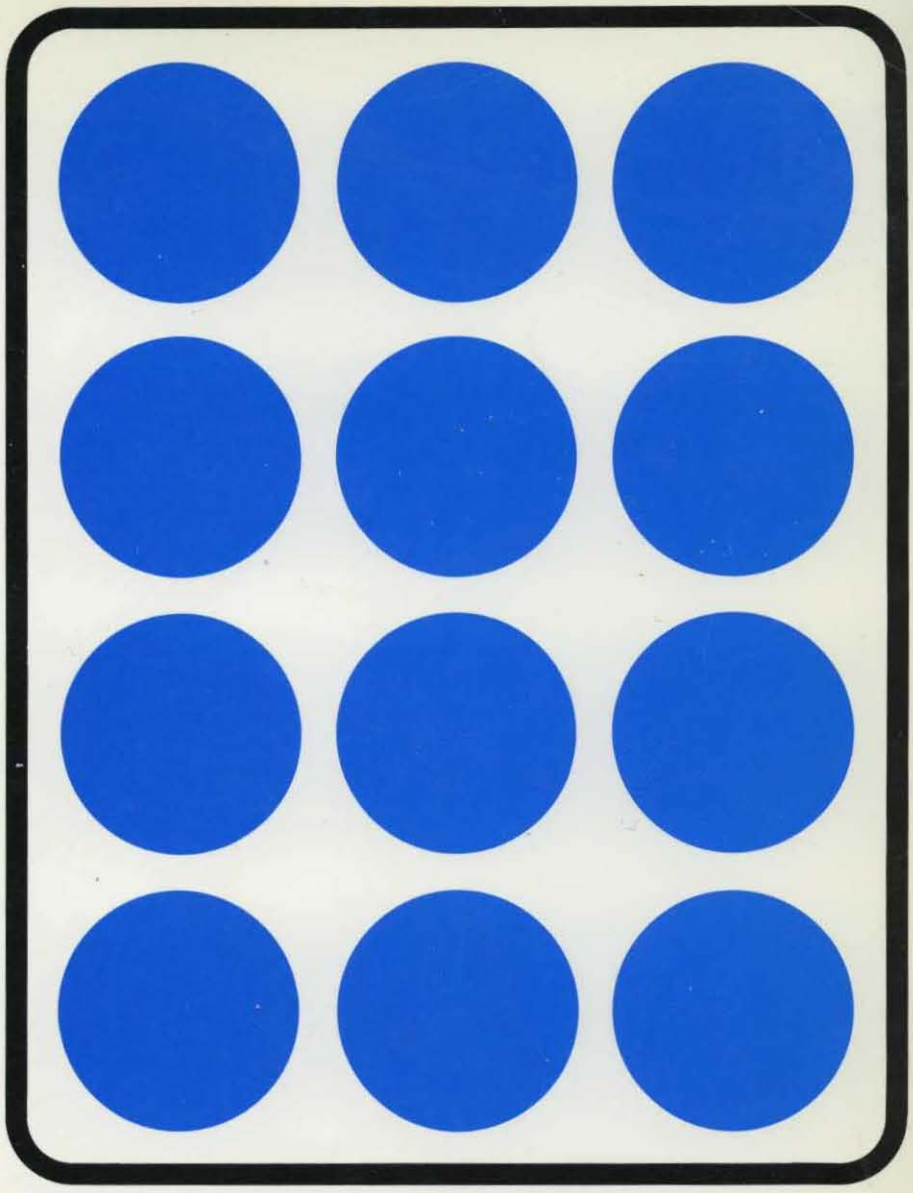
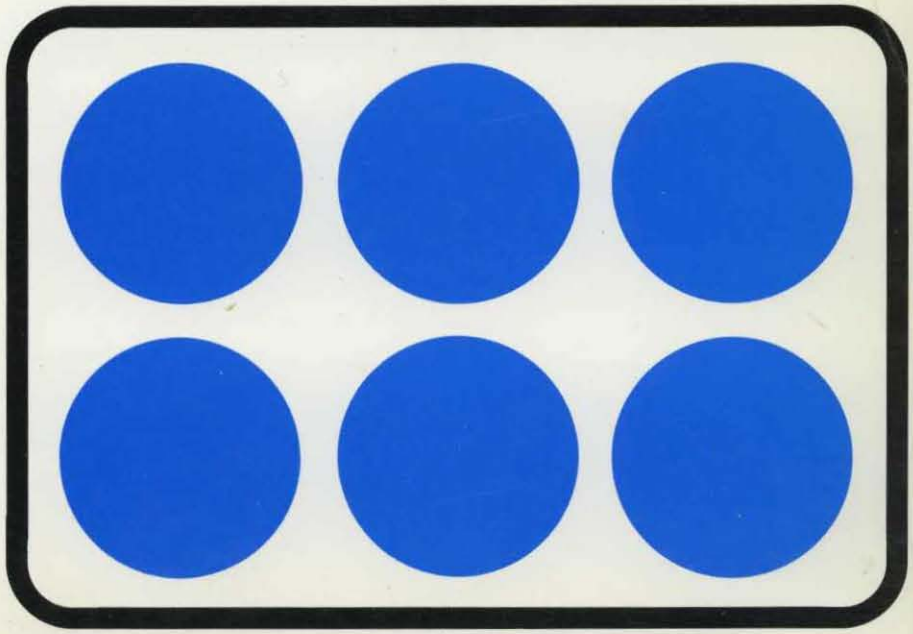


1980 DISK/TREND® REPORT



RIGID DISK DRIVES

1980 DISK/TREND® REPORT

RIGID DISK DRIVES

July, 1980

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FOREWORD

The DISK/TREND Report has reached its fourth year, slightly thicker in size, reflecting the continuing growth in the industry -- more companies, more products, higher revenues.

As regular users know, the DISK/TREND Report is published 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.

A large number of regular users also know that I am always willing to provide any appropriate additional information on the disk drive business which I may have readily available. 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.

The DISK/TREND format is still evolving, and your suggestions are requested for any improvements which will make the report more useful to you. Many user ideas are already included, and more are always welcome.

James N. Porter

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INTRODUCTION

The format remains the same

As usual, the DISK/TREND format has been kept essentially the same in 1980, to make the report as usable as possible to regular users. Here are a few new items to watch for:

* Additional product breakdowns have been added for two product groups. 14 inch vs. 8 inch shipment forecasts have been provided for the disk cartridge drives more than 12 MB group. And the product breakdown for the fixed disk drives less than 30 MB group has now been expanded to include 5.25 inch drives, as well as the 14 inch and 8 inch breakdown added last year.

* In response to numerous requests, an attempt is being made this year to include some basic information on OEM prices. A new line has been added to the report's specification section, with the current OEM price in the United States for most drives intended for that market. Obviously, prices are changed without notice, so please use the information with the appropriate caution.

Please note these points, which could be confusing

* Terms which might have different meanings for various people within the computer industry are defined in the specifications section.

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

Worldwide revenue generated by sales of moving head rigid disk drives totaled $3,816,700,000 in 1979, an increase of 12.4% over 1978. This represents approximately the same total growth predicted in last year's DISK/TREND Report.

Making the largest contributions to 1979's growth were fixed disk drives in the 30-200 MB group, storage module drives, and disk cartridge drives more than 12 MB. On the other hand, disk pack drives 29-58 MB and data module drives continued to decline.

The disk drive industry is still in the midst of a prolonged period of growth, and market development of relatively youthful products is having a greater influence on total revenue generation than the current economic recession. Despite flat or negative outlooks for certain product groups, the DISK/TREND projection for worldwide total revenue in 1980 is up 25.9%, with 1981 up another 25.2%. The DISK/TREND projections through 1983 are higher than last year's, with the difference to be found in higher expectations for all of the fixed disk drive product groups. The forecasts for 1980 through 1983 represent an average annual growth rate of 24%.

Underlying this year's DISK/TREND projections is the assumption that the current recession will reach its depth in the third or fourth quarter of 1980, with a good recovery during the first half of 1981. If unforeseen events should cause a deeper or longer economic decline, the projections would be adversely affected.

TABLE 1

CONSOLIDATED WORLDWIDE SHIPMENTS

ALL EXISTING MOVING HEAD DISK DRIVE GROUPS

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1979		Forecast							
	Shipments		1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	504.6	804.9	623.5	1,002.3	1,024.2	1,643.5	1,553.9	2,493.1	1,753.6	2,809.4
Other U.S. Captive	886.7	1,398.3	1,069.1	1,680.9	1,243.4	1,939.0	1,466.6	2,269.7	1,656.5	2,547.4
TOTAL U.S. CAPTIVE	1,391.3	2,203.2	1,692.6	2,683.2	2,267.6	3,582.5	3,020.5	4,762.8	3,410.1	5,356.8
PCM	236.1	335.7	263.4	385.4	224.9	319.9	247.4	353.0	457.1	654.2
OEM	409.0	558.5	618.1	856.3	753.2	1,041.0	864.2	1,190.4	939.0	1,287.3
TOTAL U.S. NON-CAPTIVE	645.1	894.2	881.5	1,241.7	978.1	1,360.9	1,111.6	1,543.4	1,396.1	1,941.5
TOTAL U.S. SHIPMENTS	2,036.4	3,097.4	2,574.1	3,924.9	3,245.7	4,943.4	4,132.1	6,306.2	4,806.2	7,298.3
Non-U.S. Manufacturers										
Captive	1.0	614.4	--	748.3	32.6	850.3	58.3	1,026.3	112.4	1,198.7
PCM	6.6	19.8	8.8	20.5	9.2	24.0	18.3	47.3	35.3	84.8
OEM	5.9	85.1	24.7	112.0	59.3	201.0	85.2	304.5	112.6	406.6
TOTAL NON-U.S. SHIPMENTS	13.5	719.3	33.5	880.8	101.1	1,075.3	161.8	1,378.1	260.3	1,690.1
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	2,049.9	3,816.7	2,607.6	4,805.7	3,346.8	6,018.7	4,293.9	7,684.3	5,066.5	8,988.4

Industry structure

Despite a few dropouts in the last year, there was a net increase in the number of companies manufacturing disk drives throughout the world. The count remains 7 firms each in Japan and in Europe, but the United States total has increased to 32 companies, counting only those with specific announced products. Several other startup firms will be added to the list next year. Multinational manufacturing activities by IBM, Siemens, Burroughs and others are counted as single operations.

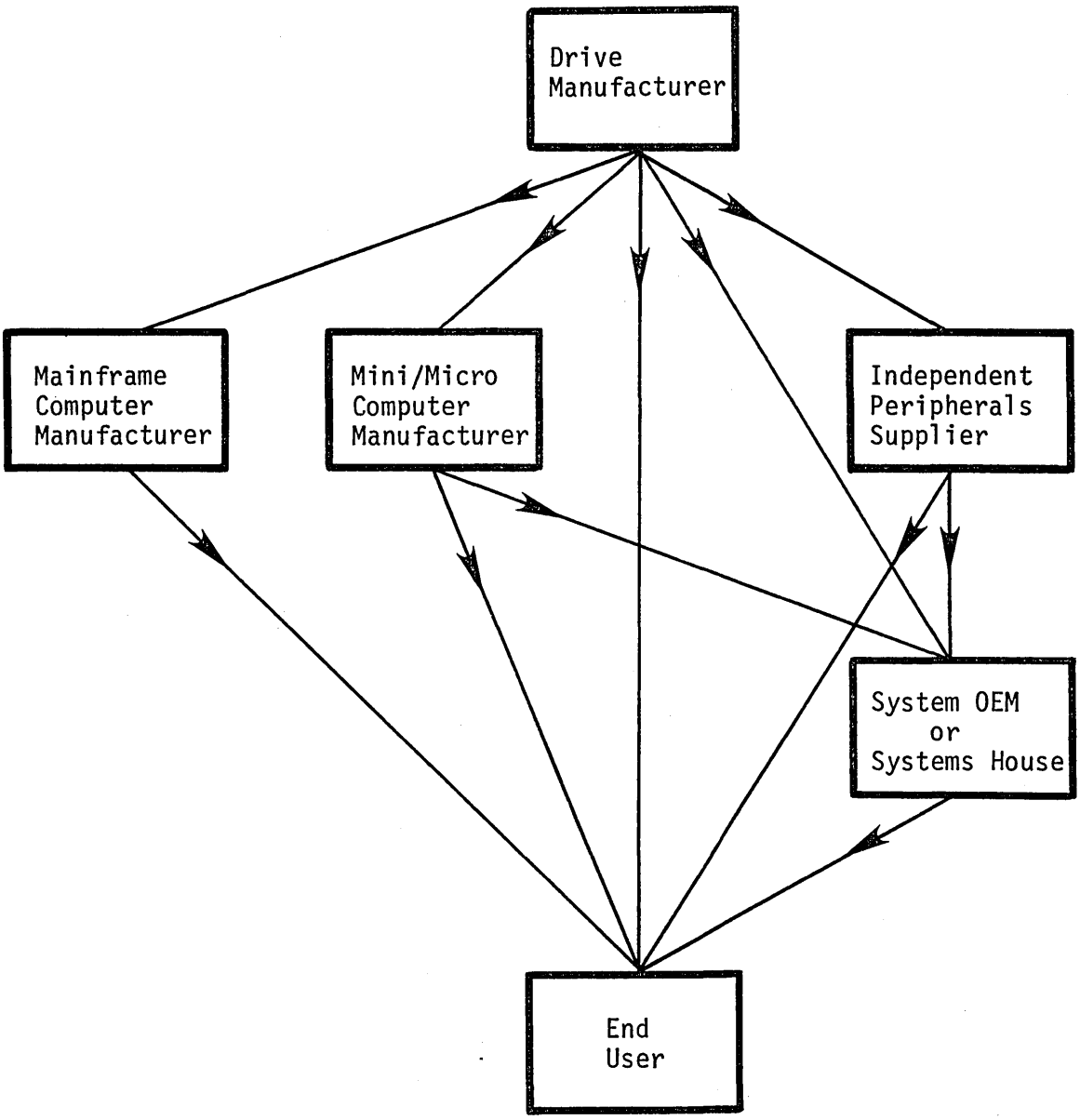
The distribution pattern for non-captive disk drives, as illustrated in Figure 1, can be confusing to observers not familiar with the industry's marketing practices. Plug compatible manufacturers sell or rent drives directly to end users -- primarily end users of IBM systems. OEM drives, however, are sold to all levels of the industry and to buyers with all levels of technical resources. Many customers of the OEM drive manufacturer normally perform the additional functions of designing and manufacturing interfaces, controllers, power supplies and enclosures.

On the other hand, thousands of small system OEMs lack the resources to build the additional hardware required to supplement basic OEM drives, or would simply prefer to use limited resources on other tasks. In addition, many OEM drives are used by the thousands of systems houses, especially those in the United States, which are involved only in development of software for the systems which they sell and install. In this environment, a variety of independent peripherals suppliers have evolved, to provide controllers and other hardware needed for system integration.

Figure 1

NON-CAPTIVE MARKETING STRUCTURE

Moving Head Disk Drives



Marketing channels

IBM's estimated share of worldwide disk drive revenues declined from $1,132,700,000 in 1978 to $804,900,000 in 1979. The biggest reason was a slight drop in shipments of large fixed disk drives, combined with IBM's 1979 price reductions. New revenue from Piccolo drive shipments was offset by declines in older disk drives.

However, IBM's disk drive revenue is already growing again due to heavy shipments of Piccolo drives, plus the start of 3370 shipments. Further sharp growth is expected through 1983, sparked mainly by Piccolo and by major shipments of drives with large price tags per spindle: 3370, 3375 and 3380. IBM's average annual disk drive revenue growth through 1983 is forecast at 38.2%.

Revenue generated by other captive drive manufacturers is expected to grow at a more modest 16.9% annually through 1983. Most of this growth is also expected to occur in the fixed disk drive groups, but captive drive manufacturers will also continue to be very active in the removable disk pack and disk cartridge areas IBM has completely abandoned.

Worldwide PCM revenues were down 10.9% in 1979, due to the collapse of shipments for 3330 type drives, and up 14.2% in 1980, because of the growth in shipments of 3350 type drives. The PCM roller coaster will continue in 1981 as IBM zaps the independents with heavy shipments of 3370 and 3380 drives, then show a recovery as PCM versions of the new drives build up delivery rates in 1982 and 1983.

OEM drive revenues will achieve an average annual growth of 28.1% through 1983, built on a solid base of thousands of individual OEM customers.

TABLE 2

CONSOLIDATED WORLDWIDE SHIPMENTS

MARKET CLASS REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	1979 Shipments $M	1979 Shipments %	FORECAST 1980 $M	1980 %	1981 $M	1981 %	1982 $M	1982 %	1983 $M	1983 %
U.S. Manufacturers										
IBM	804.9	21.1	1,002.3	20.9	1,643.5	27.3	2,493.1	32.4	2,809.4	31.3
Other U.S. Captive	1,398.3	36.6	1,680.9	35.0	1,939.0	32.2	2,269.7	29.5	2,547.4	28.3
PCM	335.7	8.8	385.4	8.0	319.9	5.3	353.0	4.6	654.2	7.3
OEM	558.5	14.6	856.3	17.8	1,041.0	17.3	1,190.4	15.5	1,287.3	14.3
Total U.S. Mfgr's.	3,097.4	81.2	3,924.9	81.7	4,943.4	82.1	6,306.2	82.1	7,298.3	81.2
Non-U.S. Manufacturers										
Captive	614.4	16.1	748.3	15.6	850.3	14.1	1,026.3	13.4	1,198.7	13.3
PCM	19.8	.5	20.5	.4	24.0	.4	47.3	.6	84.8	.9
OEM	85.1	2.2	112.0	2.3	201.0	3.3	304.5	4.0	406.6	4.5
Total Non-U.S. Mfgr's.	719.3	18.8	880.8	18.3	1,075.3	17.9	1,378.1	17.9	1,690.1	18.8
Worldwide Total	3,816.7	100.0	4,805.7	100.0	6,018.7	100.0	7,684.3	100.0	8,988.4	100.0

Product mix

Fixed disk drives grew to a 42.0% share of total disk drive worldwide revenues in 1979, and passed the 50% mark in 1980. The DISK/TREND projection for 1983 shows fixed disk drives with 71.9% of total worldwide revenues, with about half of the fixed disk share going to large fixed disk drives over 200 MB. The other big winner will be disk cartridge drives more than 12 MB, which will hold an estimated 10.2% of worldwide revenues in 1983. Except for storage module drives 25-80 MB, which are destined for steady but modest growth, all other product groups are now declining.

OEM market

OEM products are expected to follow the industry's general growth patterns, with a few exceptions. The largest divergence is found in large fixed disk drives, an area with low penetration for OEM drives, since the world's mainframers manufacture most of their own large fixed disk drives internally. Growth in OEM revenues through 1983 will be generated entirely from small and mid-range fixed disk drives, plus disk cartridge drives more than 12 MB and storage module drives. Control Data's share of the worldwide OEM drive market increased to 46.7% for 1979, with Century Data Systems at 13.2%, boosted by the addition of the Diablo disk cartridge drives.

PCM market

In 1978, worldwide PCM market shares of the three leaders were: Storage Technology, 33.2%; Memorex, 23.9%; ISS/Univac, 15.5%. In 1979, the lineup was: Storage Technology, 34.8%; Memorex, 27.4%; Control Data, 22.0%. It looks like the leaders include a tough new competitor.

