Ltd.	Hokushin Electric Works, Ltd.	Hokushin Electric Works, Ltd.	IBM	IBM	IBM	IBM
DRIVE	CD-2100	CD-2400	CD-2800	1131	2310	5444-1	5444-2/3
DISK/TREND GROUP	7	7	7	1	1	1	1
MEDIA: Manufacturer's number	--	--	--	2315	2315	5440	5440
Generic type	Fixed	Fixed	Fixed	2315	2315	5440	5440
TECHNOLOGY TYPE, DRIVE	2314	2314	3330-11	2310	2310	5444	5444
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 3.0	U: 6.0	U: 12.0	--	--	F: 1.22	F: 2.45
REMOVABLE	--	--	--	F: 1.024	F: 1.024	F: 1.22	F: 2.45
Capacity per track (Bytes)	U: 7,500	U: 7,500	U: 15,000	F: 2,560	F: 2,560	F: 6,144	F: 6,144
Data surfaces per spindle	2	2	2	2	2	4	4
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	203	408	408	200	200	100	200
TPI	100	200	200	100	100	100	100
BPI	2200	2200	4400	1100	1100	2200	2200
RPM	1500	1500	1500	1500	1500	1500	1500
Average positioning time (msec)	70	70	70	520	520	153	269
Average rotational delay (msec)	20	20	20	20	20	20	20
Average access time (msec)	90	90	90	540	540	173	289
Data transfer rate (KBytes/sec)	195	195	390.5	97.5	97.5	199	199
FIRST CUSTOMER SHIPMENT	1976	1976	1977	11/65	11/65	1970	1970
COMMENTS				1130	1130	System/3	System/3

HOKUSHIN

IBM

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	5444-A1	5444-A2	5022-1	5022-2	5447-A1	5447-A2	2311-1
DISK/TREND GROUP	1	1	1	1	1	1	--
MEDIA: Manufacturer's number	5440	5440	5440	5440	5440	5440	1316
Generic type	5440	5440	5440	5440	5440	5440	1316
TECHNOLOGY TYPE, DRIVE	5444	5444	5444	5444	5444	5444	2311
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	F: 1.22	F: 2.45	F: 2.45	F: 2.45	F: 2.45	F: 7.35	--
REMOVABLE	F: 1.22	F: 2.45	F: 2.45	F: 2.45	F: 2.45	F: 2.45	F: 7.25
Capacity per track (Bytes)	F: 6,144	F: 6,144	F: 6,144	F: 6,144	F: 6,144	F: 6,144	F: 3,625
Data surfaces per spindle	4	4	4	4	4	8	10
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	100	200	200	200	200	200	203
TPI	100	100	100	100	100	100	100
BPI	2200	2200	2200	2200	2200	2200	1100
RPM	1500	1500	1500	1500	1500	1500	2400
Average positioning time (msec)	86	126	269	126	126	126	75
Average rotational delay (msec)	20	20	20	20	20	20	12.5
Average access time (msec)	106	146	289	146	146	146	87.5
Data transfer rate (KBytes/sec)	199	199	199	199	199	199	156
FIRST CUSTOMER SHIPMENT	1971	1971	1971	1971	1976	1976	6/65
COMMENTS	System/3	System/3	System/7	System/7	System/3	System/3	System/360

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	2311-11	2311-12	2314-1	2314-A 2314-B 2312 2319	5445	3330-1	3330-11
DISK/TREND GROUP	--	--	3	3	3	5	5
MEDIA: Manufacturer's number	1316	1316	2316	2316	2316	3336-1	3336-11
Generic type	1316	1316	2316	2316	2316	3336-1	3336-11
TECHNOLOGY TYPE, DRIVE	2311	2311	2314	2314	2314	3330-1	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	--	--	--	--	--
REMOVABLE	F: 5.4	F: 2.7	F: 29.176	F: 29.176	F: 20.48	F: 100.018	F: 200.036
Capacity per track (Bytes)	F: 2,700	F: 2,700	F: 7,294	F: 7,294	F: 5,120	F: 13,030	F: 13,030
Data surfaces per spindle	10	10	20	20	20	19	19
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	203	103	203	203	203	411	815
TPI	100	100	100	100	100	192	370
BPI	1100	1100	2200	2200	2200	4040	4040
RPM	2400	2400	2400	2400	2400	3600	3600
Average positioning time (msec)	75	60	75	60	60	30	30
Average rotational delay (msec)	12.5	12.5	12.5	12.5	12.5	8.3	8.3
Average access time (msec)	87.5	72.5	87.5	72.5	72.5	38.3	38.3
Data transfer rate (KBytes/sec)	156	156	312.5	312.5	312.5	806	806
FIRST CUSTOMER SHIPMENT	11/70	11/70	4/65	A-8/69 B,2319-12/70	6/72	8/71	1973
COMMENTS	System/360	System/360	System/360 System/370	System/360 System/370	System/3	System/370 303X Series 4341	System/370 303X Series 4341

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	3340-A2 3340-B1,B2	3340-A2 3340-B1,B2	3340-A2 3340-B1,B2	3340-C2	5022-3	5022-4	5448
DISK/TREND GROUP	6	6	6	6	7	7	7
MEDIA: Manufacturer's number	3348-35	3348-70	3348-70F	3348-70	--	--	--
Generic type	3348-35	3348-70	3348	3348	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3340	3340	3340	3340	2314	2314	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	--	--	F: 2.45	F: 2.45	F: 9.8
REMOVABLE	F: 34.9(S/370)	F: 69.8(S/370)	.502F. Head F: 69.388	F: 50.872	--	--	--
Capacity per track (Bytes)	F: 16,736	F: 16,736	F: 16,736	F: 16,736	F: 6,144	F: 6,144	F: 6,144
Data surfaces per spindle	3	6	6	6	2	2	8
Heads per data surface	2	2	2	2	1	1	1
Tracks per surface	696/2	696/2	696/2	696/2	200	200	200
TPI	300	300	300	300	100	100	100
BPI	5636	5636	5636	5636	2200	2200	2200
RPM	2964	2964	2964	2964	1500	1500	1500
Average positioning time (msec)	25	25	25	25	269	126	126
Average rotational delay (msec)	10.1	10.1	10.1	10.1	20	20	20
Average access time (msec)	35.1	35.1	35.1	35.1	289	146	146
Data transfer rate (KBytes/sec)	885	885	885	885	199	199	199
FIRST CUSTOMER SHIPMENT	11/73	11/73	11/73	11/73	1971	1971	1Q77
COMMENTS	System/370 System/7 303X Series 4341	System/370 System/7 System/3 303X Series 4341	System/370 System/7 System/3 303X Series 4341	System/3-12	System/7	System/7	System/3

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	5320-XX1	5320-XX2	5320-XX3	5320-XX4	4962-1 4962-2	4962-1F 4062-2F	4962-3 4962-4
DISK/TREND GROUP	7	7	7	7	7	7	7
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	Gulliver	Gulliver	Gulliver	Gulliver	Gulliver	Gulliver	Gulliver
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE						0.122 MB Fixed Heads	
Total capacity (MBytes) FIXED	F: 3.210	F: 5.053	F: 9.170	F: 13.778	F: 9.308	F: 9.308	F: 13.962240
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 15,360	F: 15,360	F: 15,360	F: 15,360	F: 15,360	F: 15,360	F: 15,360
Data surfaces per spindle	1	1	1	2	1	1	2
Heads per data surface	2	2	2	2/1	2	2	2/1
Tracks per surface	209	329	597	598/299	606	F: 8 M: 606	606
TPI	300	300	300	300	300	300	300
BPI	5636	5636	5636	5636	5636	5636	5636
RPM	2964	2964	2964	2964	2964	2964	2964
Average positioning time (msec)	50.4	70	72.5	72.5	40	40	40
Average rotational delay (msec)	10.1	10.1	10.1	10.1	10.1	10.1	10.1
Average access time (msec)	60.5	80.1	82.6	82.6	50.1	50.1	50.1
Data transfer rate (KBytes/sec)	889	889	889	889	889	889	889
FIRST CUSTOMER SHIPMENT	4Q76	1/75	1/75	2Q76	4Q76	4Q76	
COMMENTS	System/32	System/32	System/32	System/32	Series/1	Series/1	Series/1

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	4963-29A 4963-29B	4963-23A 4963-23B	4963-64A 4963-64B	4963-58A 4963-58B	5340-XX1	5340-XX2	5340-XX3
DISK/TREND GROUP	7	7	8	8	7	7	7
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	Picollo	Picollo	Picollo	Picollo	Gulliver	Gulliver	Gulliver
NOMINAL DISK DIAMETER	210mm	210mm	210mm	210mm	14"	14"	14"
PERFORMANCE		0.131 MB Fixed Heads		0.131 MB Fixed Heads			(Drive consists of 2 spindles)
Total capacity (MBytes) FIXED	F: 29.327360	F: 23.461888	F: 64.520192	F: 58.654720	F: 8.616960	F: 13.271040	F: 27.156480
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 16,384	F: 16,384	F: 16,384	F: 15,360	F: 15,360	F: 15,360
Data surfaces per spindle	5	5	11	11	2	2	2
Heads per data surface	1	1	1	1	2/1	2/1	2/1
Tracks per surface	359	359	359	359	402/201	604/302	604/302
TPI	450	450	450	450	300	300	300
BPI	8530	8530	8530	8530	5636	5636	5636
RPM	3125	3125	3125	3125	2964	2964	2964
Average positioning time (msec)	27	27	27	27	35	40	40
Average rotational delay (msec)	9.6	9.6	9.6	9.6	10.1	10.1	10.1
Average access time (msec)	36.6	36.6	36.6	36.6	45.1	50.1	50.1
Data transfer rate (KBytes/sec)	1031	1031	1031	1031	889	889	889
FIRST CUSTOMER SHIPMENT	2/79	2/79	2/79	2/79	1/78	1/78	1/78
COMMENTS	Series/1	Series/1	Series/1	Series/1	System/34	System/34	System/34

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	5340-XX4	5340-XX5	5381 - All Models	8130-A21 8140-A31 A41 A51	8130-A22 8140-A32 A42 A52	8130-A23 8140-A33 A43 A53	8130-A24 8140-A34 A44 A54
DISK/TREND GROUP	8	8	8	7	7	8	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	Picollo	Picollo	Picollo	Picollo	Picollo	Picollo	Picollo
NOMINAL DISK DIAMETER	210mm	210mm	210mm	210mm	210mm	210mm	210mm
PERFORMANCE		(Drive consists of 2 spindles)			.131072 MB Fixed Heads		.131072 MB Fixed Heads
Total capacity (MBytes) FIXED	F: 63.905792	F: 128.425984	F: 64.520192	F: 29.327360	F: 23.461888	F: 64.520192	F: 58.654720
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 16,384	F: 16,384	F: 16,384	F: 16,384	F: 16,384	F: 16,384
Data surfaces per spindle	11	11	11	5	5	11	11
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	359	359	359	359	359	359	359
TPI	450	450	450	450	450	450	450
BPI	8530	8530	8530	8530	8530	8530	8530
RPM	3125	3125	3125	3125	3125	3125	3125
Average positioning time (msec)	27	27	27	27	27	27	27
Average rotational delay (msec)	9.6	9.6	9.6	9.6	9.6	9.6	9.6
Average access time (msec)	36.6	36.6	36.6	36.6	36.6	36.6	36.6
Data transfer rate (KBytes/sec)	1031	1031	1031	1031	1031	1031	1031
FIRST CUSTOMER SHIPMENT	1/79	1/79	8/79	3Q79	3Q79	3Q79	3Q79
COMMENTS	System/34	System/34	System/38 5381 Processor available with up to six disk spindles	8100 System	8100 System	8100 System	8100 System