Figure 2
CHANGING PRODUCT MIX
CONSOLIDATED WORLDWIDE DISK DRIVE SHIPMENTS

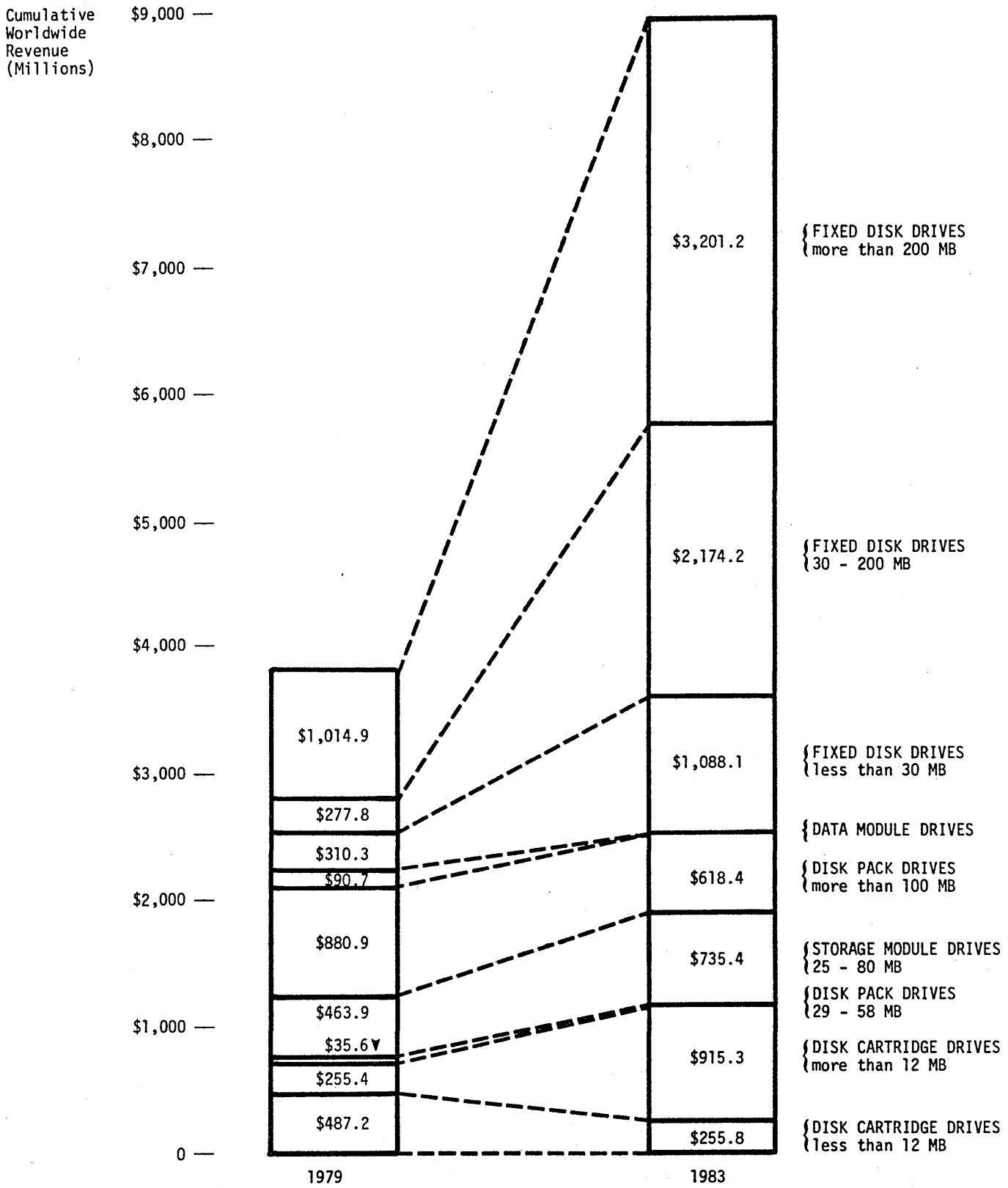


TABLE 3

CONSOLIDATED WORLDWIDE SHIPMENTS
PRODUCT CATEGORY REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES ALL MANUFACTURERS	1979 Shipments $M	1979 Shipments %	FORECAST 1980 $M	1980 %	1981 $M	1981 %	1982 $M	1982 %	1983 $M	1983 %
Disk Cartridge Drives Less than 12 MB	487.2	12.8	496.6	10.3	437.3	7.3	346.5	4.5	255.8	2.8
Disk Cartridge Drives More than 12 MB	255.4	6.7	389.9	8.1	548.8	9.1	748.3	9.7	915.3	10.2
Disk Pack Drives 29-58 MB	35.6	.9	19.3	.4	7.8	.1	--	--	--	--
Storage Module Drives 25-80 MB	463.9	12.2	563.6	11.7	615.7	10.2	681.9	8.9	735.4	8.2
Disk Pack Drives More than 100 MB	880.9	23.1	895.0	18.6	837.6	13.9	737.4	9.6	618.4	6.9
Data Module Drives	90.7	2.4	10.2	.2	5.7	.1	--	--	--	--
Fixed Disk Drives Less than 30 MB	310.3	8.1	491.7	10.2	709.1	11.8	924.5	12.0	1,088.1	12.1
Fixed Disk Drives 30-200 MB	277.8	7.3	650.3	13.5	1,136.0	18.9	1,765.5	23.0	2,174.2	24.2
Fixed Disk Drives More than 200 MB	1,014.9	26.6	1,289.1	26.8	1,720.7	28.6	2,480.2	32.3	3,201.2	35.6
Total Worldwide Revenue	3,816.7	100.0	4,805.7	100.0	6,018.7	100.0	7,684.3	100.0	8,988.4	100.0
% U.S. Mfg.	81.2%		81.7%		82.1%		82.1%		81.2%	
Annual Growth Rate			+25.9%		+25.2%		+27.7%		+17.0%	

TABLE 4

OEM WORLDWIDE SHIPMENTS
PRODUCT CATEGORY REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES ALL MANUFACTURERS	1979 Shipments $M	1979 Shipments %	FORECAST 1980 $M	1980 %	1981 $M	1981 %	1982 $M	1982 %	1983 $M	1983 %
Disk Cartridge Drives Less than 12 MB	223.3	34.7	233.7	24.1	202.7	16.3	156.9	10.5	122.6	7.2
Disk Cartridge Drives More than 12 MB	64.1	10.0	125.4	13.0	219.8	17.7	323.3	21.6	411.7	24.3
Disk Pack Drives 29-58 MB	29.4	4.6	19.3	2.0	7.8	.6	--	--	--	--
Storage Module Drives 25-80 MB	141.7	22.0	201.4	20.8	213.2	17.2	228.9	15.3	238.1	14.1
Disk Pack Drives More than 100 MB	116.3	18.1	235.2	24.3	268.2	21.6	263.3	17.6	228.3	13.5
Data Module Drives	6.8	1.1	4.3	.4	2.6	.2	--	--	--	--
Fixed Disk Drives Less than 30 MB	35.4	5.5	90.0	9.3	169.4	13.6	243.5	16.3	314.0	18.5
Fixed Disk Drives 30-200 MB	25.5	4.0	50.6	5.2	128.1	10.3	229.3	15.3	309.8	18.3
Fixed Disk Drives More than 200 MB	1.1	.2	8.4	.9	30.2	2.4	49.7	3.3	69.4	4.1
Total Worldwide Revenue	643.6	100.0	968.3	100.0	1,242.0	100.0	1,494.9	100.0	1,693.9	100.0
% U.S. Mfg.	86.8%		88.4%		83.8%		79.6%		76.0%	
Annual Growth Rate			+50.5%		+28.3%		+20.4%		+13.3%	

TABLE 5

1979 ESTIMATED MARKET SHARES

WORLDWIDE SHIPMENTS OF ALL MOVING HEAD DISK DRIVES
(Value of non-U.S. currencies estimated at July, 1980, rates)

	CAPTIVE		PCM		OEM		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
Ampex	--	--	--	--	18.4	2.9	18.4	0.5
Burroughs	417.0	14.8	--	--	--	--	417.0	10.9
Century Data Systems	--	--	--	--	84.9	13.2	84.9	2.2
Control Data	336.5	11.9	78.1	22.0	300.2	46.7	714.8	18.7
Data General	96.8	3.5	--	--	--	--	96.8	2.5
Datapoint	25.4	0.9	--	--	--	--	25.4	0.7
Digital Equipment	130.4	4.6	--	--	--	--	130.4	3.4
Hewlett-Packard	122.6	4.4	--	--	--	--	122.6	3.2
IBM	803.1	28.5	--	--	--	--	803.1	21.0
ISS/Univac	169.8	6.0	36.2	10.2	1.0	0.2	207.0	5.4
Memorex	--	--	97.5	27.4	41.7	6.5	139.2	3.7
Microdata	37.5	1.3	--	--	1.0	0.2	38.5	1.0
Northern Telecom	46.7	1.7	--	--	1.8	0.3	48.5	1.3
Perkin Elmer	2.8	0.1	--	--	23.9	3.7	26.7	0.7
Pertec	14.6	0.5	--	--	32.9	5.1	47.5	1.2
Storage Technology	--	--	123.9	34.8	--	--	123.9	3.3
Western Dynex	--	--	--	--	20.5	3.9	20.5	0.6
Other U.S.	--	--	--	--	32.2	5.0	32.2	0.8
U.S. Total	2,203.2	78.2	335.7	94.4	558.5	86.8	3,097.4	81.1
NON-U.S. MANUFACTURERS								
Data Recording Equipment	--	--	--	--	20.0	3.1	20.0	0.5
Fujitsu	169.8	6.0	--	--	4.6	0.7	174.4	4.6
Hitachi	111.3	4.0	5.4	1.5	7.7	1.2	124.4	3.3
Isotimpex	--	--	--	--	12.5	1.9	12.5	0.3
Mitsubishi	43.4	1.5	--	--	19.6	3.1	63.0	1.6
Nippon Electric Company	104.8	3.7	--	--	5.1	0.8	109.9	2.9
Nippon Peripherals, Ltd.	11.0	0.4	14.4	4.1	--	--	25.4	0.7
Philips	36.2	1.3	--	--	--	--	36.2	0.9
Siemens	101.6	3.6	--	--	--	--	101.6	2.7
Toshiba	36.3	1.3	--	--	0.9	0.1	37.2	1.0
Other Non-U.S.	--	--	--	--	14.7	2.3	14.7	0.4
Non-U.S. Total	614.4	21.8	19.8	5.6	85.1	13.2	719.3	18.9
Worldwide Total	2,817.6	100.0	355.5	100.0	643.6	100.0	3,816.7	100.0

Note: Drives manufactured by ISS, NPL or Hitachi 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
Ampex	O			X	X	X			X	
Ball Computer	O				X	X			X	
Burroughs	C,O	X		X	X	X		X	X	X
Century Data Systems	O	X	X		X	X		X	X	
Control Data	C,P,O	X	X	X	X	X	X	X	X	X
Dastek	O									X
Data General	C	X	X		X	X		X		
Datapoint	C	X	X							
Digital Equipment	C	X	X							
Disk Memory Technology	O							X		
Hewlett-Packard	C	X	X		X	X		X		
IBM	C							X	X	X
International Memories	O							X		
ISS/Univac	C,P		X		X	X			X	X
Kennedy	O							X	X	
Memorex	P,O		X			X		X	X	X
Microcomputer Systems	O							X		
Microdata	C	X						X	X	
Micropolis	O							X	X	
New World	C,O							X		
Northern Telecom	C	X	X					X		
Okidata	O							X	X	
Perkin Elmer	C,O	X	X							
Pertec	C,O	X	X					X		
Priam	O							X	X	
Shugart Associates	C,O							X		
Shugart Technology	O							X		
SLI Industries	O							X	X	
Storage Technology	P,O								X	X
Tandon Magnetics	O							X		
Vermont Research	O		X							
Western Dynex	O	X						X		
Japanese Manufacturers										
Fujitsu	C,O		X			X	X	X	X	X
Hitachi	C,P,O					X	X	X	X	X
Hokushin	O	X	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,P,O						X		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	X					X	X	
Isotimpex	O	X		X		X				
Philips	C,O	X	X		X			X		
Siemens	C,O					X				X

TECHNICAL REVIEW

Competing technologies

The years go by, and the many "promising" alternatives to magnetic disk recording still fail to show up in the marketplace. Why? The answers appear to lie in the two key facts that magnetic recording has a lot of room left for improvements and that the alternatives proposed are not significantly better.

Magnetic recording on rigid disks is in its third decade of commercial reality, and thousands of individuals responsible for system planning decisions have a working familiarity with disk drive reliability, availability, prices, interface requirements, and impact on system software. To be seriously considered, any proposed alternative would have to overcome the very real momentum of its entrenched disk competition -- so the alternative device would have to offer greatly improved capabilities or reduced price. A slight advantage for the alternative will not dent the market for disk drives.

The continuing increase in magnetic recording densities, with a corollary reduction in system cost per megabyte stored, has also been the nemesis of proposed alternative technologies. Too often the plans of competitors have been based on a stationary disk drive target -- but the target moves constantly in the direction of lower cost.

And there are other important reasons why the alternative technologies are not yet in the market place:

1. It's very costly to complete the development to the point of production startup for a new storage technology, and managements responsible for the appropriations needed have not perceived high probability of commercial success for most of the technologies proposed.

2. The computer industry obviously prefers to use engineering and specific devices with broad support and usage. Usually, this means that a major factor in the industry must support new technologies if they are not to flounder through years of difficult pioneering in the market. And most of the time, at least in storage devices, it also means that IBM must support the approach.

3. Finally, hardly anyone takes a new computer peripheral seriously until samples are actually available. The industry is very practical in these matters, especially with OEM products. All experienced system designers know that many promised products never really happen, so it's safe to assume that no serious planning for utilization of a new storage device will occur until the first evaluation units show up.

Despite all the negative background described above, there are several good ideas for improved storage technologies still receiving attention. It's even possible one or more may become real products if they are shaped into truly practical configurations, and if appropriate backing is provided. Here are the more likely candidates:

* Optical disk: There have been several abortive attempts in the past to introduce optical data storage systems in various forms. All have been commercial failures, because of the limited market applicability of the specific devices introduced. The most pressing limitation of these and all other optical data recording technologies so far available is the lack of a way to revise recorded data, so that they are "non-reversible."

  Today, however, most of the attention given to optical recording is going to various approaches to optical disk devices. These technologies are still non-reversible, but extremely high recording densities and fast access times may make optical disk a good bet for certain data storage tasks. There is little doubt that the basic inventions necessary for data recording on optical disk have all been made, but the most pressing questions for the companies active in the field is just what kind of products to develop from the technology.

  The technical literature is full of attempts to rationalize the use of optical disks as a general purpose disk drive replacement.

The idea is to overcome the limitation of a non-reversible storage medium by developing systems to allow rewriting revised records through a series of new locations. Unfortunately, such a system could result in an investment in dead records, at best -- and in a heavy usage database could be impractical. The more recent product planning for optical data disk products seems to be concentrating on more suitable specialized data storage applications, such as large, rarely updated files and backup for large magnetic disk drives. These applications could hold some promise for optical disk, properly exploiting its fast access times and the ability to store great amounts of data in a small space.

The field has attracted many big names, including Philips, RCA, Xerox, Hitachi, Exxon, Thomson-CSF and others. The earliest digital optical disk in wide use may be the Toshiba document storage system due for production shipments next year. This is a system which will store digital information generated by a facsimile device, and is apparently not intended to handle the storage of machine readable characters, the normal job for magnetic disk drives. It is considered unlikely that products intended for the computer room will enter the marketplace before 1983.

* Magnetic bubbles: There has been considerable internal analysis within the magnetic bubble fraternity during the last year as to why all of the predictions made during the late 1970s regarding bubble's superiority over magnetic disks haven't turned into a real market position. It appears that the members of the fraternity are reaching the conclusion that (1) the product wasn't really ready and (2) bubbles were shooting at the wrong target.

The confusion over various interface and control requirements from various suppliers, lack of control circuits, products perceived as interim offerings, and high prices have held down market acceptance to the early plungers who are willing to work hard to use a new product and accept the high associated risks. And bubble marketing managers have found that moving head disk drives are an impossible target for many years, due to a clear pricing advantage.

But the bubble programs are starting to move. Suppliers are starting to respond to the market segments which can really take advantage of bubbles' key strong points: The suitability for harsh environments and the suitability for on line storage considered small for rigid disk drives, from 50 KB to 1 MB. Promising application areas are industrial control systems, point of sale terminals, portable terminals and computers, medical instrumentation and military systems. As these markets start to consume bubble chips in quantity, the inevitable experience curve reductions in cost and pricing will occur, and bubbles

could be priced at the 5 millicent per bit level by about 1985. Of course, at that level they still will be much more costly than magnetic disk drives, either rigid or floppy, and will lack floppy's key advantage of cheap removable media.

* Charge coupled devices: So far, CCDs appear to be a by-passed technology, as far as potential impact on the disk drive business goes. The technology was thought to be a possible replacement for head-per-track drives, and as a supplement to disk storage as cache memory. However, the semiconductor manufacturers in the forefront in developing CCD markets have dropped their support level for the products announced, seriously inconveniencing the OEMs already planning products with CCD memory. The reason for the change in emphasis is apparently the fast progress made by RAMs, and the lack of clear-cut advantages for CCD.

* EBAM (Electron-beam accessed MOS storage): EBAM still intrigues many engineers, but seems as remote a product prospect as ever. It uses an electron beam, deflected as required to store a charge in the oxide layer of an MOS target. It is probably suitable only for very large systems and would require extensive changes in operating software to operate efficiently.

* High capacity flexible disk drives: The low-end rigid disk drives now being introduced with great expectations could be challenged for many applications by floppy drives with capacities up to 10 MB during the next few years. Several technical approaches are in the development stage, in a wide range of companies, including IBM, the established floppy drive manufacturers, and new start-up companies. Burroughs has already introduced a drive with a capacity of 3 MB per diskette. The most likely scenario will be an introduction by IBM during the next year or so, and a rush to offer similar products by the existing floppy drive manufacturers. It's likely the drive involved will have about 3 MB capacity on a new 8" diskette -- and will be a tempting alternative to designers of very small business systems now considering 5.25 inch Winchester drives. Best case availability of such drives is about two years in the future.

Disk drive enhancements

IBM's use of thin film heads in the 3370, 3375 and 3380 will initiate a new set of industry standards for high density recording, which will eventually be used throughout the disk drive industry. As in the past, the predominant usage pattern for new technology is expected to be: In-

troduction by IBM, usage in PCM drives competing directly against IBM's drives, and eventual application in a variety of OEM drives. With a few exceptions, this pattern is expected to repeat itself again.

* Recording heads: Ferrite heads in widespread usage today are generally operated in the 4,000 to 8,500 BPI range. There have been several predictions that the eventual linear densities for thin film heads used in longitudinal recording will be at least in the 25,000 to 50,000 BPI range. The 3370 heads now in use by IBM, however, operate at only 8,128 flux reversals per inch, following the usual IBM pattern of engineering new recording devices conservatively. The drive's effective BPI of 12,134 is obtained through an encoding scheme. Although IBM isn't talking about recording density on the 3380, due for delivery first quarter of 1981, the estimate by competitors is about 10,000 FRPI, yielding about 15,000 net BPI.

  The industry is now in the process of reducing IBM's 3370 heads to the status of a multiple-sourced commodity. In addition to the internal head development activities by many major disk drive manufacturers, independent head manufacturers are now offering samples. New head manufacturers such as Dastek and Magnex are competing with established manufacturers of ferrite heads such as Applied Magnetics, Information Magnetics and National Micronetics for a share of the new thin film head market. It is expected that thin film head availability will not be a limiting factor for the disk drive industry, after the next year of start-up headaches.

* Recording disks: IBM's competitors have been relieved to learn that all of IBM's new drives still use particulate coatings, thus avoiding the additional complexity of introducing new disk surface technology, in addition to changes in head technology. The 3370 disk is merely a refinement of the existing 3340/3350/Piccolo disk coating process, and thus producible by competitors with much of their existing equipment. The 3380 is probably more of the same thing, but with a thicker aluminum substrate. So the industry continues to await the introduction of new disk magnetic surfaces using thin metallic films, whether plated, sputtered, or whatever. The industry consensus is that thin film media will be used on the next generation of drives, but that appears to be several years in the future.

* Head positioning methods: High density magnetic disk systems are useless without the ability to position heads accurately and quickly. The 3370 operates at 635 TPI, and the 3380 is estimated at about 760 TPI -- with several announced disk pack drives also in the 760 TPI range. All of these drives use a dedicated band of

servo tracks to control head positioning, but some may be approaching the practical limit for this method when used with a large number of disks in a stack, due to the build-up of mechanical tolerances involved. The industry would find an innovative breakthrough in head positioning very helpful for the next generation of disk drives.

* Longitudinal vs. perpendicular recording: All of the digital tape and disk recording systems in use today involve magnetizing elongated particles in a plane parallel to the recording surface -- known as longitudinal recording. However, as recording densities go higher, the limits of the capability of longitudinal recording to resolve flux changes will be reached. The problem is to develop a recording medium with higher resolution capability. There is growing interest, still in the laboratory stage, in perpendicular recording, for the next stage in magnetic recording density improvements. In perpendicular, or vertical recording, the head and recording medium are arranged to allow particles to be magnetized in a plane vertical to the recording surface. Published research claims digital recording densities using vertical techniques of at least 100,000 BPI, with the potential to exceed the linear recording densities obtained with optical disk recording.

  At this time the commercial future for perpendicular recording is not clear, but the process has interesting possibilities in disk recording, as well as in tape recording. Companies known to be involved in research in the field include IBM, Eastman Kodak, Sony, and others.

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 sales or leases of internally manufactured drives by computer manufacturers or system OEMs primarily for use with their own systems. 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 CDC to users of IBM Series/1 systems.

* 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.

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. Controllers sold as separate units are not included, nor are spare parts or service. When individual disk drive models include integral control functions, such as may be required for the first drive on a string of drives, the actual value of each unit is used. 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 1980 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 analyzed 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, Xylogics and Emulex.

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

1980 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
Century Data Systems	Diablo D-31, D-44B
Cii-Honeywell Bull	D120, D135
Control Data	9427H
Data General	6045, 6095
Datapoint	9360
Data Recording Equipment	3212, 4044B, D9427H
Digital Equipment	RK05J, RL01, RL02
Hewlett-Packard	7900
Hokushin	CD-4400, CD5400S
Isotimpex	ISOT 1370, SM 5400
Microdata	7401, 7403
Mitsubishi	M802F/S
Nippon Electric Company	N7711, N7715
Perkin Elmer	VT-2222
Pertec	D3341, D3441
Philips	X1215, X1216
Western Dynex	DD-6121, DD-6222

All removable-only or fixed/removable disk drives with a total capacity per spindle of less than 12 MB are included in this group. 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 D120 and D135, which use a 10.5" disk in a special cartridge.

Market status

DISK/TREND estimate of total market size:

Worldwide sales	1979	1980	1981	1982	1983
U.S. manufacturers	407.9	410.0	351.9	271.6	193.2
All manufacturers	487.2	496.6	437.3	346.5	255.8

This product group has been characterized during 1979 and 1980 by the flat growth to be expected from a mature product type at the height of its product life cycle. Net worldwide shipments are expected to increase slightly in 1980, up to 5.7% over 1979. Total revenues are predicted at an even smaller increase, up 1.9%.

U.S. OEM drive shipments, the largest product segment in the group, reached 60,600 spindles in 1979, up 20.2% from 1978, but the total for 1980 is expected to be up only 1.1%. Thus it appears that the market class which has created most of the continued growth for disk cartridge drives in this group has finally stopped growing. Small business systems and other application areas have continued their growth in 1980, but the availability of other attractive disk storage configurations has finally taken its toll. The most significant competition has been provided by disk cartridge drives with larger capacity, such as the Control Data "cartridge module" drives, and by small fixed disk drives. Small Winchester disk drives, especially the 8 inch versions, have been a latent competitive threat for several years. In 1980, the threat became real, as production programs really got underway.

Control Data's 9427 Hawk drive continues to increase its dominance of OEM markets, with shipments increasing from 17,000 units in 1978 to 25,700 units in 1979 -- a 35.5% share of the worldwide OEM market. The

Diablo disk cartridge drives (now marketed by Century) continue to decline in market share: 33.8% in 1977, 23.8% in 1978, 14.5% in 1979.

Unit shipments of new captive drives actually increased in 1980, but this increase was due entirely to the robust growth of a young drive family, the DEC RL01/RL02. While most other manufacturers of captive drives were gradually phasing out their older single disk cartridge drives in this class in favor of other types of disk drives, DEC was phasing out the older RK05J in favor of the new RL01 and the double track density version, the RL02. Both drives are priced significantly lower than any other competitive captive disk drives. DEC's aggressive prices for these drives, combined with their high shipment volume, account for the slight decrease in total worldwide captive drive revenues, despite a modest increase in unit shipments.

Marketing trends

DISK/TREND projections made in previous years have incorrectly forecasted declines in unit shipments for disk cartridge drives in this group, but every indication now indicates the time for this group to go downhill has finally arrived. Other disk drive configurations with more attractive price/performance, physical size and/or reliability are now actually available in production quantities. The average annual decline in total worldwide shipments is now projected at 18.4% through 1983.