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	8101-A11	8101-A13	3310-A1 3310-A2 3310-B1 3310-B2	3344-B2 3344-B2F	3350-A2 3350-B2 3350-C2	3350-A2F 3350-B2F 3350-C2F	3370-A1 3370-A11 3370-B1 3370-B11
DISK/TREND GROUP	7	8	8	9	9	9	9
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	Picollo	Picollo	Picollo	3350	3350	3350	*
NOMINAL DISK DIAMETER	210mm	210mm	210mm	14"	14"	14"	*
PERFORMANCE				1.004 MB Fixed Head Option		1.144 MB Fixed Heads	
Total capacity (MBytes) FIXED	F: 29.327360	F: 64.520192	F: 64.520192	F: 279.558	F: 317.5	F: 317.5	F: 571.392
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 16,384	F: 16,384	F: 16,736	F: 19,069	F: 19,069	*
Data surfaces per spindle	5	11	11	15	15	15	*
Heads per data surface	1	1	1	2	2	2	*
Tracks per surface	359	359	359	1114	1110	1110	*
TPI	450	450	450	478	478	478	*
BPI	8530	8530	8530	5636	6425	6425	*
RPM	3125	3125	3125	2964	3600	3600	2964
Average positioning time (msec)	27	27	27	25	25	25	20
Average rotational delay (msec)	9.6	9.6	9.6	10.1	8.4	8.4	10.1
Average access time (msec)	36.6	36.6	36.6	35.1	33.4	33.4	30.1
Data transfer rate (KBytes/sec)	1031	1031	1031	885	1198	1198	1859
FIRST CUSTOMER SHIPMENT	3Q79	3Q79	3/79	2Q76	1Q76	1Q76	4Q79
COMMENTS	8100 System	8100 System	4331	System/370 System/3 303X Series 4341	System/370 303X Series 4341	System/370 303X Series 4341	43X1 Series System/38 *Not yet announced

MANUFACTURER	International Memories, Inc.	International Memories, Inc.	Isotimpex	Isotimpex	Isotimpex	ISS/Univac	ISS/Univac
DRIVE	7710	7720	ISOT 1370	EC 5052	EC 5061	Univac 8415	715
DISK/TREND GROUP	7	7	1	--	3	2	3
MEDIA: Manufacturer's number	--	--	EC 5269	EC 5053	EC 5261	F 1215-00	--
Generic type	Fixed	Fixed	5440	1316	2316	5440	2316
TECHNOLOGY TYPE, DRIVE	3340	3340	2314	2311	2314	3330-11	2314
NOMINAL DISK DIAMETER	200mm	200mm	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 11.12	U: 20.5	F: 2.45	--	--	F: 24.8	--
REMOVABLE	--	--	F: 2.45	F: 7.25	F: 29	F: 8.3	F: 58.4
Capacity per track (Bytes)	U: 10,800	U: 10,800	F: 6,144	F: 3,625	F: 7,294	F: 10,240	F: 7,294
Data surfaces per spindle	3	5	4	10	20	F: 3 R: 2	20
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	350	380	203	203	203	F: 815 R: 411	406
TPI	300	300	100	100	100	F: 370 R: 185	200
BPI	5868	6000	2200	1100	2200	4040	2200
RPM	3600	3600	2400	2400	2400	2800	2400
Average positioning time (msec)	50	50	45	70	50	33	29
Average rotational delay (msec)	8.3	8.3	12.5	12.5	12.5	10.7	12.5
Average access time (msec)	58.3	58.3	57.5	82.5	62.5	43.7	41.5
Data transfer rate (KBytes/sec)	648	648	312	156	312	625	312.5
FIRST CUSTOMER SHIPMENT	1/79	1/80	1976	1971	1976	2/77	6/71
COMMENTS							

IMI ISOTIMPEX ISS/UNIVAC

MANUFACTURER	ISS/Univac	ISS/Univac	ISS/Univac	ISS/Univac	ISS/Univac	ISS/Univac	ISS/Univac
DRIVE	Univac 8418-92	Univac 8418-94	7330-1	733-10 7330-10	733-11 7330-11	7330-12	717
DISK/TREND GROUP	4	4	5	5	5	5	8
MEDIA: Manufacturer's number	F 1216-01	F 1216-02	--	--	--	--	--
Generic type	SMD	SMD	3336-1	3336-1	3336-11	3336 (Spec)	Fixed
TECHNOLOGY TYPE, DRIVE	3330-11	3330-11	3330-1	3330-1	3330-11	3330-11	3350
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							1.2 MB Fixed Head Option
Total capacity (MBytes) FIXED	--	--	--	--	--	--	U: 66
REMOVABLE	F: 28.9	F: 57.9	F: 100	F: 100	F: 200	F: 317.5	--
Capacity per track (Bytes)	F: 10,240	F: 10,240	F: 13,030	F: 13,030	F: 13,030	F: 19,069	U: 19,968
Data surfaces per spindle	7	7	19	19	19	19	3
Heads per data surface	1	1	1	1	1	1	2
Tracks per surface	411	815	411	411	815	887	1120
TPI	370	370	192	192	370	402	476
BPI	4040	4040	4040	4040	4040	6965	6366
RPM	2800	2800	3600	3600	3600	3600	3600
Average positioning time (msec)	27	33	27	27	27	30	35
Average rotational delay (msec)	10.7	10.7	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	37.7	43.7	35.3	35.3	35.3	38.3	43.3
Data transfer rate (KBytes/sec)	625	625	806	806	806	1260	1198
FIRST CUSTOMER SHIPMENT	11/75	3/76	9/72	5/75	2/75	1977	
COMMENTS			GSA Version	Equivalent to Univac 8430	Equivalent to Univac 8433	Equivalent to Univac 8434	

MANUFACTURER	ISS/Univac	ISS/Univac	ISS/Univac	ISS/Univac	ISS/Univac	Kennedy Company	Kennedy Company
DRIVE	717	717	735	7350	Univac 8470	7000 Series	7000 Series
DISK/TREND GROUP	8	8	9	9	9	7	7
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3350	3350	3350	3350	3350	3340	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	210mm	210mm
PERFORMANCE	1.2 MB Fixed Head Option	1.2 MB Fixed Head Option	1.26 MB Fixed Head Option		2.0 MB Fixed Head Option		
Total capacity (MBytes) FIXED	U: 110	U: 154	U: 353.8	F: 317.5	F: 683	U: 4.032	U: 12.096
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 19,968	U: 19,968	U: 21,060	F: 19,069	F: 33,880	U: 11,520	U: 11,520
Data surfaces per spindle	5	7	15	15	16	1	3
Heads per data surface	2	2	2	2	2	1	1
Tracks per surface	1120	1120	1120	1110	1260	350	350
TPI	476	476	476	478	538	300	300
BPI	6366	6366	6714	6366	11,134	5280	5280
RPM	3600	3600	3600	3600	3600	3600	3600
Average positioning time (msec)	35	35	23	23	23	50	50
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	43.3	43.3	31.3	31.3	31.3	58.3	58.3
Data transfer rate (KBytes/sec)	1198	1198	1260	1198	2097	688	688
FIRST CUSTOMER SHIPMENT			1978	4Q77	6/80	1Q80	1Q80
COMMENTS			Single spindle drive	Equivalent to Univac 8450	1100/60	Rotary Actuator	Rotary Actuator

ISS/UNIVAC

KENNEDY

MANUFACTURER	Kennedy Company	Kennedy Company	Kennedy Company	Memorex	Memorex	Memorex	Memorex
DRIVE	5301-14	5302-42	5303-70	3670-1/2	3675	677	3640
DISK/TREND GROUP	7	8	8	5	5	5	6
MEDIA: Manufacturer's number	--	--	--	Mark X	Mark XI	Mark XI	Data Mark
Generic type	Fixed	Fixed	Fixed	3336-1	3336-11	3336-11	3348
TECHNOLOGY TYPE, DRIVE	3340	3340	3340	3330-1	3330-11	3330-11	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 14.112	U: 42.336	U: 70.56	--	--	--	--
REMOVABLE	--	--	--	F: 100	F: 200	U: 208.18	F: 35/70
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 20,160	F: 13,030	F: 13,030	U: 13,440	F: 16,736
Data surfaces per spindle	1	3	5	19	19	19	3/6
Heads per data surface	2	2	2	1	1	1	2
Tracks per surface	700	700	700	411	815	815	348/696
TPI	300	300	300	192	384	370	300
BPI	6000	6000	6000	4040	4040	4040	5636
RPM	3000	3000	3000	3600	3600	3600	2964
Average positioning time (msec)	45	45	45	27	27	28.5	20
Average rotational delay (msec)	10	10	10	8.3	8.3	8.3	10.1
Average access time (msec)	55	55	55	35.3	35.3	36.8	30.1
Data transfer rate (KBytes/sec)	1000	1000	1000	806	806	806	885
FIRST CUSTOMER SHIPMENT	1Q78	1Q78	1Q78	10/77	10/74	1976	1977
COMMENTS				PCM 3330-1	PCM 3330-11	OEM	PCM 3340 Mfg. by Nippon Peripherals, Ltd.

KENNEDY

MEMOREX

MANUFACTURER	Memorex	Memorex	Memorex	Memorex	Memorex	Memorex	Memorex
DRIVE	101	601-25	601-50	601-75	3644	3650-A2 3650-B2 3650-C2	3652-A2 3652-B2 3652-C2
DISK/TREND GROUP	7	7	8	8	9	9	9
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3340	3340	3340	3340	3350	3350	2 x 3350
NOMINAL DISK DIAMETER	200mm	14"	14"	14"	14"	14"	14"
PERFORMANCE		0.5/1.0 MB F. Head Option	0.5/1.0 MB F. Head Option	0.5/1.0 MB F. Head Option	1.004 MB Fixed Head Option	1.144 MB Fixed Head Option	1.144 MB Fixed Head Option
Total capacity (MBytes) FIXED	F: 11.7	U: 25.144	U: 50.288	U: 75.432	F: 279.558	F: 317.5	F: 635
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 12,288	U: 17,960	U: 17,960	U: 17,960	F: 16,736	F: 19,069	F: 19.069
Data surfaces per spindle	4	2	4	6	15	15	15
Heads per data surface	1	2	2	2	2	2	2
Tracks per surface	244	700	700	700	1114	1110	2220
TPI	195	300	300	300	480	480	960
BPI	6100	5636	5636	5636	5636	6425	6425
RPM	2964	2964	2964	2964	2964	3600	3600
Average positioning time (msec)	70	32	32	32	25	25	25
Average rotational delay (msec)	10.1	10.1	10.1	10.1	10.1	8.3	8.3
Average access time (msec)	80.1	42.1	42.1	42.1	35.1	33.3	33.3
Data transfer rate (KBytes/sec)	595	885	885	885	885	1198	1198
FIRST CUSTOMER SHIPMENT	1Q80	1977	1977	1977	7/78	4Q77	3Q79
COMMENTS	OEM Stepping Motor Actuator	OEM	OEM	OEM	PCM 3344	PCM 3350	PCM Double Density 3350