The market class with the sharpest decline is expected to be OEM drives shipped by U.S. manufacturers, with a forecasted reduction of shipments through 1983 averaging 21.7% annually. System OEMs using these drives will react with increasing rapidity to attractive competitive alternatives.

The intentions of most system manufacturers producing drives in this class are already clear. While DEC seems committed to the RL01/RL02 for the next year or two, other manufacturers of captive drives have introduced alternate configurations, with more coming. The trend, as in the OEM drive area, has been to introduce both lower cost small fixed disk drives and higher capacity disk cartridge drives. The average annual decline in worldwide captive shipments through 1983 is estimated at 17.7%.

OEM drive shipments by non-U.S. manufacturers are not expected to peak until 1981. The current increases are derived from growth by Cii-HB's 10.5" disk cartridge drives and the start of European manufacturing for the 9427H (CDC's leading OEM disk cartridge drive) by United Peripherals, Ltd., the joint venture company owned by Data Recording Instruments and Control Data.

Technical trends

The older disk cartridge drives which comprise the core of this product group are vulnerable to drives employing newer technology. While some of the newer drives fall within the capacity and configuration definition of this group, many of the newer designs replacing the existing volume leaders are in different types of configurations or offer greater capacities.

Technical innovations to be found in disk cartridge drives falling within the group under 12 MB already involve the two key improvements expected to be carried even further: Improved density and smaller disk diameters. The embedded servo system used by DEC for the RL01/RL02 has

the potential to increase recording densities in removable disk drives even further than at present. And the 10.5" disk diameter used by the Cii-Honeywell Bull drives will probably not be the end of disk shrinkage for this group. Removable-only drives using 8 inch disk cartridges such as the Control Data Lark cartridge are probable, and 5.25 inch disk cartridges are a distinct possibility.

Forecasting assumptions

1. 1980 will be the peak shipment year for U.S. OEM disk cartridge drives in this group, with a continuous decline in succeeding years, due to competitive pressure from low cost fixed disk drives and higher capacity disk cartridge drives.

2. Non-U.S. OEM drive production will not peak until 1981, due to the influence of newer product programs, but will decline thereafter.

3. OEM price levels will decline only slightly, due to the mature status of the market and the continued increase in the average capacity of drives shipped.

4. Captive drive production will decline after 1980, since many captive manufacturers are transitioning to other drive configurations for their low capacity requirements. Average prices for captive drives will continue to fall, because of the increasing share of captive drive production to be held by the low priced DEC RL01 and RL02.

TABLE 7

DISK CARTRIDGE DRIVES, LESS THAN 12 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1979		Forecast							
	Shipments		1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	143.0	229.0	141.5	226.9	128.5	201.0	102.7	160.8	71.0	110.9
TOTAL U.S. CAPTIVE	143.0	229.0	141.5	226.9	128.5	201.0	102.7	160.8	71.0	110.9
PCM	--	--	--	--	--	--	--	--	--	--
OEM	118.9	178.9	124.6	183.1	99.6	150.9	73.1	110.8	52.4	82.3
TOTAL U.S. NON-CAPTIVE	118.9	178.9	124.6	183.1	99.6	150.9	73.1	110.8	52.4	82.3
TOTAL U.S. SHIPMENTS	261.9	407.9	266.1	410.0	228.1	351.9	175.8	271.6	123.4	193.2
Non-U.S. Manufacturers										
Captive	1.0	34.9	--	36.0	--	33.6	--	28.8	--	22.3
PCM	--	--	--	--	--	--	--	--	--	--
OEM	4.5	44.4	7.2	50.6	9.2	51.8	9.3	46.1	6.8	40.3
TOTAL NON-U.S. SHIPMENTS	5.5	79.3	7.2	86.6	9.2	85.4	9.3	74.9	6.8	62.6
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	267.4	487.2	273.3	496.6	237.3	437.3	185.1	346.5	130.2	255.8
OEM Average Price ($000)	3.0	3.1	3.0	3.1	3.0	3.1	2.9	3.0	2.8	2.9

TABLE 8

DISK CARTRIDGE DRIVES, LESS THAN 12 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1979		Forecast							
	Shipments		1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	(5.6)	(8.3)	(5.9)	(8.7)	(5.2)	(7.6)	(4.8)	(7.1)	(4.4)	(6.5)
Other U.S. Captive	25.3	40.5	27.0	43.3	25.7	40.2	21.4	33.5	14.8	23.1
TOTAL U.S. CAPTIVE	19.7	32.2	21.1	34.6	20.5	32.6	16.6	26.4	10.4	16.6
PCM	--	--	--	--	--	--	--	--	--	--
OEM	40.3	60.6	41.7	61.3	33.2	50.3	25.2	38.2	18.7	29.4
TOTAL U.S. NON-CAPTIVE	40.3	60.6	41.7	61.3	33.2	50.3	25.2	38.2	18.7	29.4
TOTAL U.S. SHIPMENTS	60.0	92.8	62.8	95.9	53.7	82.9	41.8	64.6	29.1	46.0
Non-U.S. Manufacturers										
Captive	.1	3.5	--	3.6	--	3.5	--	3.1	--	2.5
PCM	--	--	--	--	--	--	--	--	--	--
OEM	1.2	11.8	2.1	14.8	2.8	15.7	2.9	14.4	2.2	13.0
TOTAL NON-U.S. SHIPMENTS	1.3	15.3	2.1	18.4	2.8	19.2	2.9	17.5	2.2	15.5
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	61.3	108.1	64.9	114.3	56.5	102.1	44.7	82.1	31.3	61.5
Installed at Year End										
IBM	47.7	70.7	41.8	62.0	36.6	54.4	31.8	47.3	27.4	40.8
Non-IBM	334.1	558.9	404.9	681.9	466.6	791.6	516.1	880.8	551.8	948.8
WORLDWIDE TOTAL	381.8	629.6	446.7	743.9	503.2	846.0	547.9	928.1	579.2	989.6

TABLE 9

DISK CARTRIDGE DRIVES, LESS THAN 12 MB

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

Distribution Channel	1979 U.S. Net Shipments Units (000)	1979 U.S. Net Shipments %	FORECAST 1980 %	FORECAST 1981 %	FORECAST 1982 %	FORECAST 1983 %
Mainframe computer manufacturers	8.2	19.7	16.8	14.2	12.1	10.3
Mini/micro computer manufacturers	12.4	29.9	30.5	29.3	28.1	26.9
System OEMs/systems houses	13.2	31.8	35.1	38.4	41.3	43.9
Independent peripherals suppliers	6.8	16.4	16.7	17.1	17.4	17.8
Direct to end user/retail dealers	0.9	2.2	0.9	1.0	1.1	1.1
TOTAL	41.5					

TABLE 10

DISK CARTRIDGE DRIVES, LESS THAN 12 MB

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1979 Net Shipments To United States Destinations Units (000)	To United States Destinations %	Worldwide Units (000)	Worldwide %
Control Data	15.4	37.1	25.7	35.5
Century Data Systems	8.9	21.4	10.5	14.5
Pertec	6.3	15.2	8.4	11.6
Western Dynex	3.9	9.4	8.1	11.2
Data Recording Equipment	--	--	5.1	7.0
Perkin Elmer	2.9	7.0	4.8	6.6
Other U.S.	2.9	7.0	3.1	4.3
Other Non-U.S.	1.2	2.9	6.7	9.3
TOTAL	41.5	100.0	72.4	100.0

DISK CARTRIDGE DRIVES, MORE THAN 12 MB

1980 DISK/TREND REPORT

DISK CARTRIDGE DRIVES, MORE THAN 12 MB

Coverage

Examples of disk drives in this group include:

14" disk diameter

Ampex	DFR-932, DFR-964, DFR-996
Century Data Systems	H-32, H-64, H-96
Control Data	9448-32, 9448-64, 9448-96 CMD
Data General	6070
Datapoint	9374
Digital Equipment	RK06, RK07
Data Recording Equipment	D9448-32, D9448-64, D9448-96
Fujitsu	M-2201, M-2211
Hewlett-Packard	7906
Hokushin	CD-5200, CD-5400
Mitsubishi	M803
Perkin Elmer	VT-2422
Pertec	D3461, D3481
Philips	X1217, X1240
Toshiba	MK-200R
Vermont Research	5017

10.5" disk diameter

Cii-Honeywell Bull	D 140

8" disk diameter

Control Data	9455 Lark module drive
Memorex	201

All drives in this group use a removable disk cartridge, which is usually, but not always, combined with one or more fixed disks. Drives in the group may be classified as follows:

> Conventional fixed/removable cartridge format -- drives which are essentially the same physical configuration as lower capacity 14" cartridge drives, but which use 10 MB removable cartridges combined with 10 MB fixed disks (Data General 6070, Perkin Elmer VT-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 series).

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), Vermont Research's 5017 (26 MB fixed/26 MB removable, with embedded servo), and the new Control Data 9455 Lark (8 MB fixed/8 MB removable, on 195 mm disks, with embedded servo).

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1979	1980	1981	1982	1983
U.S. manufacturers	194.3	315.6	436.2	595.5	725.9
All manufacturers	255.4	389.9	548.8	748.3	915.3

All segments of the market for disk cartridge drives in this group are in a rapid growth phase. The well-established U.S. captive production programs are expected to total 20,700 units in 1980, a 40.8% increase over 1979. The continually growing appetite for more capacity by users of Data General, DEC and Hewlett-Packard disk cartridge drives has established a growth pattern which will not be stopped for some time.

The OEM market is experiencing even more explosive growth, paced by Control Data's "cartridge module drive" family. The CMD, which first achieved quantity production in mid-1977, provides the upward growth path needed by the numerous system OEMs and systems houses still using large quantities of smaller capacity disk cartridge drives, and offers the advantage of interface compatibility with the widely used SMD drives, with the resulting availability of widely available standard controllers. Control Data shipped 10,000 OEM drives in this group in 1979, achieving

a 64.1% share of the worldwide non-captive market. Total OEM shipments by U.S. manufacturers in 1979 were 13,400 units, with 1980 shipments expected to increase by 103.7%.

The most significant product introduction in this group is certainly the long anticipated announcement in May, 1980, of the Control Data Lark drive -- expected to be the first of several 8 inch disk drives to be introduced by CDC during the next few years. Because it avoids the need for a separate backup device, the Lark is also expected to provide a powerful marketing tool for CDC in penetrating the low-end of the small business system market. The Lark is available initially only with an SMD interface, and is expected to be in heavy demand from the large existing CDC customer base now using various disk drives with this interface family. 1980 shipments will probably total only a few hundred drives.

Marketing trends

It is expected that the OEM market for drives in this group will continue to be dominated by CDC's CMD and similar competitive drives -- at least for the next two years. However, it is believed that a significant portion of the CMD's potential growth will be diverted to an equivalent 8 inch drive using 16 MB cartridges by 1983. Average annual increases in unit shipments by U.S. manufacturers are projected to average 51.8% through 1983, for drives using all disk diameters.

The CDC Lark, using an 8 inch, 8 MB cartridge, will be produced in production quantities in 1981. Production of Lark drives and other 8 inch drives is projected at 11,000 units worldwide OEM in 1981, 28,500 in 1982, and 56,100 in 1983. It should be noted that these totals in-

clude both 8 inch disk cartridge drives and, arbitrarily, the 10.5 inch Cii-Honeywell Bull drive.

Captive drive production is expected to maintain a stable growth pattern, although at a pace considerably more modest than OEM drives. Average annual growth through 1983 is projected at 24.3%.

Technical trends

As in other DISK/TREND product groups, the probable trends for new products in the large capacity disk cartridge area involve increased recording densities and/or smaller disk diameters. While the product types already introduced are expected to dominate markets for the next few years, 8 inch disk cartridges with capacities of 16 MB or higher are expected before 1983, and 5.25 inch disk cartridges in the capacity range covered by this product group are certainly possible before 1983.

The eventual role of 14 inch disk cartridges, however, is not expected to be extinction, certainly through the mid-1980s. Continually increasing recording densities will make the 14 inch disk cartridge a viable format for many years to come.

Forecasting assumptions

1. The CMD and similar drives will remain the leading OEM disk cartridge drive configuration in this group through 1983.
2. 8 inch disk cartridge drives will be widely accepted, due to integral backup capability, small physical size and competitive pricing, with OEM shipments approaching those for 14 inch drives by 1983.
3. Captive drive production will be concentrated in 14 inch drives through 1983, with relatively minor 8 inch drive shipments.

TABLE 11

DISK CARTRIDGE DRIVES, MORE THAN 12 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1979		Forecast							
	---Shipments--		-----1980-----		-----1981-----		-----1982-----		-----1983-----	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	88.1	140.8	128.8	208.3	160.6	258.6	211.1	342.4	251.0	407.0
TOTAL U.S. CAPTIVE	88.1	140.8	128.8	208.3	160.6	258.6	211.1	342.4	251.0	407.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	38.0	53.5	68.0	107.3	115.8	177.6	170.2	253.1	223.4	318.9
TOTAL U.S. NON-CAPTIVE	38.0	53.5	68.0	107.3	115.8	177.6	170.2	253.1	223.4	318.9
TOTAL U.S. SHIPMENTS	126.1	194.3	196.8	315.6	276.4	436.2	381.3	595.5	474.4	725.9
Non-U.S. Manufacturers										
Captive	--	50.5	--	56.2	--	70.4	--	82.6	--	96.6
PCM	--	--	--	--	--	--	--	--	--	--
OEM	1.0	10.6	7.0	18.1	17.9	42.2	21.6	70.2	24.5	92.8
TOTAL NON-U.S. SHIPMENTS	1.0	61.1	7.0	74.3	17.9	112.6	21.6	152.8	24.5	189.4
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	127.1	255.4	203.8	389.9	294.3	548.8	402.9	748.3	498.9	915.3
OEM Average Price ($000)	4.0	4.1	3.9	3.9	3.7	3.7	3.7	3.7	3.4	3.4

TABLE 12

DISK CARTRIDGE DRIVES, MORE THAN 12 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1979		Forecast							
	Shipments		1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	9.2	14.7	12.8	20.7	15.9	25.6	20.9	33.9	25.1	40.7
TOTAL U.S. CAPTIVE	9.2	14.7	12.8	20.7	15.9	25.6	20.9	33.9	25.1	40.7
PCM	--	--	--	--	--	--	--	--	--	--
OEM	9.5	13.4	17.3	27.3	31.3	48.0	46.0	68.4	65.7	93.8
TOTAL U.S. NON-CAPTIVE	9.5	13.4	17.3	27.3	31.3	48.0	46.0	68.4	65.7	93.8
TOTAL U.S. SHIPMENTS	18.7	28.1	30.1	48.0	47.2	73.6	66.9	102.3	90.8	134.5
Non-U.S. Manufacturers										
Captive	--	3.8	--	4.1	--	5.1	--	5.9	--	6.8
PCM	--	--	--	--	--	--	--	--	--	--
OEM	.2	2.2	1.9	4.9	4.7	11.1	6.0	19.5	7.0	26.5
TOTAL NON-U.S. SHIPMENTS	.2	6.0	1.9	9.0	4.7	16.2	6.0	25.4	7.0	33.3
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	18.9	34.1	32.0	57.0	51.9	89.8	72.9	127.7	97.8	167.8
Installed at Year End										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	33.6	60.2	65.6	117.2	117.5	207.0	190.4	334.7	288.2	502.5
WORLDWIDE TOTAL	33.6	60.2	65.6	117.2	117.5	207.0	190.4	334.7	288.2	502.5

TABLE 13

DISK CARTRIDGE DRIVES, MORE THAN 12 MB

WORLDWIDE SHIPMENTS

14" AND 8" DISK DIAMETERS

	DISK DRIVE SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1979 Shipments		Forecast 1980		1981		1982		1983	
	14"	8"	14"	8"	14"	8"	14"	8"	14"	8"
U.S. Manufacturers										
IBM	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	14.7	--	20.7	--	25.3	0.3	29.9	4.0	33.7	7.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	13.4	--	27.0	0.3	39.5	8.5	47.4	21.0	49.8	44.0
TOTAL U.S. SHIPMENTS	28.1	--	47.7	0.3	64.8	8.8	77.3	25.0	83.5	51.0
Non-U.S. Manufacturers										
Captive	3.8	--	3.7	0.4	4.1	1.0	4.5	1.4	4.9	1.9
PCM	--	--	--	--	--	--	--	--	--	--
OEM	2.2	--	3.7	1.2	8.6	2.5	12.0	7.5	14.4	12.1
TOTAL NON-U.S. SHIPMENTS	6.0	--	7.4	1.6	12.7	3.5	16.5	8.9	19.3	14.0
TOTAL WORLDWIDE SHIPMENTS	34.1	--	55.1	1.9	77.5	12.3	93.8	33.9	102.8	65.0
14"/8" ANNUAL SHARE	100%	--	97%	3%	86%	14%	73%	27%	61%	39%

TABLE 14

DISK CARTRIDGE DRIVES, MORE THAN 12 MB

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

Distribution Channel	1979 U.S. Net Shipments Units (000)	1979 U.S. Net Shipments %	FORECAST 1980 %	1981 %	1982 %	1983 %
Mainframe computer manufacturers	3.7	38.2	33.6	29.3	25.4	22.1
Mini/micro computer manufacturers	2.0	20.6	24.3	25.0	22.5	20.1
System OEMs/systems houses	3.6	37.1	37.4	40.3	45.9	50.6
Independent peripherals suppliers	0.4	4.1	4.7	5.4	6.2	7.2
Direct to end user/retail dealers	--	--	--	--	--	--
TOTAL	9.7					

TABLE 15

DISK CARTRIDGE DRIVES, MORE THAN 12 MB

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1979 Net Shipments To United States Destinations Units (000)	To United States Destinations %	Worldwide Units (000)	Worldwide %
Control Data	7.0	72.2	10.0	64.1
Other U.S.	2.5	25.8	3.4	21.8
Other Non-U.S.	0.2	2.0	2.2	14.1
TOTAL	9.7	100.0	15.6	100.0

DISK PACK DRIVES, 29-58 MB

1980 DISK/TREND REPORT

DISK PACK DRIVES, 29-58 MB

Coverage

Examples of disk drives in this group include:

IBM	2314, 2319, 5445
Control Data	9746, 9747
Isotimpex	EC 5061
Nippon Electric Company	DKU 312, DKU 314

IBM's 2314, which was introduced with System/360 in 1965 as a 29 MB drive, established the model for the numerous drives which followed from a large number of disk drive manufacturers. All drives in this group utilize the same basic technology and physical configuration as IBM's 2314, but most of the drives now in production are "double density" 58 MB versions.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1979	1980	1981	1982	1983
U.S. manufacturers	19.8	13.5	5.3	--	--
All manufacturers	35.6	19.3	7.8	--	--

Worldwide production of new drives in this group has declined from 9,200 spindles in 1978, to 4,100 spindles in 1979, and is expected to drop to 2,500 spindles in 1980. The DISK/TREND unit shipment summary, Table 17, shows negative shipments during these years, due to the retirements of IBM and PCM drives which have been occurring for several years.

For all practical purposes, the U.S. OEM market for these drives has ceased to exist in 1980, but a small market still remains in Europe. This market is the residue of a once large worldwide market for 2314s, as the primary auxiliary storage device for the industry's mainframes and large minicomputers. These drives have stayed in production much longer than many industry participants had expected, because few OEMs are willing to expend the resources necessary to provide for attachment of newer, more cost effective disk drives to old computer systems. Thus the market for the 2314 lingered on, driven by the continuing sales of many older systems on which the drives are used, combined with the demand for add-on drives to be used with installed systems.

The last production of captive drives occurred in 1979, in both Japan and the United States. As in the OEM market, these 2314-equivalent drives were displaced by development of newer computer systems using disk drives of later design.

Marketing trends

Obviously, the trend for drives in this group is all down, with the end in sight. It is expected that the limited production of OEM drives will again be sharply reduced in 1981. DISK/TREND projections indicate the end of production in 1981, but the actual end will depend on product planning actions in Eastern Europe.

The heavy retirements of 2314s will continue for several years, as new generations of computers displace older ones in greater numbers, especially the aging thousands of IBM System/360s still in use throughout the world. The DISK/TREND estimate of net worldwide shipments became a negative number in 1979, and will continue that way.