MANUFACTURER	Microcomputer Systems Corp.	Microcomputer Systems Corp.	Microcomputer Systems Corp.	Microcomputer Systems Corp.	Microcomputer Systems Corp.	Microcomputer Systems Corp.	Microcomputer Systems Corp.
DRIVE	MSC-5925 MSC-5900	MSC-5925 MSC-5900	MSC-5925 MSC-5900	MSC-5925 MSC-5900	MSC-8000	MSC-8000	MSC-8000
DISK/TREND GROUP	7	8	8	8	8	8	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3340	3340	3340	3340	Picollo	Picollo	Picollo
NOMINAL DISK DIAMETER	14"	14"	14"	14"	200mm	200mm	200mm
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 12.5	U: 37.6	U: 62.7	U: 87.8	U: 40	U: 50	U: 110
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 17,920	U: 17,920	U: 17,920	U: 17,920	U: 16,500	U: 16,500	U: 16,500
Data surfaces per spindle	1	3	5	7	4	5	11
Heads per data surface	2	2	2	2	1	1	1
Tracks per surface	700	700	700	700	607	607	607
TPI	300	300	300	300	510	510	510
BPI	5636	5636	5636	5636	8500	8500	8500
RPM	2964	2964	2964	2964	4500	4500	4500
Average positioning time (msec)	40	40	40	40	25	25	25
Average rotational delay (msec)	10.12	10.12	10.12	10.12	6.7	6.7	6.7
Average access time (msec)	50.12	50.12	50.12	50.12	31.7	31.7	31.7
Data transfer rate (KBytes/sec)	885	885	885	885	1200	1200	1200
FIRST CUSTOMER SHIPMENT	3Q79	3Q79	3Q79	3Q79	1980	1980	1980
COMMENTS	MSC-5900 is subsystem, including ¼" cartridge tape	MSC-5900 is subsystem, including ¼" cartridge tape	MSC-5900 is subsystem, including ¼" cartridge tape	MSC-5900 is subsystem, including ¼" cartridge tape	Rotary Actuator. Subsystem includes unique tape backup.	Rotary Actuator	Rotary Actuator

MANUFACTURER	Microdata	Microdata	Microdata	Microdata	Microdata	Microdata	Microdata
DRIVE	2853 9100 7407	2854 9101 7403	2855 9200 7405	2856 9201 7401	Reflex 7501	Reflex 7502	Reflex 7503
DISK/TREND GROUP	1	1	1	1	7	8	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	5440	5440	5440	5440	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	2314	2314	2314	2314	3340	3340	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE					.54 MB Fixed Head Option	.54 MB Fixed Head Option	.54 MB Fixed Head Option
Total capacity (MBytes) FIXED	--	--	U: 2.5	U: 5.0	U: 12.5	U: 37.6	U: 62.7
REMOVABLE	U: 2.5	U: 5.0	U: 2.5	U: 5.0	--	--	--
Capacity per track (Bytes)	U: 7,812	U: 7,812	U: 7,812	U: 7,812	U: 17,920	U: 17,920	U: 17,920
Data surfaces per spindle	2	2	4	4	1	3	5
Heads per data surface	1	1	1	1	2	2	2
Tracks per surface	204	408	204	408	700	700	700
TPI	100	200	100	200	300	300	300
BPI	2200	2200	2200	2200	5636	5636	5636
RPM	1500	1500	1500	1500	2964	2964	2964
Average positioning time (msec)	35	35	35	35	30	30	30
Average rotational delay (msec)	20	20	20	20	10.1	10.1	10.1
Average access time (msec)	55	55	55	55	40.1	40.1	40.1
Data transfer rate (KBytes/sec)	200	200	200	200	885	885	885
FIRST CUSTOMER SHIPMENT	1974	1975	1974	1975	1977	1977	1975
COMMENTS	2400 RPM Option	2400 RPM Option	2400 RPM Option	2400 RPM Option			

MICRODATA

MANUFACTURER	Microdata	Microdata	Microdata	Microdata	Micropolis	Micropolis	Micropolis
DRIVE	Reflex II-A	Reflex II-B	Reflex II-C	Reflex II-D	1201-I	1202-I	1203-I
DISK/TREND GROUP	7	8	8	8	7	7	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3350	3350	3350	3350	3350	3350	3350
NOMINAL DISK DIAMETER	14"	14"	14"	14"	200mm	200mm	200mm
PERFORMANCE	1.2 MB Fixed Head Option	1.2 MB Fixed Head Option	1.2 MB Fixed Head Option	1.2 MB Fixed Head Option			
Total capacity (MBytes) FIXED	U: 22.4	U: 67.2	U: 112.0	U: 156.8	U: 6.81 MFM U: 8.975 GCR	U: 20.44 MFM U: 26.93 GCR	U: 34.06 MFM U: 44.87 GCR
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 19,968	U: 19,968	U: 19,968	U: 19,968	U: 11,745 MFM U: 15,475 GCR	U: 11,745 MFM U: 15,475 GCR	U: 11,745 MFM U: 15,475 GCR
Data surfaces per spindle	1	3	5	7	1	3	5
Heads per data surface	2	2	2	2	1	1	1
Tracks per surface	1122	1122	1122	1122	580	580	580
TPI	478	478	478	478	478	478	478
BPI	6367	6367	6367	6367	6640 MFM 8750 GCR*	6640 MFM 8750 GCR*	6640 MFM 8750 GCR*
RPM	3530	3530	3530	3530	3600	3600	3600
Average positioning time (msec)	30	30	30	30	42	42	42
Average rotational delay (msec)	8.5	8.5	8.5	8.5	8.3	8.3	8.3
Average access time (msec)	38.5	38.5	38.5	38.5	50.3	50.3	50.3
Data transfer rate (KBytes/sec)	1175	1175	1175	1175	705 MFM 928.75 GCR	705 MFM 928.75 GCR	705 MFM 928.75 GCR
FIRST CUSTOMER SHIPMENT	2Q79	2Q79	2Q79	2Q79	4Q79	4Q79	4Q79
COMMENTS					Rotary Actuator	Rotary Actuator	Rotary Actuator

*8750 GCR is recorded at 5833 FRPI

MICRODATA

MICROPOLIS

MANUFACTURER	Micropolis	Micropolis	Micropolis	Mitsubishi Electric Corporation	Mitsubishi Electric Corporation	Mitsubishi Electric Corporation	Mitsubishi Electric Corporation
DRIVE	1221-1	1222-1	1223-1	M802F M802S	M803F M803S	M2850 M2850F	M2851F
DISK/TREND GROUP	7	7	8	1	2	4	4
MEDIA: Manufacturer's number	--	--	--	370111	802029	50-802282	80-802282
Generic type	Fixed	Fixed	Fixed	5440	5440	Trident	Trident
TECHNOLOGY TYPE, DRIVE	3350	3350	3350	2314	3330-1	3330-11	3330-11
NOMINAL DISK DIAMETER	200mm	200mm	200mm	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	F: 7.13	F: 21.4	F: 35.6	U: 6.375	U: 12.75	--	--
REMOVABLE	--	--	--	U: 6.375	U: 12.75	U: 54.7	U: 82.1
Capacity per track (Bytes)	F: 12,288	F: 12,288	F: 12,288	U: 7,812	U: 15,624	U: 13,440	U: 20,160
Data surfaces per spindle	1	3	5	4	4	5	5
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	580	580	580	408	408	815	815
TPI	478	478	478	200	200	370	370
BPI	8750 GCR*	8750 GCR*	8750 GCR*	2211	4420	4040	6060
RPM	3600	3600	3600	2400	2400	3600	3600
Average positioning time (msec)	42	42	42	45	45	30	30
Average rotational delay (msec)	8.3	8.3	8.3	12.5	12.5	8.3	8.3
Average access time (msec)	50.3	50.3	50.3	57.5	57.5	38.3	38.3
Data transfer rate (KBytes/sec)	928.75	928.75	928.75	312.5	625	806	1209
FIRST CUSTOMER SHIPMENT	4Q79	4Q79	4Q79	1974	1976	1977	1978
COMMENTS	Rotary Actuator	Rotary Actuator	Rotary Actuator				

* 8750 GCR is recorded at 5833 FRPI

MICROPOLIS MITSUBISHI

MANUFACTURER	Mitsubishi Electric Corporation	Mitsubishi Electric Corporation	Mitsubishi Electric Corporation	Mitsubishi Electric Corporation	Mitsubishi Electric Corporation	Mitsubishi Electric Corporation	Mitsubishi Electric Corporation
DRIVE	M2836A	M2837	M2838F	M2883-10	M2883-20	M2883-30	M2883-40
DISK/TREND GROUP	5	5	5	7	7	8	8
MEDIA: Manufacturer's number	J20045	J20134	J20789	--	--	--	--
Generic type	3336-1	3336-11	3336-11	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3330-1	3330-11	3330-11	3340	3340	3340	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE				0.81 MB Fixed Head Option	0.81/2.42 F. Head Option	0.81 Fixed Head Option	0.81/2.42 F. Head Option
Total capacity (MBytes) FIXED	--	--	--	U: 13.47	U: 26.93	U: 40.40	U: 53.86
REMOVABLE	F: 100	F: 200	U: 312.1	--	--	--	--
Capacity per track (Bytes)	F: 13,030	F: 13,030	U: 20,160	U: 20,160	U: 20,160	U: 20,160	U: 20,160
Data surfaces per spindle	19	19	19	1	2	3	4
Heads per data surface	1	1	1	2	2	2	2
Tracks per surface	411	815	815	678	678	678	678
TPI	192	370	370	286	286	286	286
BPI	4040	4040	6060	6060	6060	6060	6060
RPM	3600	3600	3600	2964	2964	2964	2964
Average positioning time (msec)	30	30	30	38	38	38	38
Average rotational delay (msec)	8.3	8.3	8.3	10.1	10.1	10.1	10.1
Average access time (msec)	38.3	38.3	38.3	48.1	48.1	48.1	48.1
Data transfer rate (KBytes/sec)	806	806	1209	996	996	996	996
FIRST CUSTOMER SHIPMENT	1973	1976	1979	4Q78	4Q78	4Q78	4Q78
COMMENTS							

MITSUBISHI

MANUFACTURER	Mitsubishi Electric Corporation	Mitsubishi Electric Corporation	New World Computer Co., Inc.	Nippon Electric Company	Nippon Electric Company	Nippon Electric Company	Nippon Electric Company
DRIVE	M2883-50	M2883-60	MIKRO-DISK 211	N7711	N7715	DKU 300 N7731	DKU 310 N7735
DISK/TREND GROUP	8	8	7	1	1	3	3
MEDIA: Manufacturer's number	--	--	--	N9710	N9715	--	--
Generic type	Fixed	Fixed	Fixed	5440	5440	2316	2316
TECHNOLOGY TYPE, DRIVE	3340	3340	20 Transducer Flying Head	2314	2314	2314	2314
NOMINAL DISK DIAMETER	14"	14"	200mm	14"	14"	14"	14"
PERFORMANCE	0.81 Fixed Head Option	0.81 Fixed Head Option					
Total capacity (MBytes) FIXED	U: 67.33	U: 80.80	U: 2.136160	F: 2.45	F: 4.9	--	--
REMOVABLE	--	--	--	F: 2.45	F: 4.9	F: 29.176	F: 58.352
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 13,351	F: 6,144	F: 6,144	F: 7,294	F: 7,294
Data surfaces per spindle	5	6	1	4	4	20	20
Heads per data surface	2	2	20	1	1	1	1
Tracks per surface	678	678	160	204	407	204	407
TPI	286	286	100	100	200	100	200
BPI	6060	6060	8000	2200	2200	2200	2200
RPM	2964	2964	3400	2400	2400	2400	2400
Average positioning time (msec)	38	38	18.8	30	30	30	30
Average rotational delay (msec)	10.1	10.1	8.8	12.5	12.5	12.5	12.5
Average access time (msec)	48.1	48.1	27.6	42.5	42.5	42.5	42.5
Data transfer rate (KBytes/sec)	996	996	756.5	312.5	312.5	312.5	312.5
FIRST CUSTOMER SHIPMENT	4Q78	4Q78	3Q79	4/74	8/75	12/74	9/75
COMMENTS			Stepping Motor Actuator			OEM	OEM