Forecasting assumptions

1. OEM drive production will end in 1981, with production levels before that time declining continually.

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

TABLE 16

DISK PACK DRIVES, 29-58 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1979		Forecast							
	Shipments		1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	1.5	1.5	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	1.5	1.5	--	--	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	2.3	18.3	--	13.5	--	5.3	--	--	--	--
TOTAL U.S. NON-CAPTIVE	2.3	18.3	--	13.5	--	5.3	--	--	--	--
TOTAL U.S. SHIPMENTS	3.8	19.8	--	13.5	--	5.3	--	--	--	--
Non-U.S. Manufacturers										
Captive	--	4.7	--	--	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	11.1	--	5.8	--	2.5	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	--	15.8	--	5.8	--	2.5	--	--	--	--
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	3.8	35.6	--	19.3	--	7.8	--	--	--	--
OEM Average Price ($000)	7.7	7.9	--	7.7	--	7.8	--	--	--	--

TABLE 17

DISK PACK DRIVES, 29-58 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1979		Forecast							
	Shipments		1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	(2.1)	(3.5)	(1.8)	(3.0)	(1.7)	(2.8)	(1.5)	(2.5)	(1.4)	(2.3)
Other U.S. Captive	.1	.1	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	(2.0)	(3.4)	(1.8)	(3.0)	(1.7)	(2.8)	(1.5)	(2.5)	(1.4)	(2.3)
PCM	(.9)	(1.1)	(.9)	(1.0)	(.8)	(.9)	(.8)	(.9)	(.7)	(.8)
OEM	.3	2.4	--	1.8	--	.7	--	--	--	--
TOTAL U.S. NON-CAPTIVE	(.6)	1.3	(.9)	.8	(.8)	(.2)	(.8)	(.9)	(.7)	(.8)
TOTAL U.S. SHIPMENTS	(2.6)	(2.1)	(2.7)	(2.2)	(2.5)	(3.0)	(2.3)	(3.4)	(2.1)	(3.1)
Non-U.S. Manufacturers										
Captive	--	.3	--	--	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	1.3	--	.7	--	.3	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	--	1.6	--	.7	--	.3	--	--	--	--
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	(2.6)	(.5)	(2.7)	(1.5)	(2.5)	(2.7)	(2.3)	(3.4)	(2.1)	(3.1)
Installed at Year End										
IBM	22.2	38.2	20.4	35.2	18.7	32.4	17.2	29.9	15.8	27.6
Non-IBM	61.7	122.1	60.8	123.6	60.0	123.7	59.2	122.8	58.5	122.0
WORLDWIDE TOTAL	83.9	160.3	81.2	158.8	78.7	156.1	76.4	152.7	74.3	149.6

TABLE 18

DISK PACK DRIVES, 29-58 MB

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

Distribution Channel	1979 U.S. Net Shipments Units (000)	%	FORECAST 1980 %	1981 %	1982 %	1983 %
Mainframe computer manufacturers	--	--	--	--	--	--
Mini/micro computer manufacturers	0.1	30.0	--	--	--	--
System OEMs/systems houses	0.2	70.0	--	--	--	--
Independent peripherals suppliers	--	--	--	--	--	--
Direct to end user/retail dealers	--	--	--	--	--	--
TOTAL	0.3					

STORAGE MODULE DRIVES, 25-80 MB

1980 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 Data Systems	T-25, T-50, T-80
Control Data	9760, 9762, 270-10
Data General	6067
Hewlett-Packard	7920
ISS/Univac	8418
Mitsubishi	M2850F, M2851F
Philips	X1237

"Storage module drive," or SMD, is the term given by Control Data to its 9760 and 9762, with five data surfaces, originally, and later to the 9764 and 9766 with nineteen data surfaces. The term is used throughout the DISK/TREND report as a generic description for these Control Data drives and competitive equivalents. All SMDs in this group use packs with five data surfaces, yielding a capacity from 25 MB to 80 MB. Also included in this group, arbitrarily, are the Univac 8418 and the Philips X1237, with 7 and 8 data surfaces, respectively, but with capacities and technology roughly similar to the SMD's.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1979	1980	1981	1982	1983
U.S. manufacturers	456.1	551.4	590.5	635.5	673.8
All manufacturers	463.9	563.6	615.7	681.9	735.4

SMDs are preeminently an OEM disk drive, with 1979 and 1980 shipment growth continuing the rapid increases of recent years. 1979 worldwide

OEM shipments of SMDs were 30,700, an increase of 83.8% over 1978, and 1980's estimated shipments of 42,200 spindles will be an increase of 37.5% over 1979. OEM average prices actually increased slightly, reflecting a continuing concentration of shipments at the 80 MB level and the growth of the OEM customer base to include smaller OEMs and systems houses, buying in smaller quantities. Control Data's market share of non-captive drives increased from 1978's 65.8% to 70.4% in 1979, probably as the result of that firm's greater capability to expand production than its competitors. CDC's market share includes a small number of PCM drives, marketed for the first time in 1979 to the IBM Series/1 marketplace.

Captive SMD shipments for 1979 and 1980 are running higher than last year's DISK/TREND projection. The big jump in shipments occurred in 1979, with an increase of 80.7% over 1978, to a worldwide total of 20,600 spindles. The 1980 increase, however, is expected to be more modest, an increase of 12.1%, to 23,100.

Marketing trends

It is believed that the dramatic annual growth in OEM SMD shipments has slowed down, because of current availability of large capacity disk cartridge drives and fixed disk drives, all offering compatibility with Control Data's SMD interface. The average annual projected growth for worldwide OEM shipments through 1983 is 8.9%.

Worldwide shipments of captive drives are forecasted at an average annual increase of 10.6% through 1983, with no new major captive programs expected. PCM shipments to IBM's Series/1 customers are projected at a very modest level, based on industry experience to date in this market.

Technical trends

A significant question during the last few years has been the potential future of five data surface SMDs recorded at double track density, yielding 160 MB capacity. Such drives have been announced by both Ampex and Ball, but shipments of production drives have not commenced. Apparently Control Data has decided not to market such a drive, due to questionable media interchangability. Without CDC's endorsement, the future of 160 MB SMDs is probably not bright.

Another question for drives in this group is whether they will be superseded by models using 8 inch disks in removable 80 MB packs. Many of Control Data's SMD customers are convinced that CDC plans such an introduction in a few years, with capacity and interfaces similar to today's products. Clearly, this configuration is a distinct possiblity, which would further extend the life of the product group.

Forecasting assumptions

1. OEM sales will continue to grow through 1983, but at a lower rate, due to competition from high density cartridge drives and fixed disk drives.
2. No significant capacity improvements or changes in product configuration will occur in time to materially affect shipments through 1983.
3. Future OEM average prices will decline only slightly, reflecting the modest projected growth in annual shipments.
4. Captive production will increase at a moderate rate through 1983, with no significant new captive manufacturing programs.

TABLE 19

STORAGE MODULE DRIVES, 25-80 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1979 Shipments		Forecast							
			1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	182.9	310.5	206.2	346.2	226.4	377.3	246.5	410.8	268.3	446.2
TOTAL U.S. CAPTIVE	182.9	310.5	206.2	346.2	226.4	377.3	246.5	410.8	268.3	446.2
PCM	5.2	5.2	6.4	6.4	6.3	7.6	7.5	10.0	6.2	7.4
OEM	108.6	140.4	153.6	198.8	158.2	205.6	165.4	214.7	169.4	220.2
TOTAL U.S. NON-CAPTIVE	113.8	145.6	160.0	205.2	164.5	213.2	172.9	224.7	175.6	227.6
TOTAL U.S. SHIPMENTS	296.7	456.1	366.2	551.4	390.9	590.5	419.4	635.5	443.9	673.8
Non-U.S. Manufacturers										
Captive	--	6.5	--	9.6	--	17.6	--	32.2	--	43.7
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	1.3	--	2.6	--	7.6	--	14.2	--	17.9
TOTAL NON-U.S. SHIPMENTS	--	7.8	--	12.2	--	25.2	--	46.4	--	61.6
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	296.7	463.9	366.2	563.6	390.9	615.7	419.4	681.9	443.9	735.4
OEM Average Price ($000)	4.6	4.6	4.8	4.8	4.6	4.6	4.4	4.5	4.3	4.4

TABLE 20

STORAGE MODULE DRIVES, 25-80 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1979		Forecast							
	Shipments		1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	11.9	20.2	13.4	22.5	14.7	24.5	15.9	26.5	17.2	28.6
TOTAL U.S. CAPTIVE	11.9	20.2	13.4	22.5	14.7	24.5	15.9	26.5	17.2	28.6
PCM	.4	.4	.5	.5	.5	.6	.6	.8	.5	.6
OEM	23.6	30.5	32.3	41.8	34.4	44.7	37.6	48.8	39.4	51.2
TOTAL U.S. NON-CAPTIVE	24.0	30.9	32.8	42.3	34.9	45.3	38.2	49.6	39.9	51.8
TOTAL U.S. SHIPMENTS	35.9	51.1	46.2	64.8	49.6	69.8	54.1	76.1	57.1	80.4
Non-U.S. Manufacturers										
Captive	--	.4	--	.6	--	1.1	--	2.0	--	2.7
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	.2	--	.4	--	1.2	--	2.4	--	3.2
TOTAL NON-U.S. SHIPMENTS	--	.6	--	1.0	--	2.3	--	4.4	--	5.9
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	35.9	51.7	46.2	65.8	49.6	72.1	54.1	80.5	57.1	86.3
Installed at Year End										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	72.7	104.9	118.9	170.7	168.5	242.8	222.6	323.3	279.7	409.6
WORLDWIDE TOTAL	72.7	104.9	118.9	170.7	168.5	242.8	222.6	323.3	279.7	409.6

TABLE 21

STORAGE MODULE DRIVES, 25-80 MB

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

Distribution Channel	1979 U.S. Net Shipments Units (000)	%	FORECAST 1980 %	1981 %	1982 %	1983 %
Mainframe computer manufacturers	0.3	1.3	1.8	2.4	2.3	2.2
Mini/micro computer manufacturers	17.5	72.9	61.9	52.7	44.7	38.1
System OEMs/systems houses	3.2	13.3	23.0	31.4	39.1	45.6
Independent peripherals suppliers	2.6	10.8	11.5	11.7	12.0	12.2
Direct to end user/retail dealers	0.4	1.7	1.8	1.8	1.9	1.9
TOTAL	24.0					

TABLE 22

STORAGE MODULE DRIVES, 25-80 MB

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1979 Net Shipments To United States Destinations Units (000)	%	Worldwide Units (000)	%
Control Data	17.6	73.3	21.9	70.4
Century Data Systems	5.4	22.5	6.0	19.3
Other U.S.	1.0	4.2	3.0	9.7
Other Non-U.S.	--	--	0.2	0.6
TOTAL	24.0	100.0	31.1	100.0

DISK PACK DRIVES, MORE THAN 100 MB

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, BD-160
Burroughs	9383-16, 9484-8
Century Data Systems	T-200, T-300, T-600
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
Isotimpex	ES-5066, ES-5067
ISS/Univac	733-10, 733-11, 733-12
Memorex	3670, 3675, 677
Mitsubishi	M2836A, M2837, M2838F
Nippon Electric	N276, N277
Siemens	3465, 3468
Toshiba	DSU-450

Except for the special versions noted below, all drives in the group are based on IBM's 3330 drive and 3336 pack, with 19 data surfaces. Most of the drives of this type currently manufactured are equivalent to the 200 MB IBM 3330-11 or the increasingly important Control Data 300 MB SMD, which achieves its additional capacity with a 50% increase in linear recording density (BPI).

A variety of other drives using removable packs with unique physical configurations are currently offered: Hewlett-Packard 7925 (120 MB on nine surfaces), Ball BD-100 and Ampex DM-9160 (160 MB on five surfaces), Burroughs 9393-16 (174 MB on twenty surfaces), Siemens 3465 (143 MB on nine surfaces), and ISS 7330-12 (317.5 MB, the equivalent to IBM's 3350, with a nineteen surface removable disk pack).

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1979	1980	1981	1982	1983
U.S. manufacturers	614.9	662.0	632.7	560.9	462.1
All manufacturers	880.9	895.0	837.6	737.4	618.4

A surprising surge in shipments of both 200 MB 3330 equivalent drives and 300 MB SMDs to OEM customers has occurred in 1979 and 1980, creating a much higher shipment level for U.S. OEM drive manufacturers than was anticipated in the last DISK/TREND report. 1979 shipments of 13,300 spindles were up 25.5% over 1978, and 1980's shipments are estimated to be up a startling 95.5%, to 26,000 units. The explanation of this increase appears to be a combination of high activity levels among system OEMs offering mainframes, superminis and larger small business systems, the growth of capacity-hungry data base management systems, and a frequent preference to stay with removable disk drives. Control Data again held the leading market share for non-captive drives, with 47.5% in 1979. Memorex' 31.6% share is based heavily on shipments to DEC.

On the other hand, worldwide captive production of drives in this group apparently peaked in 1979, with a slight decline expected in 1980, as several major mainframers start to emphasize large fixed disk drives.

The very small remaining production of PCM new drives has been overshadowed in 1980 by the larger number of retirements, yielding a negative value for the first time. It is believed that IBM went into the negative shipment area in 1979.

Marketing trends

Shipments of OEM drives are finally expected to peak in 1981, with

declines thereafter, as the result of improved competition from fixed disk drives ranging from 160 MB to 675 MB. Captive production should continue to decrease through 1983, suffering from product planning choices already made by the major mainframers and minicomputer manufacturers, also in favor of large fixed disk drives. Despite declining production for these key market classes, however, production of new drives in 1983 is expected to still be as high as 44,600 spindles, reflecting this product group's workhorse hold in the industry. IBM and PCM drive retirements will continue to grow, as improved disk drives and systems are introduced.

Technical trends

The only known pending product innovations in this product group involve the increased track density planned for drives such as the Ampex DM-9160, Ball BD-160 and Century T-600. Delays in achieving market entry for these drives, which operate in the 740 to 768 TPI range, suggest nagging technical difficulties in achieving adequate media interchangability over a large population of drives, under varying field conditions. These considerations, plus lack of support by CDC, the OEM drive leader, presently indicate a poor outlook for these products.

Forecasting assumptions

1. The population of IBM and PCM 3330 drives is now declining, due to the impact of IBM's 3350 and successor drives.
2. IBM will not introduce any other large removable disk drive.
3. OEM drives will decline after 1981 due to the impact of large fixed disk drives, and captive drives will continue their current decline for the same cause.

TABLE 23

DISK PACK DRIVES, MORE THAN 100 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1979		Forecast							
	Shipments		1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	287.3	458.7	259.9	417.2	228.9	369.6	186.8	302.5	146.5	237.6
TOTAL U.S. CAPTIVE	287.3	458.7	259.9	417.2	228.9	369.6	186.8	302.5	146.5	237.6
PCM	29.9	39.9	10.4	13.8	--	--	--	--	--	--
OEM	94.4	116.3	163.5	231.0	186.6	263.1	175.7	258.4	152.2	224.5
TOTAL U.S. NON-CAPTIVE	124.3	156.2	173.9	244.8	186.6	263.1	175.7	258.4	152.2	224.5
TOTAL U.S. SHIPMENTS	411.6	614.9	433.8	662.0	415.5	632.7	362.5	560.9	298.7	462.1
Non-U.S. Manufacturers										
Captive	--	266.0	--	228.8	--	199.8	--	171.6	--	152.5
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	--	--	4.2	--	5.1	--	4.9	--	3.8
TOTAL NON-U.S. SHIPMENTS	--	266.0	--	233.0	--	204.9	--	176.5	--	156.3
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	411.6	880.9	433.8	895.0	415.5	837.6	362.5	737.4	298.7	618.4
OEM Average Price ($000)	8.7	8.7	8.9	8.9	8.8	8.8	8.7	8.7	8.6	8.6

TABLE 24

DISK PACK DRIVES, MORE THAN 100 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1979		Forecast							
	Shipments		1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	(.5)	(.9)	(2.3)	(4.2)	(3.6)	(6.7)	(3.8)	(7.2)	(3.5)	(6.6)
Other U.S. Captive	12.4	19.8	11.9	19.1	10.9	17.6	9.2	14.9	7.4	12.0
TOTAL U.S. CAPTIVE	11.9	18.9	9.6	14.9	7.3	10.9	5.4	7.7	3.9	5.4
PCM	.9	1.2	(.6)	(.8)	(1.9)	(2.4)	(2.4)	(3.0)	(3.1)	(3.9)
OEM	10.8	13.3	18.4	26.0	21.2	29.9	20.2	29.7	17.7	26.1
TOTAL U.S. NON-CAPTIVE	11.7	14.5	17.8	25.2	19.3	27.5	17.8	26.7	14.6	22.2
TOTAL U.S. SHIPMENTS	23.6	33.4	27.4	40.1	26.6	38.4	23.2	34.4	18.5	27.6
Non-U.S. Manufacturers										
Captive	--	9.5	--	8.2	--	7.4	--	6.6	--	6.1
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	--	--	.4	--	.5	--	.5	--	.4
TOTAL NON-U.S. SHIPMENTS	--	9.5	--	8.6	--	7.9	--	7.1	--	6.5
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	23.6	42.9	27.4	48.7	26.6	46.3	23.2	41.5	18.5	34.1
Installed at Year End										
IBM	40.8	68.6	38.5	64.4	34.9	57.7	31.1	50.5	27.6	43.9
Non-IBM	106.5	189.2	136.2	242.1	166.4	295.1	193.4	343.8	215.4	384.5
WORLDWIDE TOTAL	147.3	257.8	174.7	306.5	201.3	352.8	224.5	394.3	243.0	428.4

TABLE 25

DISK PACK DRIVES, MORE THAN 100 MB

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

Distribution Channel	1979 U.S. Net Shipments Units (000)	%	FORECAST 1980 %	1981 %	1982 %	1983 %
Mainframe computer manufacturers	1.4	10.9	10.7	10.5	10.3	10.0
Mini/micro computer manufacturers	7.1	55.5	60.5	62.5	62.7	62.0
System OEMs/systems houses	1.5	11.7	17.5	19.0	19.6	20.1
Independent peripherals suppliers	0.8	6.3	6.5	6.9	7.4	7.9
Direct to end user/retail dealers	2.0	15.6	4.8	1.1	--	--
TOTAL	12.8					

TABLE 26

DISK PACK DRIVES, MORE THAN 100 MB

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1979 Net Shipments To United States Destinations Units (000)	%	Worldwide Units (000)	%
Control Data	5.0	39.1	7.5	47.5
Memorex	4.9	38.3	5.0	31.6
Other U.S.	2.9	22.6	3.3	20.9
TOTAL	12.8	100.0	15.8	100.0

Notes: 1. Includes drives manufactured by ISS and resold by others in the PCM market.
2. Based on shipments of new drives, before deduction for retirements of PCM drives.

DATA MODULE DRIVES, 35-70 MB

1980 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

All drives in this group are designed to provide media interchangability with standard IBM 3348 data modules and equivalent products from independent media manufacuteres, in the 35 MB, 70 MB or 70F MB versions.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1979	1980	1981	1982	1983
U.S. manufacturers	79.3	4.3	2.6	--	--
All manufacturers	90.7	10.2	5.7	--	--

The IBM 3340 holds a unique distinction in the disk drive industry as the original "Winchester" drive, introducing technology in 1973 which has influenced the design of more individual disk drive models than any other previous key industry product. Ironically, however, the removable data module feature, and the specific IBM configurations, have been copied only in the CDC 9770 and the NPL NP20. The rest of the industry decided that the costly data module, containing heads and arms in addition to disks, was priced too high for their markets, in view of the limited capacity offered.

The IBM 3340 remained in quantity production until 1979, with an estimated DISK/TREND peak installed base of 65,000 spindles. However, non-IBM production is expected to top out at 9,900 in 1981. U.S. OEM production by Control Data has gone primarily to NCR, which markets the drive as the NCR 6590. The NPL PCM drive has been distrubted by Memorex in the U.S. and by BASF in Europe, with captive versions used with systems marketed by NPL's parent companies, Fujitsu and Hitachi. Worldwide total non-IBM production was only 1,600 spindles in 1979, and is estimated at less than a thousand units in 1980. Movement to more cost effective disk drives by IBM and the other system manufacturers using equivalent drives has sealed the coffin for the 3340.

Marketing trends

IBM 3340s were widely installed on System/3 and the low end of System/370. Now that IBM has started to impact these installed system populations with deliveries of System/38, 4331 and 4341 -- combined with new disk drives such as the 3310 and 3370 -- the 3340s are expected to be retired in large quantities starting in 1981.

The limited PCM programs using NPL's drives are not expected to continue in 1981. The existing captive applications for the NPL drive are expected to be phased out during the next year or two.

NCR's purchases of the Control Data drive are declining under pressure from more cost effective disk drive configurations. The program is likely to end in 1981. Adoption of the CDC 9770 by any other significant OEM remains very unlikely, due to unfavorable comparisons with other drive formats, in both hardware and media costs.

Technical trends

No further IBM product introductions are expected in this group of disk drives. IBM's newer fixed disk drives all employ head-disk assemblies intended to be removed only by customer engineers, not by customers.

NPL had previously announced the NP22, a double track density version of the standard 3340, with a 140 MB capacity. Regardless of the technical feasability of this drive, NPL has apparently withdrawn it, in view of the overall decline in the 3340 market.

Forecasting assumptions

1. IBM will not extend the 3340 class of products with new introductions, and will not reinstitute new production for the 3340.

2. OEM markets for drives in this class will remain negligible, due to the lower drive and media costs for alternative disk drives. The limited PCM market will be phased out, for the same reasons.

TABLE 27

DATA MODULE DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1979		Forecast							
	Shipments		1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	46.8	72.5	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	46.8	72.5	--	--	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	6.8	6.8	4.3	4.3	2.6	2.6	--	--	--	--
TOTAL U.S. NON-CAPTIVE	6.8	6.8	4.3	4.3	2.6	2.6	--	--	--	--
TOTAL U.S. SHIPMENTS	53.6	79.3	4.3	4.3	2.6	2.6	--	--	--	--
Non-U.S. Manufacturers										
Captive	--	7.8	--	4.7	--	3.1	--	--	--	--
PCM	1.2	3.6	--	1.2	--	--	--	--	--	--
OEM	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	1.2	11.4	--	5.9	--	3.1	--	--	--	--
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	54.8	90.7	4.3	10.2	2.6	5.7	--	--	--	--
OEM Average Price ($000)	8.5	8.5	8.6	8.6	8.7	8.7	--	--	--	--

TABLE 28

DATA MODULE DRIVES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1979		Forecast							
	Shipments		1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	3.1	4.8	--	--	(1.4)	(2.1)	(3.8)	(5.6)	(4.1)	(6.1)
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	3.1	4.8	--	--	(1.4)	(2.1)	(3.8)	(5.6)	(4.1)	(6.1)
PCM	--	--	--	--	--	--	--	--	--	--
OEM	.8	.8	.5	.5	.3	.3	--	--	--	--
TOTAL U.S. NON-CAPTIVE	.8	.8	.5	.5	.3	.3	--	--	--	--
TOTAL U.S. SHIPMENTS	3.9	5.6	.5	.5	(1.1)	(1.8)	(3.8)	(5.6)	(4.1)	(6.1)
Non-U.S. Manufacturers										
Captive	--	.5	--	.3	--	.2	--	--	--	--
PCM	.1	.3	--	.1	--	--	--	--	--	--
OEM	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	.1	.8	--	.4	--	.2	--	--	--	--
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	4.0	6.4	.5	.9	(1.1)	(1.6)	(3.8)	(5.6)	(4.1)	(6.1)
Installed at Year End										
IBM	42.2	65.0	42.2	65.0	40.8	62.9	37.0	57.3	32.9	51.2
Non-IBM	2.9	8.5	3.4	9.4	3.7	9.9	3.7	9.9	3.7	9.9
WORLDWIDE TOTAL	45.1	73.5	45.6	74.4	44.5	72.8	40.7	67.2	36.6	61.1

TABLE 29

DATA MODULE DRIVES

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

Distribution Channel	1979 U.S. Net Shipments Units (000)	%	FORECAST 1980 %	1981 %	1982 %	1983 %
Mainframe computer manufacturers	0.8	88.9	83.3	100.0	--	--
Mini/micro computer manufacturers	0.0	--	--	--	--	--
System OEMs/systems houses	0.0	--	--	--	--	--
Independent peripherals suppliers	0.0	--	--	--	--	--
Direct to end user/retail dealers	0.1	11.1	16.7	--	--	--
TOTAL	0.9					

FIXED DISK DRIVES, LESS THAN 30 MB

1980 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
BASF	6150
Burroughs	9493-9
Century Data Systems	Marksman M-10, M-20
Control Data	9414, 9730-12, 230-20
Data General	6102, 6104
Digital Equipment	RK05F
Fujitsu	M-2251, M-2252
Hewlett-Packard	7910
Hitachi	MFD 90/135, DK 62-20
Hokushin	CD-2800
Kennedy	5301-14
Microdata	Reflex 7501
Mitsubishi	M 2883-10/20
Nippon Electric Company	N 7721, D 1210
Northern Telecom	4518, 4510
Okidata	3301
Pertec	D1451
Philips	X1250, X1220
Shugart Associates	SA 4004, SA 4008
Toshiba	MK-100F

8" disk diameter

IBM	4963-29, 8100 system, 5520 system
BASF	6171, 6172
Data Recording Equipment	3112, 3120
Fujitsu	M-2301, M-2302
Hitachi	DK 801
Hokushin	CD-8005, CD-8020
International Memories	7710
Kennedy	7000
Memorex	101, 102
Microcomputer Systems	MSC-8100
Micropolis	1201-I, 1222-I
New World	Mikro-Disk VIII-1
Pertec	D 8000
Priam	Diskos 2050
Shugart Associates	SA 1002, SA 1004
SLI Industries	Cheyenne
Toshiba	MK80F-10

5.25" disk diameter

New World	Mikro-Disk V-1TF
Shugart Technology	ST 506
Tandon Magnetics	172-3-DC, 254-2-DC

This DISK/TREND group now includes a combination of 14 inch, 8 inch and 5.25 inch fixed disk drives, since all perform the same basic function, for the same application areas. The 14 inch drive subgroup is a mixture of old and new product designs, including both Winchester technology, mostly 3340 level, and drives designed with older 2314 and 3330 technologies. Most of the 8 inch and 5.25 inch drives announced to date use variations of 3340 or 3350 Winchester technology. IBM's "Piccolo" 8 inch drives use a refinement of Winchester technology, operating at 450 TPI, 8530 BPI. The novel New World drives offer either coated or plated disks.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1979	1980	1981	1982	1983
U.S. manufacturers	260.0	413.1	585.0	759.7	864.2
All manufacturers	310.3	491.7	709.1	924.5	1,088.1

Until 1979, the 14 inch Gulliver drive was IBM's principal product in this drive group. The Gulliver is a one-platter drive using 3340 technology, and reached estimated production levels in excess of 20,000 drives per year for use with System/32, System/34 Series 1 and various terminals. Gulliver production is now in decline, and the growth in IBM's low-end fixed disk drives is concentrated in the three-platter version of the Piccolo.

In 1979, OEM shipments of 14 inch drives in this group were evenly split between drives using older 2314 and 3330 technology, and newer Winchester drives designed for low cost, such as the Shugart 4000 series and the Century Marksman series. However, starting in 1980, the Winchester drives are dominating shipments of OEM drives, on the strength of numerous adoptions of the newer drives for a wide variety of systems. Worldwide shipments of 14 inch OEM drives were 12,600 units in 1979, rising to 20,800 units in 1980.

The most significant activity in OEM drives was the long-anticipated acceleration of 8 inch disk drive shipments. In 1979 only two thousand pioneer 8 inch drives were shipped, but the worldwide 1980 OEM total is projected at 30,900 units. At least nine companies are expected to be shipping such drives by the end of 1980, with the volume leadership held by Shugart Associates and International Memories.

Also being watched closely in the industry is the development of production for OEM 5.25 inch Winchester drives. Although a specific product was not announced until early 1980, the Shugart Technology ST 560 is expected to be in limited production prior to the close of 1980. Other firms are expected to enter this market with comparable drives, but none are expected to start shipments until 1981.

Captive drives in this group have been in production for the last few years, using both Winchester and earlier recording technology. However, the newly designed 14 inch Winchester drives introduced in 1979 by Data General, Hewlett-Packard and several non-U.S. companies have resulted in greatly increased shipments in 1980. Worldwide non-IBM

shipments of captive 14 inch drives totaled 29,200 drives in 1980, up 83.7% over 1979. Non-IBM captive shipments of 8 inch drives are just starting in 1980.

The need to provide backup for data stored on fixed disks is a requirement which is generally recognized, and which has created apparent obstacles for many system OEMs considering for the first time the use of small fixed disk drives. Industry participants with large system experience have relied on ½ inch computer tape for disk back up for the last two decades -- but the hardware cost for this solution was seen as too high by most small system planners. Floppy drives so far available are too limited in capacity for convenient 100% disk back-up, and high capacity versions of the ¼ inch tape cartridge drive have been in limited supply, from only one supplier.

The core of the "backup problem" has been the need to find convenient and cost effective hardware/media solutions -- without which real growth could not occur in the low cost small fixed disk drive market. At this time the industry seems to have found not a single, ideal solution, but several solutions which are perceived as at least adequate.

Since floppy drives are frequently used in small systems because of their low cost, size and media handling convenience under traditional usage patterns, many OEMs have attempted to use them for backup with small fixed disks. Those OEMs which have provided the operating system capability to selectively back up data stored on the fixed disks have a good answer for their customers, but selective backup is not available on the majority of systems. Without selective backup, a user is faced with the need to back up most of the fixed disk, a cumbersome task with floppies.

Since the movement to selective backup is expected to take many years, due to the expense of software development and use of additional disk capacity, 100% disk backup remains the basic pattern for most system OEMs. Many such OEMs, especially those with larger multi-terminal small business systems, have found the new ½ inch tape streaming drives to be the preferred backup answer, expecially when interchange with larger systems is needed. A larger number of system OEMs is apparently finding the answer in the high capacity ¼ inch tape cartridge drives pioneered by Data Electronics, Inc. The DEI momentum in this industry segment was built on drives operating in the conventional start/stop mode, but hardware prices have dropped dramatically with the introduction of high capacity streaming mode drives. DEI's status as the only source for production drives of this type has been a limiting factor with many OEMs, but the firm's success has attracted several competitors, soon to be in production.

At this time, the rapidly developing shipment levels for small fixed disk drives seem to indicate that system OEMs are ready to utilize the backup solutions now available.

Marketing trends

IBM's current product lines are expected to require much higher quantities of Piccolo drives in capacities above 30 MB than in this product group. DISK/TREND projections for IBM drives in this group assume a modest growth in total drives produced through 1983, but with a sharp transition from 14 inch to 8 inch drives.

Like IBM, the rest of the world's computer industry is clearly going to transition to the use of low capacity disk drives with disk diameters smaller than 14 inches. The DISK/TREND projection for 1983 estimates worldwide 14" drive shipments in this group at only 16% of the total, with 8 inch drives at 54% and 5.25 inch drives at 30%. The group total for all drives is forecasted to rise from 1980's 107,400 units to 471,500 in 1983, an average annual increase of 64.7%.

Worldwide OEM shipments are expected to grow even faster. The 1980 total for all disk diameters is an estimated 55,600 spindles, with the 1983 projection at 337,900, an 85.0% average annual growth. Shipments of 14 inch drives are expected to peak in 1981, the victim of smaller, lower priced drives with equivalent features.

8 inch OEM drive production is ready to move into high gear in 1981, in the United States, Japan and Europe. 1980's estimated 30,900 drives is expected to grow to 74,600 in 1981, reaching 197,100 in 1983, representing 89.4% average annual growth.

5.25 inch OEM drives are a more speculative forecasting problem, in that no production capability has actually been established, and only one of the several expected drives has even been announced. Nevertheless, the industry's appetite for such drives is known, and the extent of existing development programs is impressive. The DISK/TREND estimate for 5.25 inch drive OEM shipments in 1981 is 23,000 units, with 1983 shipments reaching 122,000.

Two fairly distinct types of drives are becoming apparent to the industry encompassing all disk diameters in this product group. Commencing first with the 14 inch Winchester drives which started to be introduced

in the mid-1970s, drives in this group usually offer either the lowest practical price combined with slow access times, or offer a price typically 30 to 50% higher, combined with access as much as twice as fast. The same pattern has been followed with 8 inch drives, with the cheap, slow drives typified by the Shugart Associates SA 1000 series, and the faster, more costly drives exemplified by the 8 inch Micropolis, IMI and BASF drives. The only 5.25 inch drive formally announced so far is the Shugart Technology drive, which is a member of the cheap, slow subgroup. It is reasonable to expect that higher performance 5.25 inch drives will come later.

The key market which is driving the rapid development of shipments for the cheap, slow 8 and 5.25 inch Winchester drives is the very small business system area. These systems typically use only one workstation, and the combination of fairly slow access times, low price, small physical size and higher capacity than floppies offer is a good example of the right product at the right time. This market segment is expected to provide a higher growth level than that available to the faster, more costly drives. That group, however, also has an attractive, if somewhat smaller market, in the numerous multi-terminal small systems already introduced, with many more in development. These systems, which cover a wide range of applications, require the faster access of the more costly drives, and generally also have a need for the higher capacities offered.

Non-IBM captive production of 8 inch drives is expected to be underway in earnest in 1981, with shipments projected at 11,300 drives. Captive shipments of 5.25 inch drives will probably not start until 1982. Unless major new captive manufacturing programs for 8 and 5.25 inch

drives are initiated in the near future, shipment levels through 1983 will be relatively small compared to OEM shipments. 1980's estimated non-IBM captive shipments of 14 inch drives totaling 29,200 spindles are expected to grow to 40,300 in 1981 and 48,100 in 1982, then remain flat for a few years.

PCM drive shipments, with IBM's Series/1 as the only practical target market will remain minor, with a transition to 8 inch drives starting to occur in 1982.

Forecasting assumptions

1. IBM's system requirements for fixed disk drives less than 30 MB will grow at a modest rate through 1983, due to a greater emphasis on applications requiring larger drives.

2. The momentum of existing non-IBM 14 inch captive drive programs will continue, with 8 and 5.25 inch production not exceeding 14 inch until 1983.

3. Shipments of 14 inch OEM drives will peak in 1981. Both 8 and 5.25 inch drives will achieve very high growth rates through 1983, with 8 inch drives shipping in greater quantities, due to earlier availability and wider applicability. Non-U.S. OEM 8 and 5.25 inch drives 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 and effective competition from IBM.

TABLE 30

FIXED DISK DRIVES, LESS THAN 30 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1979		Forecast							
	Shipments		1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	93.0	133.4	101.7	147.0	130.4	184.1	166.6	229.5	178.4	251.4
Other U.S. Captive	67.5	96.9	141.6	192.5	185.5	264.0	243.0	343.4	278.8	389.6
TOTAL U.S. CAPTIVE	160.5	230.3	243.3	339.5	315.9	448.1	409.6	572.9	457.2	641.0
PCM	1.6	1.6	2.4	2.4	3.0	4.6	4.4	7.3	4.8	8.3
OEM	24.4	28.1	62.1	71.2	102.7	132.3	136.6	179.5	162.0	214.9
TOTAL U.S. NON-CAPTIVE	26.0	29.7	64.5	73.6	105.7	136.9	141.0	186.8	166.8	223.2
TOTAL U.S. SHIPMENTS	186.5	260.0	307.8	413.1	421.6	585.0	550.6	759.7	624.0	864.2
Non-U.S. Manufacturers										
Captive	--	43.0	--	59.8	--	87.0	--	100.8	7.8	124.8
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	7.3	8.1	18.8	15.8	37.1	26.4	64.0	40.0	99.1
TOTAL NON-U.S. SHIPMENTS	--	50.3	8.1	78.6	15.8	124.1	26.4	164.8	47.8	223.9
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	186.5	310.3	315.9	491.7	437.4	709.1	577.0	924.5	671.8	1,088.1
OEM Average Price ($000)	1.9	2.0	1.6	1.6	1.3	1.3	1.1	1.1	.9	.9

TABLE 31

FIXED DISK DRIVES, LESS THAN 30 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1979		Forecast							
	Shipments		1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	13.6	19.5	13.7	19.8	16.5	23.3	19.6	27.0	20.5	28.9
Other U.S. Captive	7.6	10.9	18.1	24.6	28.1	40.0	41.9	59.2	56.9	79.5
TOTAL U.S. CAPTIVE	21.2	30.4	31.8	44.4	44.6	63.3	61.5	86.2	77.4	108.4
PCM	.2	.2	.3	.3	.4	.6	.6	1.0	.7	1.2
OEM	12.7	14.6	40.0	45.8	79.0	101.8	124.2	163.2	180.0	238.8
TOTAL U.S. NON-CAPTIVE	12.9	14.8	40.3	46.1	79.4	102.4	124.8	164.2	180.7	240.0
TOTAL U.S. SHIPMENTS	34.1	45.2	72.1	90.5	124.0	165.7	186.3	250.4	258.1	348.4
Non-U.S. Manufacturers										
Captive	--	5.0	--	7.1	--	11.6	--	15.5	1.5	24.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	2.8	4.2	9.8	10.5	24.7	24.0	58.2	40.0	99.1
TOTAL NON-U.S. SHIPMENTS	--	7.8	4.2	16.9	10.5	36.3	24.0	73.7	41.5	123.1
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	34.1	53.0	76.3	107.4	134.5	202.0	210.3	324.1	299.6	471.5
Installed at Year End										
IBM	61.2	86.4	74.9	106.2	91.4	129.5	111.0	156.5	131.5	185.4
Non-IBM	38.9	63.9	101.5	151.5	219.5	330.2	410.2	627.3	689.3	1,069.9
WORLDWIDE TOTAL	100.1	150.3	176.4	257.7	310.9	459.7	521.2	783.8	820.8	1,255.3

TABLE 32

FIXED DISK DRIVES, LESS THAN 30 MB

WORLDWIDE SHIPMENTS

14", 8" AND 5.25" DISK DIAMETERS

	DISK DRIVE SHIPMENTS, BY SHIPMENT DESTINATION (000)														
	1979 Shipments			Forecast 1980			1981			1982			1983		
	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"
U.S. Manufacturers															
IBM	19.0	0.5	--	16.0	3.8	--	14.5	8.8	--	11.2	15.8	--	6.0	22.9	--
Other U.S. Captive	10.9	--	--	22.6	2.0	--	32.5	7.5	--	40.6	13.6	5.0	43.0	22.5	14.0
PCM	0.2	--	--	0.3	--	--	0.6	--	--	0.7	0.3	--	0.5	0.7	--
OEM	12.6	2.0	--	20.8	24.6	0.4	24.8	57.0	20.0	22.2	96.0	45.0	16.7	139.1	83.0
TOTAL U.S. SHIPMENTS	42.7	2.5	--	59.7	30.4	0.4	72.4	73.3	20.0	74.7	125.7	50.0	66.2	185.2	97.0
Non-U.S. Manufacturers															
Captive	5.0	--	--	6.6	0.5	--	7.8	3.8	--	7.5	7.5	0.5	6.0	14.5	3.5
PCM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	2.8	--	--	3.5	6.3	--	4.1	17.6	3.0	3.2	38.0	17.0	2.1	58.0	39.0
TOTAL NON-U.S. SHIPMENTS	7.8	--	--	10.1	6.8	--	11.9	21.4	3.0	10.7	45.5	17.5	8.1	72.5	42.5
TOTAL WORLDWIDE SHIPMENTS	50.5	2.5	--	69.8	37.2	0.4	84.3	94.7	23.0	85.4	171.2	67.5	74.3	257.7	139.5
14"/8"/5.25" ANNUAL SHARE	95%	5%	--	65%	35%	--	42%	47%	11%	26%	53%	21%	16%	54%	30%

TABLE 33

FIXED DISK DRIVES, LESS THAN 30 MB

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

Distribution Channel	1979 U.S. Net Shipments Units (000)	1979 U.S. Net Shipments %	FORECAST 1980 %	1981 %	1982 %	1983 %
Mainframe computer manufacturers	4.1	31.8	22.3	16.7	13.4	11.4
Mini/micro computer manufacturers	1.0	7.8	9.8	10.7	8.6	6.0
System OEMs/systems houses	5.9	45.7	55.8	62.4	69.3	74.9
Independent peripherals suppliers	1.8	13.9	11.1	8.9	7.1	5.7
Direct to end user/retail dealers	0.1	0.8	1.0	1.3	1.6	2.0
TOTAL	12.9					

TABLE 34

FIXED DISK DRIVES, LESS THAN 30 MB

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1979 Net Shipments To United States Destinations Units (000)	To United States Destinations %	Worldwide Units (000)	Worldwide %
Control Data	5.8	45.0	6.6	37.5
Shugart Associates	3.0	23.3	3.2	18.2
International Memories	1.9	14.7	2.0	11.4
Other U.S.	2.2	17.0	3.0	17.0
Other Non-U.S.	--	--	2.8	15.9
TOTAL	12.9	100.0	17.6	100.0

FIXED DISK DRIVES, 30-200 MB

1980 DISK/TREND REPORT

FIXED DISK DRIVES, 30-200 MB

Coverage

Examples of disk drives in this group include:

14" disk diameter

Ampex	DF-980, DF-9150
Ball	BFM 90, BFM 160
BASF	6150
Burroughs	FD 214
Century Data Systems	Marksman M-40
Control Data	9730-80/160, 230-30
Fujitsu	F436, M2284
Hitachi	DK 62-80
Hokushin	CD-6030
ISS/Univac	717, 8402, 8417
Kennedy	5303-70
Memorex	601, 612
Microdata	Reflex 7503
Mitsubishi	M-2883-60, M-2884-2
Nippon Electric Company	N 7723, D 1240
Okidata	3306
Priam	Diskos 3350, 15450
Storage Technology	2720
Toshiba	MK-300F

10.5" disk diameter

Cii-Honeywell Bull	D168

8" disk diameter

IBM	3310, 4963-64, System/34-38, 8100 System
BASF	6173
Computer Peripherie Technik	HT40, HT70
Data Recording Equipment	3144
Fujitsu	M2311, M2312
Hokushin	CD-8030
Micropolis	1203-I, 1223-I
Nippon Peripherals, Ltd.	NP30, NP31
Priam	Diskos 3450
SLI Industries	Cheyenne
Toshiba	MK80F-30

All IBM drives in this group are actually the same basic Piccolo drive, using 450 TPI, 8530 BPI densities with 210 mm disks. The drives

from other manufacturers all use variations on 3340 or 3350 Winchester technology, except for the Cii-HB thin film heads and the CPT plated disks.

Market status

DISK/TREND estimate of total market value:

Worldwide sales ($M)	1979	1980	1981	1982	1983
U.S. manufacturers	177.0	477.0	854.9	1,328.0	1,643.7
All manufacturers	277.8	650.3	1,136.0	1,765.5	2,174.2

The expected start of dynamic growth for this product group is now underway. While only 4,700 spindles were shipped worldwide in 1978, total shipments in 1979 are estimated at 27,700, increasing to a projected 64,400 in 1980. IBM's rapid production buildup for the Piccolo drive accounts for roughly half of these increases, and also is the reason that over half of 1980's total shipments will be 8 inch drives. The 1979 IBM production is believed to be lower than last year's DISK/TREND forecast, due to delay of System/38 shipments until July, 1980.

1979 OEM drive shipments consisted entirely of 14 inch drives, mostly in the 80 MB range, for the high-end small business system market. The 1979 shipments of 14 inch drives from U.S. manufacturers were more than double the 1978 total, and a comparable increase is occurring in 1980. OEM 8 inch drive shipments are also starting in 1980, with capacities in the 35-40 MB range.

Non-IBM captive shipments will roughly double in 1980 to a worldwide total of 14,900 spindles. Shipments by non-U.S. manufacturers account for 10,500 spindles from that total, as a result of greater emphasis on development of Winchester drives in this class by Japanese firms.

Marketing trends

The IBM Piccolo is used on a growing list of major IBM systems, and the combined shipment expectation for these systems during the next several years is huge. The DISK/TREND projection for Piccolo drive shipments in this product group has been increased this year, to reflect this expectation. Enhanced versions of the current 64 MB drive are assumed in these projections.

While other captive drive shipments by U.S. manufacturers are forecasted for increases, the growth curve is running about a year later than previous DISK/TREND projections, because of development delays in the programs of a few key manufacturers. Non-U.S. captive drive shipments, however, are based on products already in production, and previous DISK/TREND estimates are still appropriate. It is probable that shipments of 8 inch captive drives by Japanese manufacturers will start in 1981, a year before non-IBM U.S. captive 8 inch drive shipments commence.

Aggressive growth for OEM drives is expected for both U.S. and non-U.S. manufacturers through 1983, with non-U.S. manufacturers enjoying a 160.8% average annual growth, compared to 71.1% for the U.S. manufacturers. Most of this difference will be attributable to a headstart by Japanese manufacturers in development of high capacity 8 inch drives, a product area given lower priority by U.S. manufacturers.

PCM drive penetration of the IBM markets for Piccolo drives is due to remain small, because of the limited possibilities for attachment of independent drives and the delayed availability of equivalent 8 inch drives in the U.S. marketplace.

Technical trends

It remains a good bet that the IBM Piccolo will probably be increased in capacity by two to four times at some point in its future. So far, IBM has limited production to the basic 64 MB design, filling various requirements for increased capacity with multiple-spindle versions. A higher density drive would obviously lower cost per megabyte, however, and presumably IBM will take that step when it finds it convenient. A double track version would not change the transfer rate, an important controller and system consideration. On the other hand, higher speed channels are already available on the 4331 systems, and could take the transfer rate which would result from higher linear recording densities. When IBM has tamed the production process for thin film heads, an enhanced Piccolo may be the result.

Regardless of IBM's actions, use of thin film heads on both 14 inch and 8 inch OEM drives is to be expected, as a fall-out from independent manufacture of 3370-type heads. The first OEM activity with these heads could occur in 1981, and is definitely expected by 1982.

Forecasting assumptions

1. IBM's massive backlog for systems using the Piccolo drive will necessitate extremely large production levels for this drive.