MITSUBISHI NEW WORLD NIPPON ELECTRIC

MANUFACTURER	Nippon Electric Company	Nippon Electric Company	Nippon Electric Company	Nippon Electric Company	Nippon Electric Company	Nippon Electric Company	Nippon Electric Company
DRIVE	N276 N7741	N277 N7745	D 1210 N7721	D 1220 N7722	D 1240 N7723	N7751	D 1510
DISK/TREND GROUP	5	5	7	8	8	9	9
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	3336-1	3336-11	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3330-1	3330-11	3350	3350	3350	3350	3350
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE			0.48/0.96 MB F. Head Option	0.48/0.96 MB F. Head Option	0.48/0.96 MB F. Head Option	1.144 MB Fixed Head Option	1.19 MB Fixed Head Option
Total capacity (MBytes) FIXED	--	--	U: 20.8	U: 41.5	U: 83.1	F: 317.5	U: 331.5
REMOVABLE	F: 100	F: 200	--	--	--	--	--
Capacity per track (Bytes)	F: 13,030	F: 13,030	U: 19,968	U: 19,968	U: 19,968	F: 19,069	U: 19,968
Data surfaces per spindle	19	19	1	2	4	15	15
Heads per data surface	1	1	2	2	2	2	2
Tracks per surface	411	815	1062	1062	1062	1122	1122
TPI	192	370	480	480	480	480	480
BPI	4040	4040	6370	6370	6370	6400	6400
RPM	3600	3600	3600	3600	3600	3600	3600
Average positioning time (msec)	30	30	40	40	40	20	20
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	48.3	48.3	48.3	28.3	28.3
Data transfer rate (KBytes/sec)	806	806	1198	1198	1198	1198	1198
FIRST CUSTOMER SHIPMENT	7/73	11/75	9/78	9/78	9/78	12/77	5/78
COMMENTS			OEM				OEM

MANUFACTURER	Nippon Peripherals Limited	Nippon Peripherals Limited	Nippon Peripherals Limited	Nippon Peripherals Limited	Northern Telecom Systems	Northern Telecom Systems	Northern Telecom Systems
DRIVE	NP20	NP24	NP25-A2 NP25-B2 NP25-C2	NP22	3002	3004	3402
DISK/TREND GROUP	6	9	9	6	1	1	1
MEDIA: Manufacturer's number	NP-21-35/70 3348	--	--	NP-21-140 3348	--	--	--
Generic type	Data Module	Fixed	Fixed	Data Module	2315	2315	5440
TECHNOLOGY TYPE, DRIVE	3340	3350	3350	2 x 3340	2314	2314	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE		1.004 MB Fixed Head Option	1.144 MB Fixed Head Option				
Total capacity (MBytes) FIXED	--	F: 279.558	F: 317.499	--	U: 3	U: 6	U: 3
REMOVABLE	F: 35/70	--	--	F: 140	U: 3	U: 6	U: 3
Capacity per track (Bytes)	F: 16,736	F: 16,736	F: 19,069	F: 16,736	U: 7,500	U: 7,500	U: 7,500
Data surfaces per spindle	3/6	15	15	6	4	4	4
Heads per data surface	2	2	2	2	1	1	1
Tracks per surface	696/2	1114	1110	1392	203	406	203
TPI	300	480	480	600	100	200	100
BPI	5636	5636	6425	5636	2200	2200	2200
RPM	2964	2964	3600	2964	1500/2400	1500/2400	1500/2400
Average positioning time (msec)	20	20	20	20	38	38	38
Average rotational delay (msec)	10.1	10.1	8.3	10.1	20/12.5	20/12.5	20/12.5
Average access time (msec)	30.1	30.1	28.3	30.1	58/50.5	58/50.5	58/50.5
Data transfer rate (KBytes/sec)	885	885	1198	885	195/312.5	195/312.5	195/312.5
FIRST CUSTOMER SHIPMENT	1976	1977	1977	1980			
COMMENTS	3340 PCM	3344 PCM	3350 PCM	3340 PCM	OEM	OEM	OEM

NIPPON PERIPHERALS

NORTHERN TELECOM

MANUFACTURER	Northern Telecom Systems	Northern Telecom Systems	Northern Telecom Systems	Northern Telecom Systems	Northern Telecom Systems	Northern Telecom Systems	Northern Telecom Systems
DRIVE	3404	3850	3860	10DISC 5200	10DISC 5400	10DISC 5500	10DISC 5600
DISK/TREND GROUP	1	1	1	7	8	8	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	5440	2315/5440	5440	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	2314	2314	2314	3340	3340	3340	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 6	F: 2.5/5	F: 5	U: 26.94	U: 40.39	U: 53.86	U: 67.33
REMOVABLE	U: 6	F: 2.5/5	F: 5	--	--	--	--
Capacity per track (Bytes)	U: 7,500	F: 6,144	F: 6,144	U: 20,160	U: 20,160	U: 20,160	U: 20,160
Data surfaces per spindle	4	4	4	2	3	4	5
Heads per data surface	1	1	1	2	2	2	2
Tracks per surface	406	203/406	406	678	678	678	678
TPI	200	100/200	200	286	286	286	286
BPI	2200	2200	2200	6122	6122	6122	6122
RPM	1500/2400	1500/2400	2400	2964	2964	2964	2964
Average positioning time (msec)	38	38	38	38	38	38	38
Average rotational delay (msec)	20/12.5	20/12.5	12.5	10.12	10.12	10.12	10.12
Average access time (msec)	58/50.5	58/50.5	50.5	48.12	48.12	48.12	48.12
Data transfer rate (KBytes/sec)	195/312.5	195/312.5	312.5	996	996	996	996
FIRST CUSTOMER SHIPMENT		7/77	7/77	5/79	5/79	5/79	5/79
COMMENTS	OEM	PCM DEC PDP-11	PCM DATA GENERAL	OEM	OEM	OEM	OEM

NORTHERN TELECOM

MANUFACTURER	Northern Telecom Systems	Northern Telecom Systems	Northern Telecom Systems	Okidata	Okidata	Okidata	Okidata
DRIVE	10DISC 5800	SYCOR 4518	SYCOR 4520 4521	3301	3302	3303	3304
DISK/TREND GROUP	8	7	7	7	7	8	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3340	2314	2314	3340	3340	3340	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE				0.80 MB Fixed Head Option	2.40 MB Fixed Head Option	0.80 MB Fixed Head Option	2.40 MB Fixed Head Option
Total capacity (MBytes) FIXED	U: 80.80	F: 5.3	F: 10.7	U: 13.47	U: 26.94	U: 40.39	U: 53.86
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 20,160	F: 6,656	F: 13,312	U: 20,160	U: 20,160	U: 20,160	U: 20,160
Data surfaces per spindle	6	2	2	1	2	3	4
Heads per data surface	2	1	1	2	2	2	2
Tracks per surface	678	400	400	678	678	678	678
TPI	286	200	200	286	286	286	286
BPI	6122	2200	4400	6122	6122	6122	6122
RPM	2964	2400	2400	2964	2964	2964	2964
Average positioning time (msec)	38	50	50	38	38	38	38
Average rotational delay (msec)	10.12	12.5	12.5	10.1	10.1	10.1	10.1
Average access time (msec)	48.12	62.5	62.5	48.1	48.1	48.1	48.1
Data transfer rate (KBytes/sec)	996	312.5	625	996	996	996	996
FIRST CUSTOMER SHIPMENT	5/79	1975		7/77	7/77	7/77	7/77
COMMENTS	OEM	445 System	Add-on drives for 445 System				

NORTHERN TELECOM

OKIDATA

MANUFACTURER	Okidata	Okidata	Perkin Elmer	Perkin Elmer	Perkin Elmer	Perkin Elmer	Pertec
DRIVE	3305	3306	SF-2212 ST-2212	SF-2221 ST-2221	SF-2222 ST-2222	ST-2422	D3311/D3312
DISK/TREND GROUP	8	8	1	1	1	2	1
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	2315/5440	2315	2315/5440	5440	5440
TECHNOLOGY TYPE, DRIVE	3340	3340	2314	2314	2314	3330-1	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE	0.80 MB Fixed Head Option	0.80 MB Fixed Head Option					
Total capacity (MBytes) FIXED	U: 67.33	U: 80.80	--	U: 6.25	U: 6.25	U: 12.5	--
REMOVABLE	--	--	U: 6.25	U: 6.25	U: 6.25	U: 12.5	U: 3.17
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 7,812	U: 7,812	U: 7,812	U: 15,625	U: 7,812
Data surfaces per spindle	5	6	2	4	4	4	2
Heads per data surface	2	2	1	1	1	1	1
Tracks per surface	678	678	408	408	408	408	203
TPI	286	286	200	200	200	200	100
BPI	6122	6122	2200	2200	2200	4400	2200
RPM	2964	2964	2400	1500	2400	2400	1500/2400
Average positioning time (msec)	38	38	37.5	37.5	37.5	37.5	35
Average rotational delay (msec)	10.1	10.1	12.5	20	12.5	12.5	20/12.5
Average access time (msec)	48.1	48.1	50.0	57.5	50.0	50.0	55/47.5
Data transfer rate (KBytes/sec)	996	996	312.5	195	312.5	625	195/312.5
FIRST CUSTOMER SHIPMENT	7/77	7/77	1/76	1/76	1/76	1/76	
COMMENTS							

OKIDATA PERKIN ELMER PERTEC

MANUFACTURER	Pertec	Pertec	Pertec	Pertec	Pertec	Pertec	Pertec
DRIVE	D3321/D3322	D3331/D3332	D3341/D3342	D3421/D3422	D3441/D3442	D3461/D3462	D3481/D3482
DISK/TREND GROUP	1	1	1	1	1	2	2
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	5440	2315	2315	5440	2315	5440	2315
TECHNOLOGY TYPE, DRIVE	2314	2314	2314	2314	2314	2314	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 3.17	--	U: 3.17	U: 6.34	U: 6.34	U: 19.03	U: 19.03
REMOVABLE	U: 3.17	U: 3.17	U: 3.17	U: 6.34	U: 6.34	U: 6.34	U: 6.34
Capacity per track (Bytes)	U: 7,812	U: 7,812	U: 7,812	U: 7,812	U: 7,812	U: 7,812	U: 7,812
Data surfaces per spindle	4	2	4	4	4	8	8
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	203	203	203	406	406	406	406
TPI	100	100	100	200	200	200	200
BPI	2200	2200	2200	2200	2200	2200	2200
RPM	1500/2400	1500/2400	1500/2400	1500/2400	1500/2400	1500/2400	1500/2400
Average positioning time (msec)	35	35	35	40	40	40	40
Average rotational delay (msec)	20/12.5	20/12.5	20/12.5	20/12.5	20/12.5	20/12.5	20/12.5
Average access time (msec)	55/47.5	55/47.5	55/47.5	60/52.5	60/52.5	60/52.5	60/52.5
Data transfer rate (KBytes/sec)	195/312.5	195/312.5	195/312.5	195/312.5	195/312.5	195/312.5	195/312.5
FIRST CUSTOMER SHIPMENT						1977	1977
COMMENTS							

MANUFACTURER	Pertec	Pertec	Philips Data Systems, B.V.	Philips Data Systems, B.V.	Philips Data Systems, B.V.	Philips Data Systems, B.V.	Philips Data Systems, B.V.
DRIVE	D1451/D1452	D8000	X1215	X1216	X1217	X1237	X1250
DISK/TREND GROUP	7	7	1	1	2	4	7
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	5440	5440	5440	Special 6-High Pack	Fixed
TECHNOLOGY TYPE, DRIVE	2314	3350	2314	2314	3330-1	3330-1	3340
NOMINAL DISK DIAMETER	14"	210mm	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 6.34	U: 20.33	F: 2.5	F: 5.0	F: 10.0	--	U: 9.62
REMOVABLE	--	--	F: 2.5	F: 5.0	F: 10.0	F: 40.0	--
Capacity per track (Bytes)	U: 7,812	U: 14,400					U: 20,830
Data surfaces per spindle	2	3	4	4	4	8	2
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	406	466	204	407	407	407	231
TPI	200	476	100	200	200	200	100
BPI	2200	6688	2200	2200	4040	4040	6356
RPM	1500/2400	3600	2400	2400	2400	2400	720
Average positioning time (msec)	70	50	35	35	35	35	144
Average rotational delay (msec)	20/12.5	8.3	12.5	12.5	12.5	12.5	41.67
Average access time (msec)	90/82.5	58.3	47.5	47.5	47.5	47.5	185.67
Data transfer rate (KBytes/sec)	195/312.5	870	312.5	312.5	538	538	250
FIRST CUSTOMER SHIPMENT		12/79			1975	1975	1979
COMMENTS	Also available as 12.68 MB: D1461/D1462 (4 surfaces)	Rotary Actuator					Stepping Motor Actuator FD Interface

PERTEC PHILIPS

MANUFACTURER	Philips Data Systems, B.V.	Priam	Priam	Priam	Shugart Associates	Shugart Associates	Siemens
DRIVE	X1220	DISKOS 3350	DISKOS 6650	DISKOS 2050	SA 4004	SA 4008	PS5-1 PS5-2
DISK/TREND GROUP	7	8	8	7	7	7	5
MEDIA: Manufacturer's number	--	--	--	--	--	--	V26374-Q7
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Special
TECHNOLOGY TYPE, DRIVE	3340	3350	3350	3350	3340	3340	3330-1
NOMINAL DISK DIAMETER	14"	14"	14"	200mm	14"	14"	14"
PERFORMANCE					0.144 MB Fixed Head Option	0.144 MB Fixed Head Option	
Total capacity (MBytes) FIXED	F: 20.02	U: 33.25	U: 66.5	U: 20.0	U: 14.5	U: 29.0	--
REMOVABLE	--	--	--	--	--	--	U: 73.3
Capacity per track (Bytes)	F: 14,592	U: 19,968	U: 19,968	U: 13,200	U: 18,000	U: 18,000	U: 20,160
Data surfaces per spindle	2	2	2	3	2	4	9
Heads per data surface	2	2/1	2/1	1	2	2	1
Tracks per surface	700	1110	2220	505	404	404	411
TPI	300	480	960	480	172	172	192
BPI	6540	6370	6370	6370	5534	5534	6060
RPM	3000	3125	3125	4700	2964	2964	2400
Average positioning time (msec)	35	50	50	50	87	87	23
Average rotational delay (msec)	10.0	9.7	9.7	6.4	10.1	10.1	12.5
Average access time (msec)	45.0	59.7	59.7	56.4	97.1	97.1	35.5
Data transfer rate (KBytes/sec)	1305	1030	1030	1030	889	889	806
FIRST CUSTOMER SHIPMENT	1979	6/79	1980	4/80	3Q78	3Q78	9/75
COMMENTS	Embedded Servo; Rotary Actuator; SMD Interface	Linear Motor Actuator	Linear Motor Actuator	Linear Motor Actuator	Stepping Motor Actuator	Stepping Motor Actuator	OEM Equivalent to Siemens 3455

PHILIPS PRIAM SHUGART SIEMENS

MANUFACTURER	Siemens	Siemens	Siemens	Storage Technology Corporation	Storage Technology Corporation	Storage Technology Corporation	Storage Technology Corporation
DRIVE	PS5-3 PS5-4	PS5-5 PS5-6	PS5-7 PS5-8	8100	2707	2710	2720
DISK/TREND GROUP	5	5	9	5	8	8	8
MEDIA: Manufacturer's number	V26374-Q9	--	--	--	--	--	--
Generic type	Special	3336-11	Fixed	3336-1	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3330-11	3330-11	3350	3330-1	3350	3350	3350
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE			1.115 MB Fixed Head Option				
Total capacity (MBytes) FIXED	--	--	517.1	--	F: 39.8	F: 93.4	F: 200.6
REMOVABLE	U: 146.6	U: 309.5	--	F: 100	--	--	--
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 20,160	F: 13,030	F: 18,432	F: 18,432	F: 18,432
Data surfaces per spindle	9	19	19	19	2	4	8
Heads per data surface	1	1	2	1	2/1	2/1	2/1
Tracks per surface	823	823	1350	411	1454	1454	1454
TPI	384	384	590	192	555	555	555
BPI	6060	6060	6060	4040	6706	6706	6706
RPM	2400	2400	2400	3600	2250	2250	2250
Average positioning time (msec)	23	23	20	28	25	25	25
Average rotational delay (msec)	12.5	12.5	12.5	8.3	13.6	13.6	13.6
Average access time (msec)	35.5	35.5	32.5	36.3	38.6	38.6	38.6
Data transfer rate (KBytes/sec)	806	806	806	806	768	768	768
FIRST CUSTOMER SHIPMENT	12/76	1977	10/78	4/75	3Q79	3Q79	3Q79
COMMENTS	OEM Equivalent to Siemens 3465	OEM	OEM Equivalent to Siemens 3470	PCM	OEM	OEM	OEM

SIEMENS

STORAGE TECHNOLOGY

MANUFACTURER	Storage Technology Corporation	Storage Technology Corporation	Storage Technology Corporation	Storage Technology Corporation	Toshiba Corporation	Toshiba Corporation	Toshiba Corporation
DRIVE	8400	8800	8350-A2 8350-B2 8350-C2	8650-A2 8650-B2	MK-200R	DSU-450	MK-100F
DISK/TREND GROUP	9	9	9	9	2	5	7
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	5440	3336-11	Fixed
TECHNOLOGY TYPE, DRIVE	3330	3330	3350	2 x 3350	3330-1	3330-11	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE			1.144 MB Fixed Head Option	1.144 MB Fixed Head Option			U: 12.0
Total capacity (MBytes) FIXED	F: 400	F: 800	F: 317.5	F: 635	F: 10	--	F: 10.2
REMOVABLE	--	--	--	--	F: 10	F: 200	--
Capacity per track (Bytes)	F: 13,030	F: 13,030	F: 19,069	F: 19,069	F: 13,030	F: 13,030	F: 16,384
Data surfaces per spindle	114 Per Drive	114 Per Drive	15	15	4	19	1
Heads per data surface	1	1	2	2	1	1	2
Tracks per surface	552	552	1110	2220	417	815	630
TPI	238	238	480	957	188	370	318
BPI	4040	4040	6425	6425	4040	4040	5940
RPM	3600	3600	3600	3600	3600	3600	2800
Average positioning time (msec)	30	30	25	25	30	30	40
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3	8.3	10.8
Average access time (msec)	38.3	38.3	33.3	33.3	38.3	38.3	50.8
Data transfer rate (KBytes/sec)	806	806	1198	1198	806	806	896
FIRST CUSTOMER SHIPMENT	2/75	2/75	4/77	5/79	1977	1975	1977
COMMENTS	PCM	PCM	PCM	PCM Double Density 3350			

STORAGE TECHNOLOGY

TOSHIBA

MANUFACTURER	Toshiba Corporation	Vermont Research	Western Dynex	Western Dynex	Western Dynex	Western Dynex	
DRIVE	MK-300F	5017	DD-6121	DD-6221	DD-6122	DD-6222	
DISK/TREND GROUP	8	2	1	1	1	1	
MEDIA: Manufacturer's number	--	VRC5517	--	--	--	--	
Generic type	Fixed	5440	2315/5440	2315/5440	2315/5440	2315/5440	
TECHNOLOGY TYPE, DRIVE	3340	3330-11	2314	2314	2314	2314	
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	
PERFORMANCE	.262 MB Fixed Head Option						
Total capacity (MBytes) FIXED	U: 36.0 F: 30.6	F: 26.2		U: 3.13		U: 6.25	
REMOVABLE	--	F: 26.2	U: 3.13	U: 3.13	U: 6.25	U: 6.25	
Capacity per track (Bytes)	F: 16,384	F: 12,800	U: 7,812	U: 7,812	U: 7,812	U: 7,812	
Data surfaces per spindle	3	4	2	4	2	4	
Heads per data surface	2	1	1	1	1	1	
Tracks per surface	630	1032	203	203	406	406	
TPI	318	500	100	100	200	200	
BPI	5940	4000	2200	2200	2200	2200	
RPM	2800	3165	1500/2400	1500/2400	1500/2400	1500/2400	
Average positioning time (msec)	40	35	35	35	35	35	
Average rotational delay (msec)	10.8	9.5	20/12.5	20/12.5	20/12.5	20/12.5	
Average access time (msec)	50.8	44.5	55/47.5	55/47.5	55/47.5	55/47.5	
Data transfer rate (KBytes/sec)	896	763.8	195/312.5	195/312.5	195/312.5	195/312.5	
FIRST CUSTOMER SHIPMENT	1977	1975	1972	1972	1973	1973	
COMMENTS		Embedded Servo					

TOSHIBA VERMONT RES. WESTERN DYNEX

1979 DISK/TREND REPORT

MANUFACTURER PROFILES

Every known manufacturer of moving head disk drives is listed in this section, with a brief description of the firm's role in the industry. The heading "disk sales" refers to the DISK/TREND estimate of moving head rigid disk drives sales only -- no sales of other drive types are included, nor are sales of parts or other disk drive related products such as controllers. "Total net sales" are for each parent company's 1978 fiscal year. Northern Telecom is listed with the U.S. firms for convenience.

U.S. Manufacturers

ALPHA DATA, INC.
20750 Marilla Street
Chatsworth, CA 91311 213/882-6500

1978 disk sales: None

Alpha Data is a privately held ten year old manufacturer of head-per-track disk drives for minicomputer applications. The firm has also pioneered in development of a CCD memory designed to substitute for head-per-track disks. Its latest product is a 20 MB moving head fixed disk drive with plated heads -- the only announced drive with 14" plated disks in the industry at this time.