2. Other U.S. captive programs will continue to place emphasis on 14 inch drives through 1983. Non-U.S. captive programs will achieve higher production levels than U.S. manufacturers, due to priorities given this product area.

3. Worldwide OEM shipments will grow sharply through 1983. 14 inch drive shipments by non-U.S. firms will be roughly half of shipments by U.S. Manufacturers, but their 8 inch drive shipments will almost equal the U.S. manufacturers' shipments, due to early development emphasis.

4. PCM shipments will remain modest through 1983.

TABLE 35

FIXED DISK DRIVES, 30-200 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1979		Forecast							
	---Shipments--		-----1980-----		-----1981-----		-----1982-----		-----1983-----	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	79.4	127.4	226.6	362.6	385.6	612.4	576.7	912.6	685.0	1,074.3
Other U.S. Captive	33.4	33.4	51.3	72.9	109.9	155.8	187.7	268.2	262.3	373.7
TOTAL U.S. CAPTIVE	112.8	160.8	277.9	435.5	495.5	768.2	764.4	1,180.8	947.3	1,448.0
PCM	--	--	1.7	1.7	4.5	6.2	8.0	10.7	11.2	17.2
OEM	15.6	16.2	34.7	39.8	67.2	80.5	111.7	136.5	142.8	178.5
TOTAL U.S. NON-CAPTIVE	15.6	16.2	36.4	41.5	71.7	86.7	119.7	147.2	154.0	195.7
TOTAL U.S. SHIPMENTS	128.4	177.0	314.3	477.0	567.2	854.9	884.1	1,328.0	1,101.3	1,643.7
Non-U.S. Manufacturers										
Captive	--	91.5	--	162.5	27.0	228.0	45.9	337.5	85.8	391.3
PCM	--	--	--	--	1.8	5.5	2.7	7.2	3.5	7.9
OEM	.4	9.3	2.4	10.8	12.9	47.6	21.7	92.8	31.9	131.3
TOTAL NON-U.S. SHIPMENTS	.4	100.8	2.4	173.3	41.7	281.1	70.3	437.5	121.2	530.5
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	128.8	277.8	316.7	650.3	608.9	1,136.0	954.4	1,765.5	1,222.5	2,174.2
OEM Average Price ($000)	3.4	3.5	3.6	3.6	3.5	3.5	3.5	3.5	3.4	3.4

TABLE 36

FIXED DISK DRIVES, 30-200 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1979 Shipments		Forecast 1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	8.1	13.0	22.0	35.2	35.7	56.7	53.4	84.5	66.5	104.3
Other U.S. Captive	2.0	2.0	3.1	4.4	6.7	9.5	12.6	18.0	18.6	26.5
TOTAL U.S. CAPTIVE	10.1	15.0	25.1	39.6	42.4	66.2	66.0	102.5	85.1	130.8
PCM	--	--	.2	.2	.5	.7	.9	1.2	1.3	2.0
OEM	4.6	4.8	9.6	11.0	19.2	23.0	31.9	39.0	42.0	52.5
TOTAL U.S. NON-CAPTIVE	4.6	4.8	9.8	11.2	19.7	23.7	32.8	40.2	43.3	54.5
TOTAL U.S. SHIPMENTS	14.7	19.8	34.9	50.8	62.1	89.9	98.8	142.7	128.4	185.3
Non-U.S. Manufacturers										
Captive	--	5.4	--	10.5	1.8	15.2	3.4	25.0	6.6	30.1
PCM	--	--	--	--	.2	.6	.3	.8	.4	.9
OEM	.1	2.5	.7	3.1	3.8	14.0	6.2	26.5	9.1	37.5
TOTAL NON-U.S. SHIPMENTS	.1	7.9	.7	13.6	5.8	29.8	9.9	52.3	16.1	68.5
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	14.8	27.7	35.6	64.4	67.9	119.7	108.7	195.0	144.5	253.8
Installed at Year End										
IBM	8.1	13.0	30.1	48.2	65.8	104.9	119.2	189.4	185.7	293.7
Non-IBM	9.3	20.5	22.9	49.7	55.1	112.7	110.4	223.2	188.4	372.7
WORLDWIDE TOTAL	17.4	33.5	53.0	97.9	120.9	217.6	229.6	412.6	374.1	666.4

TABLE 37

FIXED DISK DRIVES, 30-200 MB

WORLDWIDE SHIPMENTS

14" AND 8" DISK DIAMETERS

	DISK DRIVE SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1979 Shipments		Forecast 1980		1981		1982		1983	
	14"	8"	14"	8"	14"	8"	14"	8"	14"	8"
U.S. Manufacturers										
IBM	--	13.0	--	35.2	--	56.7	--	84.5	--	104.3
Other U.S. Captive	2.0	--	4.4	--	9.5	--	14.0	4.0	17.5	9.0
PCM	--	--	0.2	--	0.7	--	0.9	0.3	0.8	1.2
OEM	4.8	--	9.4	1.6	16.0	7.0	23.0	16.0	27.5	25.0
TOTAL U.S. SHIPMENTS	6.8	13.0	14.0	36.8	26.2	63.7	37.9	104.8	45.8	139.5
Non-U.S. Manufacturers										
Captive	5.4	--	10.5	--	14.0	1.2	15.5	9.5	16.1	14.0
PCM	--	--	--	--	--	0.6	--	0.8	--	0.9
OEM	2.5	--	2.9	0.2	8.0	6.0	11.5	15.0	14.5	23.0
TOTAL NON-U.S. SHIPMENTS	7.9	--	13.4	0.2	22.0	7.8	27.0	25.3	30.6	37.9
TOTAL WORLDWIDE SHIPMENTS	14.7	13.0	27.4	37.0	48.2	71.5	64.9	130.1	76.4	177.4
14"/8" ANNUAL SHARE	53%	47%	43%	57%	40%	60%	33%	67%	30%	70%

TABLE 38

FIXED DISK DRIVES, 30-200 MB

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

Distribution Channel	1979 U.S. Net Shipments Units (000)	%	FORECAST 1980 %	1981 %	1982 %	1983 %
Mainframe computer manufacturers	--	--	--	3.5	4.5	5.8
Mini/micro computer manufacturers	0.5	10.7	11.6	12.1	12.5	12.8
System OEMs/systems houses	4.1	87.2	83.6	76.7	72.3	68.4
Independent peripherals suppliers	0.1	2.1	4.8	5.5	6.4	7.3
Direct to end user/retail dealers	--	--	--	2.2	4.3	5.7
TOTAL	4.7					

TABLE 39

FIXED DISK DRIVES, 30-200 MB

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1979 Net Shipments To United States Destinations Units (000)	%	Worldwide Units (000)	%
Memorex	2.0	42.6	2.0	27.4
Okidata	1.6	34.0	1.8	24.7
Other U.S.	1.0	21.3	1.0	13.7
Other Non-U.S.	0.1	2.1	2.5	34.2
TOTAL	4.7	100.0	7.3	100.0

FIXED DISK DRIVES, MORE THAN 200 MB

1980 DISK/TREND REPORT

FIXED DISK DRIVES, MORE THAN 200 MB

Coverage

Examples of disk drives in this category include:

IBM	3344, 3350, 3370, 3375, 3380
Burroughs	9494-2, 9494-4
Control Data	885, 9775, 819-21, 33502
Dastek	4835
Fujitsu	F493, F496
Hitachi	H-8594, H-8595, H-8587
ISS/Univac	7350, 8450, 8470
Memorex	3644, 3650, 3652, 659
Nippon Electric Company	D1510, N7751, N7755
Nippon Peripherals, Ltd.	NP24, NP25
Siemens	3470
Storage Technology	8350, 8650, 8360

Most of the drives in this group are either plug compatible versions of IBM's 3350, double density PCM versions of the 3350, or captive drives using variations of the same technology. The exceptions are Burroughs' only large fixed disk drives (201 MB, using 3330 technology on 8 surfaces), Control Data's several 22-surface drives, Univac's 8470 (16 surfaces), and the new Dastek 4835 series (200-400 MB OEM drives using thin film heads at 12,772 BPI). IBM's new 3370, 3375 and 3380 will establish the technology patterns for most future independent drives in this group.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1979	1980	1981	1982	1983
U.S. manufacturers	888.1	1,078.0	1,484.3	2,155.0	2,735.4
All manufacturers	1,014.9	1,289.1	1,720.7	2,480.2	3,201.2

Total worldwide shipments of 3350/3344 and equivalent drives by IBM and independent plug compatible vendors during 1979 and 1980 appear to have reached a plateau at an annual shipment level just above 40,000 spindles. IBM's 56.4% of this market in 1979 fell to 50.1% in 1980. The 3370 first shipment occurred on October 15, 1979, but IBM's production buildup for the first nine shipment months was very weak, apparently due to technical problems associated with the start-up. It is believed that these problems will be sufficiently tamed to enable IBM to ship an estimated 3,200 spindles during 1980.

Although IBM's average price per spindle for 3350s was slightly lower in 1980 because of the firm's mid-1979 price reductions, the average PCM price per spindle was actually increasing slightly, due to a gradual shift in product mix toward more double density drives, at 635 MB per spindle. Based on worldwide unit shipments, Storage Technology easily retained the largest share of the 1979 PCM market, at 39.8% -- but this was 10 percentage points lower than 1978. Memorex has 27.6%, up slightly, and Control Data earned a 19.9% share, a considerable increase.

Captive drives in this group have established a pronounced growth trend. Building on 1978's 1,400 spindle worldwide total, captive drives increased to 7,700 in 1979, and to an estimated 14,000 in 1980. This production activity is concentrated entirely in the major mainframers making their own drives: Burroughs, Control Data and Honeywell (through MPI), Univac, Fujitsu, Hitachi, Nippon Electric Company and Siemens.

No OEM shipments had occurred through 1979 for this product group, but activity is starting in 1980. Control Data and Memorex have both

introduced 675 MB drives with SMD interfaces, for which there is believed to be available a small, but responsive, 1980 market. The Dastek drive, first non-IBM drive in this group with thin film heads, is not expected to be shipped in significant quantities in 1980.

Marketing trends

In the next three years, IBM and PCM drive shipments in this group are expected to shift completely from 3350-type drives to drives of the 3370/3375/3380 types. Here is the DISK/TREND projection, with a breakdown by product type, of worldwide shipments in spindles:

		1980	1981	1982	1983
3344/3350 type:	IBM	21.0	10.0	2.0	--
	PCM	20.9	13.8	5.4	--
	WW total	41.9	23.8	7.4	--
3370/3375 type:	IBM	3.2	9.5	13.0	15.0
	PCM	--	2.2	9.4	12.5
	WW total	3.2	11.7	22.4	27.5
3380 type:	IBM	--	8.0	20.0	22.0
	PCM	--	--	--	9.4
	WW total	--	8.0	20.0	31.4

The net business effect of the above product life cycle patterns will be to (1) boost IBM's revenues for drives in this group from a 1979-1980 level of just under one half billion dollars per year to a 1982-1983 level three times higher, and (2) depress PCM revenues during 1981 and 1982, prior to a major jump in 1983 as the new drives reach high production levels.

The most significant variable in the above model is IBM's production build-up for the 3380 in 1981. If IBM has as many problems with the 3380 startup as it did with the 3370, the projected shipment level

would not be reached -- and PCM shipments of double density 3350s during 1981 will be higher than projected. Of course, an IBM shipment level above the projection would impact PCM shipments even more. The current DISK/TREND projection is regarded as a middle-of-the-road estimate.

Another key variable involves the ability of PCM manufacturers to initiate production of their versions of the new IBM products promptly. The historical rule of thumb has been to expect the start of PCM shipments about 18 months after IBM's first shipment. However, since 3370s were quite scarce for several months after IBM's first shipment, it is reasonable to start the 18 month clock in the Spring of 1980, when most PCM's actually acquired their first real 3370. In the case of the 3375, it is expected that this drive will be substantially similar to the 3370, so PCM shipments 12 months after IBM's first delivery in 3rd quarter 1981 are a reasonable expectation. The 3380 is expected to be a more difficult job for the PCMs, and they should be expected to require the full 18 month gestation period.

Other captive drive production by U.S. and non-U.S. manufacturers is expected to maintain a steady growth, with 1983 shipments reaching a worldwide total of 25,800 spindles, compared with 1980's 14,000 spindles. By 1982, technology similar to IBM's 3370 is expected to be used in other captive drives.

OEM drive shipments are projected at modest levels through 1983, as growing use of superminis and data base management systems create a market for disk capacity in this range. However, there is always the potential in this market class for significantly higher shipments if one or more additional major mainframers should decide to buy an available OEM drive.

Technical trends

Starting with the 3370, IBM has become much more secretive about the details of recording technologies used in their new drives. The firm still hasn't released the actual recording densities used in the 3370, despite the fact that all of its competitors have been analyzing samples of the drives for many months. For the record, the competitive consensus seems to be that the 3370 uses 635 TPI, and an effective BPI of 12,134. Recording density isn't that high, however: Actual recording is 8,128 flux reversals per inch, with the net BPI obtained from an encoding algorithm.

The 3380 technology is, of course, another closely guarded IBM secret. At this time the competitive guesses indicate a drive with 760 TPI, and a net BPI of just over 15,000 (actually recorded at about 10,000 FRPI). It will have thin film heads and particulate coated disks, on a thicker substrate. Whatever its combination of heads, disks, actuators and electronics, it is a drive which can be duplicated by the handful of disk drive manufacturers which specialize in this market.

Forecasting assumptions

1. IBM first commercial shipments of 3375 in third quarter of 1981 and 3380 in first quarter of 1981, as announced. Continuing reduction in production of 3340/3350, with last production in 1982. No significant price reductions through 1983. No other major disk drive product introductions through 1983.

2. First commercial shipment of PCM 3370s in third quarter, 1981; 3375, third quarter, 1982; 3380, third quarter, 1982. PCM shipments of 3350 drives in both standard and double density configurations remain significant through 1982.

3. Steady growth in worldwide captive production through 1983, with some drives using thin film head technology starting in 1982.

4. OEM shipments to realize only modest growth through 1983.

TABLE 40

FIXED DISK DRIVES, MORE THAN 200 MB

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1979		Forecast							
	---Shipments--		-----1980-----		-----1981-----		-----1982-----		-----1983-----	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	285.4	471.6	295.2	492.7	508.2	847.0	810.6	1,351.0	890.2	1,483.7
Other U.S. Captive	83.0	127.5	139.8	216.9	203.6	312.7	288.8	441.6	378.6	582.4
TOTAL U.S. CAPTIVE	368.4	599.1	435.0	709.6	711.8	1,159.7	1,099.4	1,792.6	1,268.8	2,066.1
PCM	199.4	289.0	242.5	361.1	211.1	301.5	227.5	325.0	434.9	621.3
OEM	--	--	7.3	7.3	20.5	23.1	31.5	37.4	36.8	48.0
TOTAL U.S. NON-CAPTIVE	199.4	289.0	249.8	368.4	231.6	324.6	259.0	362.4	471.7	669.3
TOTAL U.S. SHIPMENTS	567.8	888.1	684.8	1,078.0	943.4	1,484.3	1,358.4	2,155.0	1,740.5	2,735.4
Non-U.S. Manufacturers										
Captive	--	109.5	--	190.7	5.6	210.8	12.4	272.8	18.8	367.5
PCM	5.4	16.2	8.8	19.3	7.4	18.5	15.6	40.1	31.8	76.9
OEM	--	1.1	--	1.1	3.5	7.1	6.2	12.3	9.4	21.4
TOTAL NON-U.S. SHIPMENTS	5.4	126.8	8.8	211.1	16.5	236.4	34.2	325.2	60.0	465.8
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	573.2	1,014.9	693.6	1,289.1	959.9	1,720.7	1,392.6	2,480.2	1,800.5	3,201.2
OEM Average Price ($000)	--	11.0	9.1	9.3	9.2	9.4	9.0	9.2	8.7	9.1

TABLE 41

FIXED DISK DRIVES, MORE THAN 200 MB

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1979 Shipments		Forecast							
			1980		1981		1982		1983	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM	14.1	23.3	14.5	24.2	16.5	27.5	21.0	35.0	22.2	37.0
Other U.S. Captive	2.8	4.3	4.9	7.6	6.9	10.6	8.7	13.3	10.4	16.0
TOTAL U.S. CAPTIVE	16.9	27.6	19.4	31.8	23.4	38.1	29.7	48.3	32.6	53.0
PCM	11.8	17.1	13.3	19.8	10.5	15.0	9.1	13.0	13.3	19.0
OEM	--	--	.8	.8	2.3	2.6	3.7	4.4	4.6	6.0
TOTAL U.S. NON-CAPTIVE	11.8	17.1	14.1	20.6	12.8	17.6	12.8	17.4	17.9	25.0
TOTAL U.S. SHIPMENTS	28.7	44.7	33.5	52.4	36.2	55.7	42.5	65.7	50.5	78.0
Non-U.S. Manufacturers										
Captive	--	3.4	--	6.4	.2	7.5	.4	8.8	.5	9.8
PCM	.3	.9	.5	1.1	.4	1.0	.7	1.8	1.2	2.9
OEM	--	.1	--	.1	.3	.6	.5	1.0	.7	1.6
TOTAL NON-U.S. SHIPMENTS	.3	4.4	.5	7.6	.9	9.1	1.6	11.6	2.4	14.3
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	29.0	49.1	34.0	60.0	37.1	64.8	44.1	77.3	52.9	92.3
Installed at Year End										
IBM	51.5	85.6	66.0	109.8	82.5	137.3	103.5	172.3	125.7	209.3
Non-IBM	24.1	40.1	43.6	75.9	64.2	113.2	87.3	155.5	118.0	210.8
WORLDWIDE TOTAL	75.6	125.7	109.6	185.7	146.7	250.5	190.8	327.8	243.7	420.1

TABLE 42

FIXED DISK DRIVES, MORE THAN 200 MB

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

Distribution Channel	1979 U.S. Net Shipments Units (000)	%	FORECAST 1980 %	1981 %	1982 %	1983 %
Mainframe computer manufacturers	--	--	--	3.0	6.0	5.4
Mini/micro computer manufacturers	--	--	4.0	8.0	11.3	10.6
System OEMs/systems houses	--	--	2.0	7.0	10.3	8.7
Independent peripherals suppliers	--	--	--	--	1.4	2.3
Direct to end user/retail dealers	12.1	100.0	94.0	82.0	71.0	73.0
TOTAL	12.1					

TABLE 43

FIXED DISK DRIVES, MORE THAN 200 MB

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1979 Net Shipments To United States Destinations Units (000)	%	Worldwide Units (000)	%
Storage Technology	6.0	49.6	7.2	39.8
Memorex	2.5	20.6	5.0	27.6
Control Data	2.3	19.0	3.6	19.9
Other U.S.*	1.0	8.3	1.3	7.2
Other Non-U.S.*	0.3	2.5	1.0	5.5
TOTAL	12.1	100.0	18.1	100.0

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

DISK DRIVE SPECIFICATIONS

1980 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. It should be noted that the Cii-Honeywell Bull 10.5 inch disk cartridge and fixed disk drives are fully identified in the specification section as to disk diameter and functional specifications, but are included in the 8 inch drive statistical data in the product group analysis sections.