AMPEX CORPORATION
Memory Products Division
1020 Kifer Road
Sunnyvale, CA 94086 408/738-4910

1978 disk sales: $21,700,000
1979 total net sales: $322,050,000 Net income: $19,742,000

Ampex has had an uncertain history in computer peripherals, never fully exploiting the company's early edge in development of magnetic recording technology. Today, however, the disk drive operation is definitely in a growth mode, with the largest boost to current sales increases coming from

the storage module product line. Ampex has followed a strategy of second sourcing the successful Control Data SMD line, and has benefited from the SMD's wide acceptance on minicomputers and small business systems. The firm is adding other disk drives to its line and doesn't hesitate to resell drives from other disk drive manufacturers to avoid the delay required for internal development.

BALL COMPUTER PRODUCTS, INC.
Subsidiary of Ball Corporation
860 East Arques Avenue
Sunnyvale, CA 94086 408/733-6700

1978 disk sales: $1,100,000
1978 total net sales: $514,908,000 Net income: $18,648,000

Ball's manufacturing program for Trident-type drives was initiated in 1976, when the firm acquired rights to a drive developed by EMM. After an initial plunge into the systems house market yielded little results, a new management in the Ball computer products operation changed emphasis to the OEM market, just in time to benefit from the general boom in SMDs. The firm has added a controller, plus a 100 MB version of the basic 5-surface drive, and appears committed to expansion of its disk drive product line.

BURROUGHS CORPORATION
Burroughs Place
Detroit, MI 48232 313/972-7000

1978 disk sales: $304,500,000
1978 total net sales: $2,460,002,000 Net income: $253,364,000

Burroughs is a major captive manufacturer of disk drives. Currently, the firm's largest moving head disk drive programs involve disk cartridge drives, large disk pack drives and a Trident drive manufactured under a Calcomp license. No Winchester technology drives have yet been announced, but fixed disk drives using older recording technologies are in production. Current disk drive manufacturing operations are located at Westlake Village, California; Winnipeg, Canada; Glenrothes, Scotland; and Guadalajara, Mexico.

CENTURY DATA SYSTEMS, INC.
Subsidiary of Xerox Corporation
1270 North Kraemer Blvd.
Anaheim, CA 92806 714/632-0400

1978 disk sales: $29,100,000
1978 total net sales: $5,901,900,000 Net income: $476,900,000

In January of this year Calcomp struck a deal with Xerox for the sale of the Memory Products Division, and Century once again assumed its original

name, this time as a Xerox subsidiary. Under Calcomp the disk operation had placed strict emphasis on development of disk drives for the OEM market, after a company decision to withdraw from IBM compatible configurations. Dropping out of the PCM market dampened growth in disk drives severely, but by 1978 the product line was represented by drives in all the hot OEM growth areas: Calcomp's Trident equivalent to the SMD, the Marksman small fixed disk drives, and the Hunter high capacity disk cartridge drive. Xerox arrived just in time to provide funds needed to put the Hunter into production, and to make possible announcement of enhanced capacity versions of the other products. Century is now part of the new Xerox Memory Systems group and appears to be headed for a larger role in the industry, as the Xerox organizational entity responsible for high performance disk drives.

CONTROL DATA CORPORATION
8100 34th Avenue South
Minneapolis, MN 55440 612/853-8100

1978 disk sales: $467,500,000
1978 total net sales: $1,867,826,000 Net income: $89,464,000

Control Data remains the only manufacturer which makes disk drives in all nine DISK/TREND rigid disk drive product groups, and is easily the second largest revenue producer in the disk drive industry, after IBM. Control Data provides the management for Magnetic Peripherals, Inc., a joint venture with ownership shared by CDC and Honeywell. Disk drives shipped by MPI to either Control Data or Honeywell are considered CDC captive drives for the purposes of DISK/TREND statistics. Control Data is trying to develop a growing role in PCM disk drives, but there is no question of its No. 1 position in OEM disk drives. There are a few weak spots in the product line, but the firm has leadership positions in disk cartridge drives, SMD, CMD and disk pack drives -- any one of which would make most competitors very happy. Obviously, Control Data is at work on future OEM disk drives, and the company is expected to easily retain its overall dominance of OEM disk drives for the foreseeable future.

DASTEK CORPORATION
141 Albright Way
Los Gatos, CA 95030 408/866-0550

1978 disk sales: None

Dastek was started in 1978, with founders from IBM. The firm is oriented to technology associated with high performance disk drives, and is known to be developing a thin film head production capability. No products have actually been announced, and it is not yet completely clear whether Dastek will be selling disk drives, head-disk assemblies (HDA's) or thin film heads -- or all three. In any event, the company has moved into a new plant in Los Gatos, California, and is hiring some engineering talent with good track records.

DATA GENERAL CORPORATION
15 Turnpike Road
Westboro, MA 01581 617/366-8911

1978 disk sales: $69,200,000
1978 total net sales: $379,948,000 Net income: $40,281,000

Data General launched an ambitious internal disk drive program a few years ago and has added a steady stream of new products. With established manufacturing operations for 10 MB disk cartridge drives, 20 MB disk cartridge drives, SMDs and disk pack drives, the firm this year added a new 12 MB, 14" fixed Winchester drive. It seems reasonable to expect Data General to add any disk configuration to its line which becomes widely used with minicomputers.

DATAPOINT CORPORATION
Peripheral Products Division
686 Maude Avenue
Sunnyvale, CA 94086 408/732-7330

1978 disk sales: $14,200,000
1978 total net sales: $162,261,000 Net income: $15,278,000

Datapoint's Peripheral Products Division is the old Amcomp subsidiary, which was primarily involved with small tape drives and head-per-track drives until 1978. At that time Datapoint utilized a manufacturing license from Wangco, and started internal production of disk cartridge drives previously purchased from Wangco. It is reasonable to expect expansion of this firm's disk drive operations, either through further acquisition of manufacturing rights to newer disk drive designs or through internal development.

DIABLO SYSTEMS, INC.
Subsidiary of Xerox Corporation
24500 Industrial Blvd.
Hayward, CA 94545 415/786-5000

1978 disk sales: $42,400,000
1978 total net sales: $5,901,900,000 Net income: $476,900,000

Diablo's disk drive shipments are now declining, after a history of leadership in development of the OEM disk cartridge drive market. After a well publicized misadventure in introducing a high capacity disk cartridge drive it wasn't able to produce, Diablo dropped development of further advanced disk drives. The organization's future role in the Xerox stable of computer industry subsidiaries is apparently to concentrate in printers. Other Xerox subsidiaries will carry the disk drive banner, allowing the Diablo disk cartridge line to gradually decline, or perhaps be transferred to another Xerox unit.

DIGITAL EQUIPMENT CORPORATION
146 Main Street
Maynard, MA 01754 617/897-5111

1978 disk sales: $140,600,000
1978 total net sales: $1,436,562,000 Net income: $142,189,000

DEC's substantial revenues from manufacture of moving head disks are derived entirely from various disk cartridge drive configurations, in both of the DISK/TREND disk cartridge drive groups plus a fixed disk version in small production. During the last few years the firm has been establishing production in a new facility in Colorado Springs for the existing products. After DEC gets through moving managers and engineers back and forth between Massachusetts and Colorado, additional disk drive products are expected, including fixed Winchester drives. It's doubtful that DEC enjoys splitting the profit margin on the SMDs and disk pack drives it now buys from Control Data and Memorex for resale to its own customers -- and it's probable that the firm will try to establish internal manufacturing for the next generations of major disk drive configurations.

ELECTRONIC MEMORIES & MAGNETICS CORPORATION
Peripheral Products Division
1015 Timothy Drive
San Jose, CA 95133 408/398-7080

1978 disk sales: $7,700,000
1978 total net sales: $130,918,000 Net income: $5,799,000

EMM's disk drive revenue has been attributable entirely to the old Caelus group of disk cartridge drives, which is now enjoying the growth most manufacturers of this configuration have sustained in recent years. Despite frequent changes in key personnel, EMM continues with a program to produce a new high capacity disk cartridge drive. It's going to be necessary for EMM to complete the development and manufacturing start-up of new OEM drives soon -- since the disk cartridge is about to peak.

HEWLETT-PACKARD COMPANY
Disk Memory Division
11403 Chinden Blvd.
Boise, Idaho 83707 208/376-6000

1978 disk sales: $78,700,000
1978 total net sales: $1,728,000,000 Net income: $153,000,000

HP's emergence as a leader in minicomputers and small business systems has created a substantial capability to market disk drives, and the firm has established internal engineering and manufacturing capabilities to take

advantage of the opportunity. Disk drive operations were consolidated in an extensive facility at Boise in 1977. In addition to its line of disk cartridge and disk pack drives, most using 3330-11 technology in special configurations, HP introduced its first fixed disk drive this year, a small 14" Winchester drive.

INTERNATIONAL BUSINESS MACHINES CORPORATION
Route 22
Armonk, NY 10504 914/765-1900

1978 disk sales: $1,132,700,000
1978 total net sales: $21,076,089,000 Net income: $3,110,568,000

IBM has embarked on another cycle of system introductions, covering the range from large to small. New IBM systems usually mean new IBM disk drives, and this time the disk drives are both large and small, also. The 210 mm Piccolo drive family, which has been announced on five systems, is basically an extension of earlier 3340/3350 technology. The Piccolo's use of disks smaller than 14" diameter and its expected very high production levels will make it highly influential in the rest of the industry's product planning decisions. DISK/TREND estimates assume the Piccolo will be the alltime champion in unit shipments for a single basic drive during its product life.

In large drives, IBM has dropped only the first shoe. The 3370's 571 MB is IBM's largest disk drive so far. This drive represents a drastic increase in recording density but the details won't be clear until first delivery in fourth quarter, 1979. Most of the industry believes the 3370 uses thin film heads, a major innovation, and there is considerable interest in IBM's approach to file organization using a dual actuator. Potentially even more significant is the IBM disk drive project known by the code name "Whitney". Announcement of Whitney is popularly expected within the next year, and probably provides disk capacity more than twice that of the 3370 along with other refinements.

IBM develops disk drives to meet its own system requirements -- and, through technical leadership, to keep its auxiliary storage products in great demand, at high margins. The by-product of this activity, however, has been the establishment of defacto standards for most of the disk drives produced by the rest of the world. The entire data processing industry listens to what IBM says about disk drives, because of its dominant market position in computer systems. Therefore, the disk drives included in this round of IBM product introductions will be the most important influences in the development of independent high performance disk drives for several years.

INTERNATIONAL MEMORIES, INC.
10381 Bandley Drive
Cupertino, CA 95014 408/446-9779

1978 disk sales: None

IMI has survived a messy early history. There were firings of key executives, cancellations of financing arrangements, and public criticism between

directors -- plus numerous lawsuits in the aftermath. To the surprise of most of the disk drive industry, the dust settled, the lawsuits were dropped, and IMI started making its planned 8" disk drive. IMI has even acquired another drive manufacturer, Dataflux, a small producer of head-per-track disk drives. IMI started manufacture of 8" drives later than planned, due to the numerous disruptions, but not too late to have the first OEM drive of its type in volume production. The firm has found a receptive market in system OEMs with microprocessor based small business systems, who are buying all the drives IMI can produce. The firm is now scaling-up production as fast as it can, and should continue to have its market segment all to itself for most of the rest of 1979.

ISS/UNIVAC
Operating unit of Sperry Univac Division
Sperry Rand Corporation
10435 North Tantau Avenue
Cupertino, CA 95014 408/257-6220

1978 disk sales: $198,100,000
1978 total net sales: $4,179,319,000 Net income: $224,132,000

ISS' role is increasingly concentrated in development and production of captive disk drives for the parent Univac systems. OEM drive activities are now very small, and the organization is barely holding its own in the volatile PCM market. ISS 3330-type drives sold by Itel and others were near the top in the PCM market for years, but a slow introduction of 3350 drives has meant loss of market share to competitors. Meanwhile, ISS is about to move into its large new plant facility in Santa Clara, and production of captive drive configurations for Univac is booming.

KENNEDY COMPANY
Subsidiary of Allegheny Ludlum Industries, Inc.
540 West Woodbury Road
Altadena, CA 91001 213/798-0953

1978 disk sales: None
1978 total net sales: $1,432,461,000 Net income: $33,374,000

Allegheny Ludlum's acquisition of Kennedy in early 1979 may provide the capital this growing computer peripherals operation may need to continue its planned product expansions. From a successful history in small tape drives, Kennedy jumped into the disk drive business with an announcement of a 14" fixed Winchester drive in 1977. After various delays, production shipments started in 1979, and the firm has broadened the product line with an 8" fixed drive due for delivery in early 1980. All Kennedy operations are being consolidated into a new 340,000 square foot building later this year in Monrovia, California.

MEMOREX CORPORATION
San Tomas and Central Expressways
Santa Clara, CA 95052 408/987-1000

1978 disk sales: $130,500,000
1978 total net sales: $633,266,000 Net income: $50,197,000

PCM disk drives have always been the major part of Memorex' disk revenues, and there is no change in the situation. After leading the market for PCM 3330 drives, however, the firm has slipped into a second place role because it wasn't able to match Storage Technology's timetable for delivery of 3350 PCM drives. Revenue from OEM drives is substantial, but mostly derived from selling 3330-type drives to DEC. An OEM fixed disk drive has had only limited success. The firm's future in the OEM segment of the disk drive industry rests on establishing a broader product line, combined with a broader customer base.

MICROCOMPUTER SYSTEMS CORPORATION
432 Lakeside Drive
Sunnyvale, CA 94086 408/733-4200

1978 disk sales: None

Microcomputer Systems has established an annual $5 million disk controller business in less than five years, and has announced ambitious new disk drive products for the first time in mid-1979. The first of these is a storage subsystem using a 14" SLI head-disk assembly and a DEI high capacity tape cartridge drive, with the fixed disk drive also available as a separate product. The second product is an 8" high density fixed drive paired with an unorthodox tape backup system, and this disk drive, too, is to be offered separately.

MICRODATA CORPORATION
17481 Red Hill Avenue
Irvine, CA 92714 714/540-1113

1978 disk sales: $12,100,000
1978 total net sales: $64,951,000 Net income: $4,084,000

Microdata has continued to enhance its line of computer systems and peripherals, but uncertainty seems to be the key-word for the future. On-and-off merger discussions have been widely reported, and the firm has suffered a well publicized retrenchment in OEM marketing activities. Microdata's disk cartridge drives and Reflex fixed disk drives are sorely needed as captive products, and shipment volume for this application is growing. The question in 1979 seems to be whether the firm has the desire and money to continue investing in the always-lengthy time period required to develop substantial OEM sales.

MICROPOLIS CORPORATION
7959 Deering Avenue
Canoga Park, CA 91304 213/703-1121

1978 disk sales: None

Founded in 1977 by two of Pertec's ex-founders, Micropolis has attracted considerable attention as the only firm to market a double track density 5.25" flexible disk drive. Micropolis' floppy drive has been highly successful with system OEMs active in the microcomputer based small system market, and the firm is taking advantage of its reputation as a winner to introduce a family of 8" Winchester technology fixed disk drives. A special GCR encoding scheme is available, offering the equivalent of 8750 BPI, and an unusually high capacity for OEM 8" drives of almost 45 MB.

NEW WORLD COMPUTER COMPANY, INC.
3176 Pullman Street
Costa Mesa, CA 92626 714/556-9320

1978 disk sales: None

New World is a small firm with an unconventional approach to Winchester drive design. The company has announced an 8" fixed disk drive with a moving head array of 20 ferrite transducers. Theoretically, access time can be extremely low, because the slider must move to only eight different positions to cover all tracks. Since delivery is promised for 1979, the industry won't have to wait too long to see whether it works.

NORTHERN TELECOM SYSTEMS CORPORATION
Subsidiary of Northern Telecom, Ltd. (Canada)
Data Park
Minneapolis, MN 55440 612/932-8000

1978 disk sales: $39,500,000
1978 total net sales: $1,278,876,000 Net income: $85,619,000
(Basis: $1C = $0.85 U.S.)

Northern Telecom's U.S. computer operations are being formed from the nucleus of Sycor and Data 100, both acquired in 1978. Both of the acquired firms had manufactured rigid disk drives: Sycor, a small 14" captive fixed drive, and Data 100, both captive and OEM drives. Data 100 had acquired the Iomec line of disk cartridge drives in 1976, and last year the Iomec division acquired a manufacturing license for the Okidata Winchester fixed disk drive. In addition to a probable expansion of captive disk drive production, the new organization has indicated that it plans to stay in the OEM side of its business. It is expected, however, that extensive management changes after the Northern Telecom acquisitions will have to be digested before product development decisions are complete.

OKIDATA CORPORATION
111 Gaither Drive
Mt. Laurel, NJ 08054 609/235-2600

1978 disk sales: $2,800,000

Okidata was originally a joint venture company with ownership split between Oki Electric Industry Co., Ltd., Tokyo, and U.S. investors. It has recently become a wholly owned subsidiary of Oki Electric. First deliveries of the firm's Winchester fixed drive began in 1977, with production at Santa Barbara, California -- but the early opportunity to secure market share was not exploited, as shipments remained at low levels in 1978. Manufacturing licenses for this drive have been obtained by Northern Telecom and Mitsubishi, both of whom are in production, and by Data Recording Equipment, which has not initiated production.

PERKIN-ELMER CORPORATION
Memory Products Division
7301 Orangewood Avenue
Garden Grove, CA 92641 714/891-3711

1978 disk sales: $25,300,000
1978 total net sales: $553,979,000 Net income: $34,733,000

Perkin-Elmer's disk drive business was part of the Wangco tape and disk drive product line, acquired in 1976. Most of the Wangco management has departed, and operations have been moved to a new plant in Garden Grove, but the disk cartridge drives are still very much alive and well. The 20 MB drive, particularly, has grown rapidly in shipments, and is the only OEM disk drive of its type available in the U.S. market.

PERTEC COMPUTER CORPORATION
Peripherals Division
9600 Irondale Avenue
Chatsworth, CA 91311 213/882-0030

1978 disk sales: $28,400,000
1978 total net sales: $131,802,000 Net income: $7,183,000

Pertec's tape and disk peripherals lines have generally outperformed the firm's systems, and they apparently continue to do so. Although all rigid disk revenues in the past have been derived from various disk cartridge drive configurations, including a fixed disk version, Pertec has demonstrated an appetite for future disk markets by introducing its first Winchester technology product, an 8" drive with 20 MB capacity.

PRIAM CORPORATION
20730 Valley Green Drive
Cupertino, CA 95014 408/446-4626

1978 disk sales: None

Founded in March, 1978, to develop and manufacture OEM Winchester fixed disk drives, Priam seems to be progressing according to plan. The firm has been successful in securing venture capital, attracting experienced managers for key positions and acquiring a reputation as an outfit to watch. 14" drives are being delivered, an 8" drive has been announced, and Priam is set to move into new quarters in San Jose. Now that the preliminaries are over, the firm has a chance to show how well it can compete in the growing OEM fixed disk drive market.

SHUGART ASSOCIATES
Subsidiary of Xerox Corporation
415 Oakmead Parkway
Sunnyvale, CA 94086 408/733-0100

1978 disk sales: None
1978 total net sales: $5,901,900,000 Net income: $476,900,000

Shugart is king of the hill in OEM floppy drives, and is interested in repeating the performance in the low cost segment of the rigid fixed disk drive market. The market is just starting to take off, and Shugart's first 14" drive, the SA 4000 has contributed already by arousing wide interest among system OEMs. The 14" drive has attracted an attractive backlog, and the firm's only real short-term problem is to scale-up production fast enough to exploit the situation. Meanwhile, an 8" drive also designed for the low end of the price spectrum, has been privately shown to numerous OEMs, and is expected to be introduced later this year.

SLI INDUSTRIES
21040 Victory Blvd.
Woodland Hills, CA 91367 213/884-7300

1978 disk sales: None

SLI is a privately held company with a well established business in manufacturing linear motor actuators and other disk drive components. The firm does not manufacture assembled disk drives, but offers to supply head-disk assemblies, consisting of deck plate and spindle, rotary actuator, cover and related parts; arrangements have been made with head and disk suppliers, so that on customer order SLI will complete the HDA in its own clean room,

including writing the servo track. The firm also offers to provide specifications for all required electronics and other parts, enabling customers to assemble complete disk drives from SLI's "kit". SLI's 14" HDA is being used by Ampex and Microcomputer Systems, and the firm has announced a similar 8" product.

STORAGE TECHNOLOGY CORPORATION
2270 South 88th Street
Louisville, CO 80027 303/666-6581

1978 disk sales: $132,700,000
1978 total net sales: $300,425,000 Net income: $26,812,000

The biggest success story in the disk drive industry for 1978 has to be STC's performance with PCM 3350 drives. The firm has held a dominant position in the PCM tape drive market for years, but had never found the right combination with disk drives. However, by achieving volume 3350 deliveries six months ahead of the competition, STC secured the leading position in the PCM disk market in a single year, and so far is holding that position. The firm's announced line of smart disk drives for the OEM market, however, has fallen behind in delivery and now is expected later this year. STC's design puts many controller functions into the individual disk drive, and the jury will be out for some time before it's clear how well the OEM market will receive this approach.

VERMONT RESEARCH CORPORATION
Precision Park
North Springfield, VT 05156 802/886-2256

1978 disk sales: $500,000
1978 total net sales: $6,453,000 Net income: $477,000

VRC is a manufacturer of head-per-track drives that introduced an innovative high capacity disk cartridge drive a few years ago, only to find the world wasn't ready for it. The drive is probably the earliest announced application of embedded servo techniques for head positioning, but to date it is believed that shipments have been small.

WESTERN DYNEX CORPORATION
3536 West Osborn Road
Phoenix, AZ 85019 602/269-6401

1978 disk sales: $14,500,000

A privately held company, Western Dynex specializes in the OEM disk cartridge drive market, and is developing a fixed version of the basic drive. The firm has enjoyed good times with the continued growth of disk cartridge drives, but something more sophisticated will be needed soon if the growth is to continue.

Japanese Manufacturers (Exchange basis: 220 Yen = $1 U.S.)

FUJITSU LIMITED
6-1, Marunouchi 2-chome
Chiyoda-ku, Tokyo 100 (03)216-3211

1978 disk sales: $79,300,000
1978 total net sales: $1,761,000,000 Net income: $37,259,000

Fujitsu is a full-line manufacturer of high performance disk drives, with most of its disk drive revenues produced by the captive drives it sells with its own mainframes, minicomputers and small business systems. Large disk pack drives were still leading in volume in 1978, but substantial contributions to future disk revenues may be expected from a variety of fixed disk drives. Fujitsu and Hitachi are partners in the joint venture company, Nippon Peripherals, Ltd., which is charged with development responsibility for Winchester technology drives and their successors. However, Fujitsu retains the right to manufacture drives resulting from NPL development projects, and is now doing so with 3350-type drives and a 635 MB version. OEM activities have centered on a unique high capacity disk cartridge drive and small fixed disk drives, including a serious attempt to penetrate the U.S. OEM disk drive market.