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 "Piccolo" 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, 35-70 MB
Fixed media:	7.	Fixed disk drives, less than 30 MB
	8.	Fixed disk drives, 30-200 MB
	9.	Fixed disk drives, more than 200 MB

MANUFACTURER	AMPEX	AMPEX	AMPEX	AMPEX	AMPEX	AMPEX	AMPEX
DRIVE	DM-440	DM-441	DM-442	DM-443	DM-445	DM-446	DM-447
DISK/TREND GROUP	1	1	1	1	1	1	1
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	2315	2315	2315	2315	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: 3.125	--	U: 6.25	--	U: 3.125	--
REMOVABLE	U: 3.125	U: 3.125	U: 6.25	U: 6.25	U: 3.125	U: 3.125	U: 6.25
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	2	4	2	4	2	4	2
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	200	200	400	400	200	200	400
TPI	100	100	200	200	100	100	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	35	35	35	35
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	55/47.5	55/47.5	55/47.5	55/47.5
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	1975	1975	1975	1975	1975	1975	1975
U.S. OEM PRICE FOR 100 UNITS	$2400	$2415	$2525	$2555	$2310	$2380	$2450
COMMENTS	Mfg. by Western Dynex	Mfg. by Western Dynex	Mfg. by Western Dynex	Mfg. by Western Dynex	Mfg. by Western Dynex	Mfg. by Western Dynex	Mfg. by Western Dynex

MANUFACTURER	AMPEX	AMPEX	AMPEX	AMPEX	AMPEX	AMPEX	AMPEX
DRIVE	DM-448 DM-548	DFR-932	DFR-964	DFR-996	DM-323	DM-940	DM-980
DISK/TREND GROUP	1	2	2	2	3	4	4
MEDIA: Manufacturer's number	--	CDC 91204	CDC 91204	CDC 91204	--	--	--
Generic type	5440	CMD	CMD	CMD	2316	SMD	SMD
TECHNOLOGY TYPE, DRIVE	2314	SMD	SMD	SMD	2314	SMD	SMD
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 6.25	U: 16.289	U: 48.868	U: 81.446	--	--	--
REMOVABLE	U: 6.25	U: 16.289	U: 16.289	U: 16.289	F: 58.4	U: 41.4	U: 82.8
Capacity per track (Bytes)	U: 7,812	U: 20,160	U: 20,160	U: 20,160	F: 7,294	U: 20,160	U: 20,160
Data surfaces per spindle	4	1 Fixed 1 Removable	3 Fixed 1 Removable	5 Fixed 1 Removable	20	5	5
Heads per data surface	1	2 Fixed 1 Removable	2 Fixed 1 Removable	2 Fixed 1 Removable	1	1	1
Tracks per surface	400	823	823	823	406	411	822
TPI	200	367 Fixed 384 Removable	367 Fixed 384 Removable	367 Fixed 384 Removable	200	192	384
BPI	2200	6274 Fixed 6038 Removable	6274 Fixed 6038 Removable	6274 Fixed 6038 Removable	2200	6038	6038
RPM	1500/2400	3600	3600	3600	2400	3600	3600
Average positioning time (msec)	35	30	30	30	32	30	30
Average rotational delay (msec)	20/12.5	8.3	8.3	8.3	12.5	8.3	8.3
Average access time (msec)	55/47.5	38.3	38.3	38.3	44.5	38.3	38.3
Data transfer rate (KBytes/sec)	195/312.5	1209	1209	1209	312.5	1209	1209
FIRST CUSTOMER SHIPMENT	1975	4Q79	4Q79	4Q79	1973	10/75	1/76
U.S. OEM PRICE FOR 100 UNITS	$2525	$4200	$4900	$5500	$8200	$4700	$5250
COMMENTS	Mfg. by Western Dynex	Mfg. by Toshiba	Mfg. by Toshiba	Mfg. by Toshiba			

MANUFACTURER	AMPEX	AMPEX	AMPEX	AMPEX	AMPEX	AMPEX	AMPEX
DRIVE	DM-9160	DM-9100	DM-9200	DM-9300	DM-9300A	DM-331	PTD-930X Parallel Transfer Drive
DISK/TREND GROUP	5	5	5	5	5	5	5
MEDIA: Manufacturer's number	--	--	--	--	CDC 9883-91	--	--
Generic type	SMD	3336-1	3336-11	3336-11	3336-11	3336-11	3336-11
TECHNOLOGY TYPE, DRIVE	SMD	3330-1	3330-11	3330-11	3330-11	3330-11	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	--	--	--	--	--
REMOVABLE	U: 165.8	U: 103.17	U: 206.3	U: 309.5	U: 309.5	U: 206.3	U: 312.177
Capacity per track (Bytes)	U: 20,160	U: 13,440	U: 13,440	U: 20,160	U: 20,160	U: 13,440	U: 20,160
Data surfaces per spindle	5	19	19	19	19	19	19
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	1645	411	815	815	823	815	815
TPI	768	192	370	370	384	370	384
BPI	6038	4040	4040	6038	6038	4040	6038
RPM	3600	3600	3600	3600	3600	3600	3600
Average positioning time (msec)	28	28	28	28	28	28	28
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	36.3	36.3	36.3	36.3	36.3	36.3	36.3
Data transfer rate (KBytes/sec)	1209	806	806	1209	1209	806	1209
FIRST CUSTOMER SHIPMENT	1980	11/75	11/75	5/76	3Q80	11/74	11/78
U.S. OEM PRICE FOR 100 UNITS	$6580	$9100	$9450	$9800	$9800	$10,150	$55,000
COMMENTS							4, 6, or 9 Track Parallel Data Transfer

MANUFACTURER	AMPEX	AMPEX	AMPEX	BALL COMPUTER PRODUCTS	BALL COMPUTER PRODUCTS	BALL COMPUTER PRODUCTS	BALL COMPUTER PRODUCTS
DRIVE	DM-404	DF-980	DF-9150	BD-50	BD-80	BD-100	BD-160
DISK/TREND GROUP	7	8	8	4	4	5	5
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	SMD	SMD	SMD	SMD
TECHNOLOGY TYPE, DRIVE	2314	3350	3350	3330-11	3330-11	3330-11	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 12.5	U: 82.9	U: 158.3	--	--	--	--
REMOVABLE	--	--	--	U: 54.7	U: 82.1	U: 103.2	U: 164.2
Capacity per track (Bytes)	U: 7,812	U: 20,160	U: 20,160	U: 13,440	U: 20,160	U: 20,160	U: 20,160
Data surfaces per spindle	4	5	7	5	5	5	5
Heads per data surface	1	2	2	1	1	1	1
Tracks per surface	406	823	1122	815	815	1024	1645
TPI	200	478	478	370/384	370/384	465	768
BPI	2200	6370	6370	4040	6060	6060	6060
RPM	1500/2400	3600	3600	3600	3600	3600	3600
Average positioning time (msec)	70	30	30	30	30	30	30
Average rotational delay (msec)	20/12.5	8.3	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	90/82.5	38.3	38.3	38.3	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	195/312.5	1209	1209	806	1209	1209	1209
FIRST CUSTOMER SHIPMENT	1980	1980	1980	8/76	4/77	8/79	3Q80
U.S. OEM PRICE FOR 100 UNITS	--	--	--	$4603	$5385	$6114	$7000
COMMENTS	Mfg. by Western Dynex						

AMPEX BALL

MANUFACTURER	BALL COMPUTER PRODUCTS	BALL COMPUTER PRODUCTS	BASF	BASF	BASF	BASF	BASF
DRIVE	BFM 90	BFM 160	6240 6242	6243	6171	6172	6173
DISK/TREND GROUP	8	8	6	6	7	7	8
MEDIA: Manufacturer's number	--	--	1370	1370	--	--	--
Generic type	Fixed	Fixed	3348	3348	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3350	3350	3340	3340	3350	3350	3350
NOMINAL DISK DIAMETER	14"	14"	14"	14"	210 mm	210 mm	210 mm
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 90.6	U: 158.6	--	--	U: 8.0	U: 24.0	U: 40.0
REMOVABLE	--	--	F: 35/70	F: 50.6	--	--	--
Capacity per track (Bytes)	U: 20,160	U: 20,160	F: 16,736	F: 16,736	U: 13,344	U: 13,344	U: 13,344
Data surfaces per spindle	4	7	3/6	6	1	3	5
Heads per data surface	2	2	2	2	1	1	1
Tracks per surface	1122	1122	348/696	696	600	600	600
TPI	480	480	300	300	500	500	500
BPI	6486	6486	5636	5636	6542	6542	6542
RPM	3600	3600	2964	2964	3600	3600	3600
Average positioning time (msec)	30	30	20	20	42	42	42
Average rotational delay (msec)	8.3	8.3	10.1	10.1	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	30.1	30.1	50.3	50.3	50.3
Data transfer rate (KBytes/sec)	1209	1209	885	885	800.6	800.6	800.6
FIRST CUSTOMER SHIPMENT	8/80	8/80	1977	1979	4Q79	4Q79	1Q81
U.S. OEM PRICE FOR 100 UNITS	$4585	$5285	--	--	$1600	$1900	$2200
COMMENTS			PCM 3340 Mfg. by Nippon Peripherals	PCM 3340 Mfg. by Nippon Peripherals	OEM	OEM	OEM

BALL BASF

MANUFACTURER	BASF	BASF	BASF	BASF	BASF	BASF	BASF
DRIVE	6410 6411	6150-56	6150-84	6150-112	6150-140	6150-168	6244
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	Piccolo	3350	3350	3350	3350	3350	3350
NOMINAL DISK DIAMETER	210 mm	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	F: 64.5	U: 56.448	U: 84.672	U: 112.896	U: 141.12	U: 169.344	1.004 MB F. Head Option F: 279.558
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	U: 20,160	U: 20,160	U: 20,160	U: 20,160	U: 20,160	F: 16,736
Data surfaces per spindle	11	2	3	4	5	6	15
Heads per data surface	1	2	2	2	2	2	2
Tracks per surface	360	1400	1400	1400	1400	1400	1114
TPI	465	600	600	600	600	600	480
BPI	8530	6380	6380	6380	6380	6380	5636
RPM	3125	2976	2976	2976	2976	2976	2964
Average positioning time (msec)	27	35	35	35	35	35	20
Average rotational delay (msec)	9.6	10.1	10.1	10.1	10.1	10.1	10.1
Average access time (msec)	36.6	45.1	45.1	45.1	45.1	45.1	30.1
Data transfer rate (KBytes/sec)	1031	1000	1000	1000	1000	1000	885
FIRST CUSTOMER SHIPMENT	4Q80	3Q80	3Q80	3Q80	3Q80	3Q80	1978
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS	PCM 3310 Mfg. by Nippon Peripherals	OEM	OEM	OEM	OEM	OEM	PCM 3344 Mfg. by Nippon Peripherals

MANUFACTURER	BASF	BURROUGHS	BURROUGHS	BURROUGHS	BURROUGHS	BURROUGHS	BURROUGHS
DRIVE	6250 6252 6253	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
DISK/TREND GROUP	9	1	1	1	3	3	5
MEDIA: Manufacturer's number	--	9985-3	9985	9985	9974-4	9974-4	9974-4
Generic type	Fixed	2315	2315	2315	2316	2316	2316
TECHNOLOGY TYPE, DRIVE	3350	2314	3330-1	3330-1	2314	2314	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	F: 317.5	--	--	--	--	--	--
REMOVABLE	--	F: 2.3	F: 4.68	F: 9.3	F: 64.8	F: 87.2	F: 174.4
Capacity per track (Bytes)	F: 19,069	F: 5,760	F: 11,520	F: 11,520	F: 10,800	F: 10,800	F: 10,800
Data surfaces per spindle	15	2	2	2	20	20	20
Heads per data surface	2	1	1	1	1	1	1
Tracks per surface	1110	203	203	404	300	404	808
TPI	480	100	100	200	200	200	400
BPI	6425	2200	4400	4400	4400	4400	4400
RPM	3600	1500	1500	1500	2400	2400	2400
Average positioning time (msec)	20	60	60	35	30	30	30
Average rotational delay (msec)	8.3	20	20	20	12.5	12.5	12.5
Average access time (msec)	28.3	80	80	55	42.5	42.5	42.5
Data transfer rate (KBytes/sec)	1198	193	193	387.5	625	625	625
FIRST CUSTOMER SHIPMENT	1978			7/76	1974	1974	1976
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS	PCM 3350 Mfg. by Nippon Peripherals						Embedded Servo

BASF BURROUGHS

MANUFACTURER	BURROUGHS	BURROUGHS	BURROUGHS	BURROUGHS	BURROUGHS	BURROUGHS	BURROUGHS
DRIVE	9484-2	9484-5	9493-9	9493-18	9493-28	9493-37	FD 211
DISK/TREND GROUP	4	4	7	7	7	8	7
MEDIA: Manufacturer's number	--	9974-5	--	--	--	--	--
Generic type	Trident	Trident	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3330-11	3330-11	3330-1	3330-1	3330-1	3330-1	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	F: 9.4	F: 18.8	Drive consists of 2 spindles F: 28.2	Drive consists of 2 spindles F: 37.6	F: 20
REMOVABLE	F: 32.6	F: 65.2	--	--	--	--	--
Capacity per track (Bytes)	F: 16,200	F: 16,200	F: 11,520	F: 11,520	F: 11,520	F: 11,520	F: 14,268
Data surfaces per spindle	5	5	2	4	2	4	2
Heads per data surface	1	1	1	1	1	1	2
Tracks per surface	407	815	400	400	400	400	672
TPI	370	370	200	200	200	200	300
BPI	6039	6039	4000	4000	4000	4000	5500
RPM	3672	3672	1500	1500	1500	1500	3000
Average positioning time (msec)	25	25	35	35	35	35	35
Average rotational delay (msec)	8.3	8.3	20	20	20	20	10
Average access time (msec)	33.3	33.3	55	55	55	55	45
Data transfer rate (KBytes/sec)	1210	1210	348	348	348	348	888
FIRST CUSTOMER SHIPMENT	1977	1977	1/77	1/77	1/77	1/77	12/79
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	$3130
COMMENTS							Equivalent to B9493-19

MANUFACTURER	BURROUGHS	BURROUGHS	BURROUGHS	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS
DRIVE	FD 214	9494-2	9494-4	Diablo D-31	Diablo D-44B	Hunter H-32	Hunter H-64
DISK/TREND GROUP	8	9	9	1	1	2	2
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	2315	5440	5440	5440
TECHNOLOGY TYPE, DRIVE	3340	3330-11	3330-11	2314	2314	3330-11	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	F: 80	F: 201	Drive consists of 2 spindles F: 402	--	U: 6.25	U: 16.7	U: 50.3
REMOVABLE	--	--	--	U: 1.5/3.0	U: 6.25	U: 16.7	U: 16.7
Capacity per track (Bytes)	F: 14,268	--	--	U: 3,750/7,500	U: 7,812	U: 20,160	U: 20,160
Data surfaces per spindle	8	8	8	2	4	1 Fixed 2 Removable	3 Fixed 2 Removable
Heads per data surface	2	1	1	1	1	1	1
Tracks per surface	672	1564	1564	203	408	833 Fixed 412 Removable	833 Fixed 412 Removable
TPI	300	714	714	100	200	384 Fixed 192 Removable	384 Fixed 192 Removable
BPI	5500	6551	6551	1100/2200	2200	6060	6060
RPM	3000	3672	3672	1500	2400	3600	3600
Average positioning time (msec)	35	28	28	70	38	30	30
Average rotational delay (msec)	10	8	8	20	12.5	8.3	8.3
Average access time (msec)	45	36	36	90	50.5	38.3	38.3
Data transfer rate (KBytes/sec)	888	1300	1300	97.5/195	312.5	1209	1209
FIRST CUSTOMER SHIPMENT	12/79	4Q78	4Q78	8/70	3Q76	4Q79	4Q79
U.S. OEM PRICE FOR 100 UNITS	$4060	--	--	$2925	$3390	$4625	$4975
COMMENTS	Equivalent to B9493-76	B1800-B-7800	B1800-B7800				

BURROUGHS CENTURY

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-96	Trident T-25	Trident T-50	Trident T-80 T-82 882	Trident T-200 T-202	Trident T-300 T-302 832	Trident T-600 T-602
DISK/TREND GROUP	2	4	4	4	5	5	5
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	5440	Trident	Trident	Trident	3336-11	3336-11	3336-11
TECHNOLOGY TYPE, DRIVE	3330-11	3330-11	3330-11	3330-11	3330-11	3330-11	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 83.9	--	--	--	--	--	--
REMOVABLE	U: 16.7	U: 27.3	U: 54.7	U: 82.1	U: 208.1	U: 312.1	U: 630.4
Capacity per track (Bytes)	U: 20,160	U: 13,440	U: 13,440	U: 20,160	U: 13,440	U: 20,160	U: 20,160
Data surfaces per spindle	5 Fixed 2 Removable	5	5	5	19	19	19
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	833 Fixed 412 Removable	408	815	815	815	815	1646
TPI	384 Fixed 192 Removable	185	370	370	370	370	740
BPI	6060	4040	4040	6060	4040	6060	6060
RPM	3600	3600	3600	3600	3600	3600	3600
Average positioning time (msec)	30	30	30	30	30	30	30
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	38.3	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	1209	806	806	1209	806	1209	1209
FIRST CUSTOMER SHIPMENT	4Q79	8/75	5/75	8/75	6/76	8/76	4Q/80
U.S. OEM PRICE FOR 100 UNITS	$5325	$4550	$5200	$5935	$9375	$10,515	$12,800
COMMENTS							

MANUFACTURER	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS	CII-HONEYWELL BULL	CII-HONEYWELL BULL	CII-HONEYWELL BULL	CII-HONEYWELL BULL
DRIVE	Marksman M-10	Marksman M-20	Marksman M-40	D120	D135	D140	D164
DISK/TREND GROUP	7	7	8	1	1	2	8
MEDIA: Manufacturer's number	--	--	--	M4120 Special Cartridge	M4120 Special Cartridge	M4120 Special Cartridge	--
Generic type	Fixed	Fixed	Fixed				Fixed
TECHNOLOGY TYPE, DRIVE	3350	3350	3350	3330-11	3330-11	3330-11	Special
NOMINAL DISK DIAMETER	14"	14"	14"	10.5"	10.5"	10.5"	10.5"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 10.08	U: 20.16	U: 40.32	--	F: 5.0	F: 10.0	F: 60.2
REMOVABLE	--	--	--	F: 10.0	F: 5.0	F: 10.0	--
Capacity per track (Bytes)	U: 24,000	U: 24,000	U: 24,000	F: 12,800	F: 12,800	F: 12,800	F: 12,800
Data surfaces per spindle	1	2	4	2	2	4	2
Heads per data surface	2	2	2	1	1	1	1
Tracks per surface	420	420	420	392	392	392	1176
TPI	182	182	182	500	500	500	900
BPI	7545	7545	7545	4750	4750	4750	4850
RPM	2400	2400	2400	3600	3600	3600	3600
Average positioning time (msec)	43	43	43	65	100	65	40
Average rotational delay (msec)	12.5	12.5	12.5	8.3	8.3	8.3	8.3
Average access time (msec)	55.5	55.5	55.5	73.3	108.3	73.3	48.3
Data transfer rate (KBytes/sec)	960	960	960	920	920	920	920
FIRST CUSTOMER SHIPMENT	3Q78	3Q78	3Q78	7/78	1Q81	4Q79	1Q81
U.S. OEM PRICE FOR 100 UNITS	$1610	$1780	$2235	$2380	$2465	$3090	$3085
COMMENTS	Stepping Motor Actuator	Stepping Motor Actuator	Stepping Motor Actuator	Embedded Servo	Embedded Servo	Embedded Servo	Embedded Servo Thin Film Heads

MANUFACTURER	CII-HONEYWELL BULL	CII-HONEYWELL BULL	COMPUTER PERIPHERIE TECHNIK GmbH	COMPUTER PERIPHERIE TECHNIK GmbH	CONTROL DATA	CONTROL DATA	CONTROL DATA
DRIVE	D166	D168	HT40	HT70	9427H	9455	9448-32
DISK/TREND GROUP	8	8	8	8	1	2	2
MEDIA: Manufacturer's number	--	--	--	--	9847 (100 TPI) 9848 (200 TPI)	91208 Lark Module	91204
Generic type	Fixed	Fixed	Fixed	Fixed	5440	Drive	CMD
TECHNOLOGY TYPE, DRIVE	Special	Special	Special - Plated Disks	Special - Plated Disks	2314	LMD	SMD
NOMINAL DISK DIAMETER	10.5"	10.5"	200 mm	200 mm	14"	195 mm	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	F: 90.3	F: 120.4	U: 40	U: 70	U: 6.25	U: 8.35	U: 16.289
REMOVABLE	--	--	--	--	U: 6.25	U: 8.35	U: 16.289
Capacity per track (Bytes)	F: 12,800	F: 12,800	U: 20,160	U: 20,160	U: 7,812	U: 20,672	U: 20,160
Data surfaces per spindle	6	8	5	5	4	4	1 Fixed 1 Removable
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	1176	1176	411		406	202/4	823
TPI	900	900	300	600	200	237	384
BPI	4850	4850	10,300	10,300	2200	6774 FRPI*	6038
RPM	3600	3600	3600	3600	2400/1500	3510	3600
Average positioning time (msec)	40	40	28	28	35	50	30
Average rotational delay (msec)	8.3	8.3	8.3	8.3	12.5/20	8.55	8.3
Average access time (msec)	48.3	48.3	36.3	36.3	47.5/55	58.55	38.3
Data transfer rate (KBytes/sec)	920	920	1209	1209	312.5/195	1209	1209
FIRST CUSTOMER SHIPMENT	1Q81	1Q81	2Q80	4Q80	8/74	1Q81	9/78
U.S. OEM PRICE FOR 100 UNITS	$3355	$3625	--	--	$3915	$2990	$4835
COMMENTS	Embedded Servo Thin Film Heads	Embedded Servo Thin Film Heads	Plated Disks, Winchester Heads, Rotary Actuator, SMD Interface	Plated Disks, Winchester Heads, Rotary Actuator, SMD Interface	OEM	OEM Embedded Servo *10,161 Net BPI	OEM Separate Servo Surface for Fixed and Removable Disks

CII-HB CPT CONTROL DATA

MANUFACTURER	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
DRIVE	9448-64	9448-96	9746 9747	9760	9762	270-10	9764
DISK/TREND GROUP	2	2	3	4	4	4	5
MEDIA: Manufacturer's number	91204	91204	9873	9876	9877	877	9883-91
Generic type	CMD	CMD	2316	SMD	SMD	SMD	3336-11
TECHNOLOGY TYPE, DRIVE	SMD	SMD	2314	3330-11	3330-11	3330-11	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 48.869	U: 81.446	--	--	--	--	--
REMOVABLE	U: 16.289	U: 16.289	U: 62.5	U: 40.7	U: 81.5	F: 63	U: 154.8
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 7,812	U: 20,160	U: 20,160	F: 15,360	U: 20,160
Data surfaces per spindle	3 Fixed 1 Removable	5 Fixed 1 Removable	20	5	5	5	19
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	823	823	406	411	823	823	411
TPI	384	384	200	192	384	384	192
BPI	6038	6038	2220	6038	6038	6038	6038
RPM	3600	3600	2400	3600	3600	3600	3600
Average positioning time (msec)	30	30	35	30	30	30	30
Average rotational delay (msec)	8.3	8.3	12.5	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	47.5	38.3	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	1209	1209	312.5	1209	1209	1209	1209
FIRST CUSTOMER SHIPMENT	9/78	9/78	1974	3/74	3/75	1978	3/76
U.S. OEM PRICE FOR 100 UNITS	$5460	$6085	--	$6020	$6220	--	--
COMMENTS	OEM Separate Servo Surface for Fixed and Removable Disks	OEM Separate Servo Surface for Fixed and Removable Disks	OEM	OEM	OEM	Series/1 Interface	OEM

MANUFACTURER	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
DRIVE	9766	270-30	9780	9770	9414	9730-12	9730-24
DISK/TREND GROUP	5	5	5	6	7	7	7
MEDIA: Manufacturer's number	9883-91	883-91	9883	9778	--	--	--
Generic type	3336-11	3336-11	3336-11	3348	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3330-11	3330-11	3330-11	3340	2314	3350	3350
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	--	--	U: 12.5/6.25	.96 MB Fixed Head Option U: 12.9	.96 MB Fixed Head Option U: 25.8
REMOVABLE	U: 309.5	F: 240	F: 200	F: 35/70	--	--	--
Capacity per track (Bytes)	U: 20,160	F: 15,360	F: 13,030	F: 16,736	U: 7,812	U: 20,160	U: 20,160
Data surfaces per spindle	19	19	19	3/6	4/2	1	2
Heads per data surface	1	1	1	2	1	2	2
Tracks per surface	823	823	822	696/2	408	640	640
TPI	384	384	384	300	200/100	296	296
BPI	6038	6038	4040	5636	2200	6220	6220
RPM	3600	3600	3600	2964	2400/1500	3600	3600
Average positioning time (msec)	30	30	30	25	65	40	40
Average rotational delay (msec)	8.3	8.3	8.3	10.1	12.5/20	8.3	8.3
Average access time (msec)	38.3	38.3	38.3	35.1	77.5/85	48.3	48.3
Data transfer rate (KBytes/sec)	1209	1209	806	885	312.5/195	1209	1209
FIRST CUSTOMER SHIPMENT	3/76	1978		1976	9/76	5/77	5/77
U.S. OEM PRICE FOR 100 UNITS	$11,440	--	--	--	$2235	$3155	$3305
COMMENTS	OEM	Series/1 Interface	OEM Drive; PCM Version 33302	OEM	OEM	OEM	OEM