HITACHI, LTD.
6-2, Otemachi, 2-chome
Chiyoda-ku, Tokyo 100 (03)270-2111

1978 disk sales: $84,100,000
1978 total net sales: $10,804,418,000 Net income: $353,859,000

Hitachi is a major diversified electrical and electronics manufacturer, with less than 20% of its sales derived from the computer industry. Its full line of general purpose computer systems is supported by a large family of captive disk pack drives and fixed disk drives, with the major portion of 1978 disk drive revenues still attributable to large disk pack drives. As a co-owner of NPL, Hitachi has initiated manufacture of a 3350 type drive utilizing development carried out at NPL, and the firm has announced a dual actuator 635 MB drive, with deliveries in early 1980. OEM disk drive activities to date have involved primarily smaller fixed disk drives, and have been concentrated in Japan, with the exception of a new arrangement with Itel to supply 3350 drives for resale in the U.S.

HOKUSHIN ELECTRIC WORKS, LTD.
30-1, Shimomaruko, 3-chome
Ohta-ku, Tokyo 146 (03)759-4141

1978 disk sales: $6,500,000
1978 total net sales: $146,850,000 Net income: $2,310,000

Hokushin is a manufacturer of industrial instruments, and for years has produced the Diablo line of disk cartridge drives, under license. Faced with a lack of further development of the disk cartridge family from Diablo, Hokushin developed its own group of high capacity disk cartridge drives, which are now in production. Ironically, Hokushin's new drives resemble the specifications for Diablo's abortive Series 400 program, except for the deletion of Diablo's split actuator and embedded servo.

MITSUBISHI ELECTRIC CORPORATION
2-3, Marunouchi 2-chome
Chiyoda-ku, Tokyo 100 (03)218-2111

1978 disk sales: $21,500,000
1978 total net sales: $3,919,509,000 Net income: $56,086,000

Mitsubishi's disk drive products support a broad line of the firm's computer systems, ranging from mainframes to minicomputers. Although not active in large fixed disk drives, Mitsubishi disk drives include Winchester fixed disk drives, a variety of disk cartridge drives, large disk pack drives and the only SMDs in production in Japan: 50 MB, 80 MB and 300 MB Trident-type drives. The fixed disk drives are manufactured under license from Okidata. In addition to captive sales, an extensive OEM marketing program accounts for about half of the unit shipments.

NIPPON ELECTRIC COMPANY, LTD.
33-1, Shiba Gochome
Minato-ku, Tokyo 108 (03)454-1111

1978 disk sales: $70,600,000
1978 total net sales: $3,249,140,000 Net income: $33,777,000

NEC manufactures a broad range of telecommunications, data processing and other electronic equipment, with the computer segment accounting for about 20% of revenues. With a wide variety of mainframes, small business systems and minicomputers, captive disk drives generate over 80% of the firm's disk revenue. OEM shipments are largely confined to older technology disk pack drives. While disk cartridge drives and large disk pack drives are still in quantity production, NEC's disk development emphasis in recent years has centered on the several fixed disk drives now in production, including 3350 types.

NIPPON PERIPHERALS LIMITED
660 Miyamae, Fujisawa-shi
Kanagawa-ken 251 (0466)26-8211

1978 disk sales: $80,100,000

NPL is a joint venture company, with ownership evenly shared by Fujitsu and Hitachi. The organization is staffed with personnel drawn from the two parent companies, and is charged with responsibility to develop advanced disk drives and mass storage systems to support the system requirements of the owners and to market products in the PCM/OEM markets. As noted above, both Fujitsu and Hitachi have the right to manufacture high performance drives, and currently produce 3350 type drives. NPL carries the OEM responsibility, and has achieved substantial sales to Memorex (3340 drives) and BASF (3340 and 3350 drives) for resale in local PCM markets. These shipments are treated as PCM shipments in DISK/TREND statistics to avoid distortion of PCM market totals.

TOSHIBA CORPORATION
1-6, Uchisaiwaicho 1-chome
Chiyoda-ku, Tokyo 100 (03)501-5411

1978 disk sales: $59,800,000
1978 total net sales: $6,840,309,000 Net income: $10,709,000

Toshiba products consist of consumer electric and electronic products, numerous industrial electronic products and a broad line of minicomputers, small business systems and peripherals. Disk drives are produced mostly for captive use with Toshiba systems, and consist of a small line of high performance drives. In addition to a large disk pack drive, the firm produces a 20 MB disk cartridge drive and small fixed drives using Winchester technology.

European Manufacturers (Exchange basis: Indicated for each firm)

BASF AG
D-6700 Ludwigshafen
West Germany (0621) 4 00 81

1978 disk sales: $2,600,000
1978 total net sales: $11,131,647,000 Net income: $204,469,000
(Basis: DM 1.90 = $1 U.S.)

BASF is one of the world's major manufacturers of magnetic tape and disk media products, and has made disk drives since the early 1970's. A license from Century Data Systems was the original basis of manufacturing operations, and substantial revenue has been derived from 2314 production. In recent years, the firm has undertaken its own development programs for Winchester technology drives. A 14" OEM fixed disk drive resulted in a manufacturing program in Germany, and a start-up operation in California is expected to produce 8" fixed disk drives by the end of 1979. Although early availability of 200 mm Winchester disks from BASF was the key reason why some of the 8" drive programs now emerging are designed for 200 mm disks, BASF is using 210 mm disks on its own 8" drive. BASF is also a major participant in the European market for 3340, 3344 and 3350 PCM drives, by reselling drives made by Nippon Peripherals, Ltd.

CII Honeywell Bull
94, Avenue Gambetta
75960 Paris Cedex 20
France (1)360 02 22

1978 disk sales: $3,300,000
(Basis: FF 4.4 - $1 U.S.)

Compagnie Internationale pour l'Informatique CII-Honeywell Bull (CII-HB) is a leading European computer manufacturer with a complicated ancestry. The existing CII-HB structure was established in 1976, with 47% of the ownership held by Honeywell Information Systems, Inc. and 53% held by Compagnie des Machines Bull (CMB). The French government and the CGE Group each hold 20% of CMB, with the remaining shares in the hands of the public. CII-HB is phasing out older disk cartridge drives, and for the last few years has been pioneering a family of unique disk cartridge drives using 10.5" disks and embedded servo head positioning. The fixed disk versions of these drives announced this year will use thin film heads, the result of CII-HB's extensive internal thin film head development program. With extensive captive markets for these drives assured on its own computer systems, CII-HB has been aggressively soliciting OEM customers in both Europe and the U.S. The most significant OEM agreement to date involves a five year contract with Datapoint, including manufacturing rights.

COMPUTER PERIPHERIE TECHNIK GMBH
Bundesallee 36/37
D-1000 Berlin 31
West Germany (030)86 04 97

1978 disk sales: None

CPT was founded in 1977 to develop high performance 8" disk drives for the OEM market. Its first product, using 200 mm plated disks to provide 41 MB, with very fast claimed average access time, was shown this year at Hanover Fair. The firm plans to be in production early in 1980 and will concentrate on development of the European OEM market.

DATA RECORDING EQUIPMENT LIMITED
Subsidiary of Data Recording Instrument Co., Ltd.
Hawthorne Road, Staines
Middlesex TW18 3BJ
England (0784)61141

1978 disk sales: $20,700,000
1978 total net sales: $48,300,000 Net income: ($808,500)
(Basis: 1 Pound = $2.10 U.S.)

The DRE roots go back to an organization founded to manufacture magnetic recording heads in the mid-1950's. After a period of ownership by ICL, and another period of independence, the parent firm, DRI, eventually fell under the control of the British government's National Enterprise Board (NEB), with a 13% share retained by the original founder, Stan Grundy. The firm has generally been operating at a profit, and the 1978 loss was attributed to heavy development expenses. The latest, and perhaps most significant, development in DRI's history is the announced joint venture with Control Data, in which DRI's existing operations would be folded into a new company to be 76% owned by DRI and 24% by Control Data. The DRI disk drive, magnetic head and printer product lines would then be supplemented by local manufacturing of CDC's leading OEM disk drives and other products. After court challenges by Stan Grundy, an agreement was reached under which the NEB will buy out Grundy's minority interest, and procedures to set up the new company are now underway. Meanwhile, DRE has been manufacturing the Diablo disk cartridge drives under license for several years, with considerable success in penetrating a broad spectrum of the European OEM market. It is expected that the firm will announce an 8" fixed disk drive this fall, with production quantities available in the first half of 1980.

ISOTIMPEX
51, Chapaev St.
Sofia, Bulgaria

1978 disk sales: $10,600,000

Disk drives are manufactured by Isot, the Bulgarian state computer organization, and exported by Isotimpex, the foreign trade organization specializing in electronic products. Isotimpex disk drives are in wide use throughout Eastern Bloc countries. Disk configurations involved all follow IBM designs which have become industry standards: 2311, 2314, 5444 and 3330. Disk cartridge drives were developed under a Wangco license. Isotimpex is apparently now shipping 100 MB versions of their 3330 design, but 200 MB drives are not expected until 1981.

PHILIPS DATA SYSTEMS B.V.
Subsidiary of N. V. Philips Gloeilampenfabrieken
Postbus 245
7300 AE Apeldoorn
The Netherlands (055)230123

1978 disk sales: $15,100,000
1978 total net sales: $16,577,868,000 Net income: $358,629,000
(Basis: Fl 1.97 = $1 U.S.)

Computer industry revenues account for only about 4% of the current Philips total revenues, a mere shadow of the firm's telecommunications and consumer products contributions. Nevertheless Philips is a factor in the European minicomputer and small business systems markets. Disk drives sold on a captive basis include disk cartridge drives, including a high capacity model, a 40 MB disk pack drive, and new small fixed disk drives using Winchester technology. Philips, of course, is well known for its video disk recorder, which is now being introduced in selective U.S. markets under the company's Magnavox brand. Philips has undertaken development of a digital optical disk recorder using similar technology, but apparently has not yet settled on the configurations to be offered, nor the distribution channels to be used.

SIEMENS AG
Data and Information Systems Group
Otto-Hahn-Ring 6
D-8000 Munchen 83
West Germany

1978 disk sales: $85,500,000
1978 total net sales: $15,607,889,000 Net income: $379,252,000
(Basis: DM 1.90 = $1 U.S.)

Siemens mainframe systems are a big part of the European computer industry, despite the fact that data processing revenues constitute only about 5% of the company's total. In disk drives, Siemens concentrates on high performance drives. Enhanced 3330-11 technology is used on several disk pack drives, ranging in capacity up to 300 MB, and on a 517 MB fixed disk drive. An attempt was made to penetrate the U.S. OEM market with this drive family, but the program never really got started, due to fluctuating monetary exchange rates and the extremely competitive character of the U.S. OEM market. However, Siemens has since acquired two California flexible disk drive manufacturers as a cost effective method of entering worldwide markets for floppies, and presumably could follow the same approach to the rigid disk drive market, if desired.