MANUFACTURER	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
DRIVE	230-10 240-10*	230-20 240-20*	230-23 240-23*	230-26 240-26*	230-30 240-30*	9730-80	9730-160
DISK/TREND GROUP	7	7	8	8	8	8	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"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	.74 or 1.48 MB F. Head Option F: 9.3	.74 or 1.48 MB F. Head Option F: 25.3	.74 or 1.48 MB F. Head Option F: 37.9	.74 or 1.48 MB F. Head Option F: 50.6	.74 or 1.48 MB F. Head Option F: 63.2	.96 or 1.93 MB F. Head Option U: 82.9	.96 or 1.93 MB F. Head Option U: 165.9
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 15,360	F: 15,360	F: 15,360	F: 15,360	F: 15,360	U: 20,160	U: 20,160
Data surfaces per spindle	1	2	3	4	5	5	5
Heads per data surface	2	2	2	2	2	2	2
Tracks per surface	606	823	823	823	823	823	1646
TPI	296	340	340	340	340	340	680
BPI	6220	6220	6220	6220	6220	6220	6220
RPM	3600	3600	3600	3600	3600	3600	3600
Average positioning time (msec)	30	30	30	30	30	30	30
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	38.3	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	1209	1209	1209	1209	1209	1209	1209
FIRST CUSTOMER SHIPMENT	1Q79	2Q79	2Q79	2Q79	2Q79	1Q79	2Q79
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	$4875	$6080
COMMENTS	Series/1 Interface	Series/1 Interface	Series/1 Interface	Series 1 Interface	Series/1 Interface	OEM	OEM

*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	33801-A2 33801-B2 33801-C2 (3330 Format)	33501-A2 33501-B2 33501-C2 (3350 Format)	9776-A2 9776-B2 9776-C2	33502-A2 33502-B2 33502-C2	819-11	819-21	9775
DISK/TREND GROUP	9	9	9	9	9	9	9
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	2X3350	2X3350	2X3350	2X3350	3330-11	3330-11	2X3350
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE	1.24 MB Fixed Head Option	1.72 MB Fixed Head Option	1.72 MB Fixed Head Option	1.72 MB Fixed Head Option			1.9 MB Fixed Head Option
Total capacity (MBytes) FIXED	F: 400	F: 317.5	F: 635	F: 635	U: 325.8	U: 651.6	U: 675
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 13,030	F: 19,069	F: 19,069	F: 19,069	U: 20,160	U: 20,160	U: 20,160
Data surfaces per spindle	20	20	20	20	40	40	20
Heads per data surface	2	2	2	2	1	1	2
Tracks per surface	1686	843	1686	1686	411	823	1686
TPI	660	660	660	660	192	384	660
BPI	6350	6350	6350	6350	6000	6000	6350
RPM	3600	3600	3600	3600	3600	3600	3600
Average positioning time (msec)	25	19	25	25	50	50	25
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	33.3	27.3	33.3	33.3	58.3	58.3	33.3
Data transfer rate (KBytes/sec)	1198	1198	1198	1198	4840	4840	1209
FIRST CUSTOMER SHIPMENT	1978	1978	1Q79	1978	1978	1978	4/80
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	$15,155
COMMENTS	PCM	PCM	OEM	PCM (CDC Model 885)			OEM

MANUFACTURER	CONTROL DATA	DASTEK	DASTEK	DASTEK	DATA GENERAL	DATA GENERAL	DATA GENERAL
DRIVE	9797	4835-1	4835-2	4835-3	6045 6046 6047 6048 6050	6095	6070
DISK/TREND GROUP	9	9	9	9	1	1	2
MEDIA: Manufacturer's number	--	--	--	--	1121	1121	1145
Generic type	Fixed	Fixed	Fixed	Fixed	5440	5440	5440
TECHNOLOGY TYPE, DRIVE	3330-11	3370	3370	3370	2314	2314	3330-1
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 651.6	U: 203.5	U: 339.2	U: 407.0	F: 5.014	F: 5.014	F: 10.027
REMOVABLE	--	--	--	--	F: 5.014	F: 5.014	F: 10.027
Capacity per track (Bytes)	U: 20,160	U: 40,960	U: 40,960	U: 40,960	F: 6,144	F: 6,144	F: 12,288
Data surfaces per spindle	40	3	5	6	4	4	4
Heads per data surface	1	2	2	2	1	1	1
Tracks per surface	822	1656	1656	1656	408	408	408
TPI	384	694	694	694	200	200	200
BPI	6000	12772	12772	12772	2200	2200	4040
RPM	3600	2964/1780	2964/1780	2964/1780	2400	2400	2400
Average positioning time (msec)	50	27	27	27	38	38	38
Average rotational delay (msec)	8.3	10.1/16.9	10.1/16.9	10.1/16.9	12.5	12.5	12.5
Average access time (msec)	58.3	37.1/43.9	37.1/43.9	37.1/43.9	50.5	50.5	50.5
Data transfer rate (KBytes/sec)	4840	2000/1200	2000/1200	2000/1200	312.5	312.5	625
FIRST CUSTOMER SHIPMENT	1977	10/80	10/80	10/80	1976	1978	1978
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS	OEM 4 Track Parallel Data Transfer	Thin Film Heads SMD Interface	Thin Film Heads SMD Interface	Thin Film Heads SMD Interface			

CONTROL DATA DASTEK DATA GENERAL

MANUFACTURER	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATAPOINT
DRIVE	6067	6060	6061	6122	6098 6099 6101 6102	6100 6103 6104 6105	9350
DISK/TREND GROUP	4	5	5	5	7	7	1
MEDIA: Manufacturer's number	1143	1122	1123	1163	--	--	80362
Generic type	SMD	3336-1	3336-11	3336-11	Fixed	Fixed	2315
TECHNOLOGY TYPE, DRIVE	3330-11	3330-1	3330-11	3330-11	3340	3340	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	--	--	F: 12.58	F: 25.16	--
REMOVABLE	F: 50.074	F: 95.957	F: 190.280	F: 277.491	--	--	F: 2.49
Capacity per track (Bytes)	F: 12,288	F: 12,288	F: 12,288	F: 17,920	F: 16,384	F: 16,384	F: 6,144
Data surfaces per spindle	5	19	19	19	2	4	2
Heads per data surface	1	1	1	1	2	2	1
Tracks per surface	815	411	815	815	384	384	203
TPI	370	192	370	370	166	166	100
BPI	4040	4040	4040	6060	5760	5760	2200
RPM	3600	3600	3600	3600	2964	2964	1500
Average positioning time (msec)	35	35	35	35	60	60	70
Average rotational delay (msec)	8.3	8.3	8.3	8.3	10.1	10.1	20
Average access time (msec)	43.3	43.3	43.3	43.3	70.1	70.1	90
Data transfer rate (KBytes/sec)	806	806	806	1209	910.6	910.6	195
FIRST CUSTOMER SHIPMENT	1978	1976	1976	1Q80	3Q79	4Q79	1978
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS					Stepping Motor Actuator	Stepping Motor Actuator	

DATA GENERAL

DATAPOINT

MANUFACTURER	DATAPOINT	DATAPOINT	DATA RECORDING EQUIPMENT, LTD.	DATA RECORDING EQUIPMENT, LTD.	DATA RECORDING EQUIPMENT, LTD.	DATA RECORDING EQUIPMENT, LTD	DATA RECORDING EQUIPMENT, LTD.
DRIVE	9360	9374	312	3212	4041B	4042B	4043B
DISK/TREND GROUP	1	2	1	1	1	1	1
MEDIA: Manufacturer's number	80362	80428	--	--	--	--	--
Generic type	2315	5440	2315	2315	5440	5440	5440
TECHNOLOGY TYPE, DRIVE	2314	3330-1	2314	3330-1	2314	2314	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	F: 2.49	F: 10.027	--	--	--	--	U: 3.125
REMOVABLE	F: 2.49	F: 10.029	U: 3.0	U: 12.0	U: 3.125	U: 6.25	U: 3.125
Capacity per track (Bytes)	F: 6,144	F: 12,288	U: 7,500	U: 15,000	U: 7,812	U: 7,812	U: 7,812
Data surfaces per spindle	4	4	2	2	2	2	4
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	203	408	203	406	204	408	204
TPI	100	200	100	200	100	200	100
BPI	2200	4400	2200	4400	2200	2200	2200
RPM	1500	2400	1500	1500	2400	2400	2400
Average positioning time (msec)	70	35	70	70	38	38	38
Average rotational delay (msec)	20	12.5	20	20	12.5	12.5	12.5
Average access time (msec)	90	47.5	90	90	50.5	50.5	50.5
Data transfer rate (KBytes/sec)	195	625	195.25	390.5	312.5	312.5	312.5
FIRST CUSTOMER SHIPMENT	1978	1978	1970	1978	6/77	6/77	6/77
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS							

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	4044B	D9427H	D9448-32	D9448-64	D9448-96	3112	3120
DISK/TREND GROUP	1	1	2	2	2	7	7
MEDIA: Manufacturer's number	--	CDC 9848	CDC 91204	CDC 91204	CDC 91204	--	--
Generic type	5440	5440	CMD	CMD	CMD	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	2314	2314	SMD	SMD	SMD	3340	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	200 mm	200 mm
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 6.25	U: 6.25	U: 16.289	U: 48.869	U: 81.446	U: 11.7	U: 19.5
REMOVABLE	U: 6.25	U: 6.25	U: 16.289	U: 16.289	U: 16.289	--	--
Capacity per track (Bytes)	U: 7,812	U: 7,812	U: 20,160	U: 20,160	U: 20,160	U: 10,880	U: 10,880
Data surfaces per spindle	4	4	1 Fixed 1 Removable	3 Fixed 1 Removable	5 Fixed 1 Removable	3	5
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	408	406	823	823	823	360	360
TPI	200	200	384	384	384	300	300
BPI	2200	2200	6038	6038	6038	5800	5800
RPM	2400	2400	3600	3600	3600	4430	4430
Average positioning time (msec)	38	35	30	30	30	35	35
Average rotational delay (msec)	12.5	12.5	8.3	8.3	8.3	6.77	6.77
Average access time (msec)	50.5	47.5	38.3	38.3	38.3	41.77	41.77
Data transfer rate (KBytes/sec)	312.5	312.5	1209	1209	1209	800	800
FIRST CUSTOMER SHIPMENT	6/77	1Q80	2Q80	2Q80	2Q80	2Q80	2Q80
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS							

DRE

MANUFACTURER	DATA RECORDING EQUIPMENT, LTD.	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
DRIVE	3144	RK05J	RL01	RL02	RK06	RK07	RM02
DISK/TREND GROUP	8	1	1	1	2	2	4
MEDIA: Manufacturer's number	--	RK05K	RL01K	RL02K	RK06K	RK07K	--
Generic type	Fixed	2315	5440	5440	Special Cartridge	Special Cartridge	SMD
TECHNOLOGY TYPE, DRIVE	3340	2314	3330-1	3330-1	3330-1	3330-11	3330-11
NOMINAL DISK DIAMETER	200 mm	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 44	--	--	--	--	--	--
REMOVABLE	--	F: 2.49	F: 5.24	F: 10.48	F: 13.89	F: 27.54	F: 67.42
Capacity per track (Bytes)	U: 10,880	F: 6,144	F: 10,240	F: 10,240	F: 11,264	F: 11,264	F: 16,384
Data surfaces per spindle	5	2	2	2	3	3	5
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	816	203	256	512	411	815	823
TPI	680	100	125	250	192.3	384.6	384
BPI	5800	2040	3725	3725	4040	4040	6038
RPM	4430	1500	2400	2400	2400	2400	2400
Average positioning time (msec)	35	50	55	55	38	36.5	30
Average rotational delay (msec)	6.77	20	12.5	12.5	12.5	12.5	12.5
Average access time (msec)	41.77	70	67.5	67.5	50.5	49	42.5
Data transfer rate (KBytes/sec)	800	180	512.5	512.5	538	538	806
FIRST CUSTOMER SHIPMENT	2Q80	1975	4/78	1979	12/76	4/78	4/78
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS		Original RK05 FCS 1972	Embedded Servo	Embedded Servo			Manufactured by CDC

DRE DEC

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DISK MEMORY TECHNOLOGY, INC.	DISK MEMORY TECHNOLOGY, INC.	DISK MEMORY TECHNOLOGY, INC.	FUJITSU, LTD.	FUJITSU, LTD.
DRIVE	RM03	RK05F	301-2	301-4	301-6	M2201	F451
DISK/TREND GROUP	4	7	7	7	7	2	2
MEDIA: Manufacturer's number	--	--	--	--	--	M2951	F922P
Generic type	SMD	Fixed	Fixed Plated Disks	Fixed Plated Disks	Fixed Plated Disks	Special Cartridge	Special Cartridge
TECHNOLOGY TYPE, DRIVE	3330-11	2314	1 Head Per Slider	2 Heads Per Slider	4 Heads Per Slider	3330-11	3330-11
NOMINAL DISK DIAMETER	14"	14"	225 mm	225 mm	225 mm	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	F: 4.99	U: 0.58	U: 2.32	U: 9.29	--	--
REMOVABLE	F: 67.42	--	--	--	--	U: 50.56	F: 19.86
Capacity per track (Bytes)	F: 16,384	F: 6,144	U: 4,538	U: 9,075	U: 17,900	U: 20,480	F: 16,384
Data surfaces per spindle	5	2	2	2	2	3	3
Heads per data surface	1	1	2	2	4	1	1
Tracks per surface	823	406	64	128	256	823	404
TPI	384	200	128	128	256	370	370
BPI	6038	2040	1285	5140	10280	6135	6135
RPM	3600	1500	1800	1800	1800	2400	2400
Average positioning time (msec)	30	56	55	130	130	30	30
Average rotational delay (msec)	8.3	20	16.7	16.7	16.7	12.5	12.5
Average access time (msec)	38.3	76	71.7	146.7	146.7	42.5	42.5
Data transfer rate (KBytes/sec)	1209	180	156	312.5	625	819	819
FIRST CUSTOMER SHIPMENT	1977	7/76	1978	1978	1978	4Q77	3Q77
U.S. OEM PRICE FOR 100 UNITS	--	--	$850	$1815	$2415	$3705	--
COMMENTS	Manufactured by CDC		Stepping Motor Actuator	Stepping Motor Actuator	Stepping Motor Actuator	OEM	

DEC DISK MEMORY TECHNOLOGY FUJITSU

MANUFACTURER	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD	FUJITSU, LTD.
DRIVE	F452	M2211	F6417	F478	F479	F467	M2301
DISK/TREND GROUP	2	2	2	5	5	6	7
MEDIA: Manufacturer's number	F922P Special Cartridge	M2952 Special Cartridge	F924P Special Cartridge	F945P	F949P		--
Generic type				3336-1	3336-11	3348-35/70	Fixed
TECHNOLOGY TYPE, DRIVE	3330-11	3330-11	3330-11	3330-1	3330-11	3340	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	200 mm
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	--	--	--	--	U: 11.71
REMOVABLE	F: 39.7	U: 84.27	F: 67.6	F: 100	F: 200	F: 35/70	--
Capacity per track (Bytes)	F: 16,384	U: 20,480	F: 16,736	F: 13,030	F: 13,030	F: 16,736	U: 12,000
Data surfaces per spindle	3	5	5	19	19	3/6	4
Heads per data surface	1	1	1	1	1	2	1
Tracks per surface	808	823	808	413	815	696/2	244
TPI	370	370	370	192	370	300	195
BPI	6135	6135	5636	4040	4040	5636	6100
RPM	2400	2400	2400	3600	3600	2964	2964
Average positioning time (msec)	30	30	30	25	25	20	70
Average rotational delay (msec)	12.5	12.5	12.5	8.4	8.4	10.1	10.1
Average access time (msec)	42.5	42.5	42.5	33.4	33.4	30.1	80.1
Data transfer rate (KBytes/sec)	819	819	717	806	806	885	593
FIRST CUSTOMER SHIPMENT	3Q77	4Q79	4Q79	4Q73	3Q75	1976	7/80
U.S. OEM PRICE FOR 100 UNITS	--	$4990	--	--	--	--	--
COMMENTS		OEM					OEM Stepping Motor Actuator

MANUFACTURER	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD	FUJITSU, LTD.
DRIVE	M2302	M2311	M2312	M2251	M2252	M2253	M2282
DISK/TREND GROUP	7	8	8	7	8	8	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3340	2X3350	2X3350	3340	3340	3340	3350
NOMINAL DISK DIAMETER	200 mm	200 mm	200 mm	14"	14"	14"	14"
PERFORMANCE				.3277 or .6554 F. Head Option	.3277 or .6554 F. Head Option	.3277 or. 6554 F. Head Option	.6554 Fixed Head Option
Total capacity (MBytes) FIXED	U: 23.43	U: 32.25	U: 75.26	U: 12.7	U: 25.4	U: 50.8	U: 67.42
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 12,000	U: 20,480	U: 20,480	U: 20,480	U: 20,480	U: 20,480	U: 20,480
Data surfaces per spindle	8	3	7	1	2	4	2
Heads per data surface	1	1	1	2	2	2	2
Tracks per surface	244	525	525	630	630	630	1646
TPI	195	680	680	300	300	300	680
BPI	6100	9400	9400	6230	6230	6230	6580
RPM	2964	3600	3600	2400	2400	2400	2964
Average positioning time (msec)	70	20	20	40	40	40	27
Average rotational delay (msec)	10.1	8.3	8.3	12.5	12.5	12.5	10.12
Average access time (msec)	80.1	28.3	28.3	52.5	52.5	52.5	37.12
Data transfer rate (KBytes/sec)	593	1229	1229	819	819	819	1012
FIRST CUSTOMER SHIPMENT	7/80	8/81	8/81	2Q78	2Q78	2Q78	4Q79
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	$3450
COMMENTS	OEM Stepping Motor Actuator	OEM	OEM	OEM SMD Interface	OEM SMD Interface	OEM SMD Interface	OEM SMD Interface

MANUFACTURER	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	HEWLETT-PACKARD
DRIVE	M2283	M2284	F436	F6411	F493	F496	7900
DISK/TREND GROUP	8	8	8	8	9	9	1
MEDIA: Manufacturer's number	--	--	--	--	--	--	12869A
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	2315
TECHNOLOGY TYPE, DRIVE	3350	3350	3350	3350	3350	2X3350	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE	.6554 Fixed Head Option	.6554 Fixed Head Option					
Total capacity (MBytes) FIXED	U: 134.84	U: 168.55	F: 100	F: 135	F: 317.5	F: 635	F: 2.5
REMOVABLE	--	--	--	--	--	--	F: 2.5
Capacity per track (Bytes)	U: 20,480	U: 20,480		F: 16,736	F: 19,069	F: 19,069	F: 6,144
Data surfaces per spindle	4	5	5	5	15	20	4
Heads per data surface	2	2	2	2	2	2	1
Tracks per surface	1646	1646	1630	1630	1110	1660	200
TPI	680	680	668	668	480	668	100
BPI	6580	6580	6580	5694	6362	6426	2200
RPM	2964	2964	2400	2964	3600	3600	2400
Average positioning time (msec)	27	27	27	27	20	20	30
Average rotational delay (msec)	10.12	10.12	12.5	10.1	8.4	8.4	12.5
Average access time (msec)	37.12	37.12	39.5	37.1	28.4	28.4	42.5
Data transfer rate (KBytes/sec)	1012	1012	819	885	1198	1198	312.5
FIRST CUSTOMER SHIPMENT	4Q79	4Q79	4Q79	4Q79	4Q79	2Q80	
U.S. OEM PRICE FOR 100 UNITS	$4300	$4600	--	--	--	--	--
COMMENTS	OEM SMD Interface	OEM SMD Interface					

FUJITSU

HP

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.
DRIVE	7906	7920	7925	7910	H-8593	H-8589-1	H-8589-11
DISK/TREND GROUP	2	4	5	7	5	5	5
MEDIA: Manufacturer's number	12940A	13394A	13356A	--	H-8583	H-8581-1	H-8581-11
Generic type	2315	Special SMD	Special Pack	Fixed	Special Disk Pack	3336-1	3336-11
TECHNOLOGY TYPE, DRIVE	3330-1	3330-11	3330-11	3340	3330-11	3330-1	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 12.68	--	--	F: 12.09	--	--	--
REMOVABLE	U: 12.68	U: 63.67	F: 120.18	--	F: 100	F: 100	F: 200
Capacity per track (Bytes)	U: 15,625	U: 15,625	F: 16,384	F: 8,192	F: 13,030	F: 13,030	F: 13,030
Data surfaces per spindle	3	5	9	2	12	19	19
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	812 Fixed 406 Removable	815	815	738	815	411	815
TPI	384 Fixed 192 Removable	384	384	300	370	192	370
BPI	4680	4680	6250	3225	4040	4040	4040
RPM	3600	3600	2700	3000	3600	3600	3600
Average positioning time (msec)	25	25	25	70	30	30	25
Average rotational delay (msec)	8.3	8.33	11.1	10	8.3	8.3	8.3
Average access time (msec)	33.3	33.33	36.1	80	38.3	38.3	33.3
Data transfer rate (KBytes/sec)	937.5	937.5	937.5	526	806	806	806
FIRST CUSTOMER SHIPMENT	3/78	3/77	6/78	1Q79	1979		
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS					Two 50 MB Disk Packs on Single Spindle		

HEWLETT-PACKARD HITACHI

MANUFACTURER	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.
DRIVE	H-8586-12 H-8586-22	DK801-1	DK801-2	MFD 90-1	MFD 90-2	MFD 90-F	MFD 90-F2
DISK/TREND GROUP	6	7	7	7	7	7	7
MEDIA: Manufacturer's number	H-8584-35/70	--	--	--	--	--	--
Generic type	3348-35/70	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3340	3350	3350	3340	3340	3340	3340
NOMINAL DISK DIAMETER	14"	210 mm	210 mm	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	U: 6.9	U: 13.9	F: 1.3	F: 2.6	0.061 MB Fixed Head Option F: 1.95	0.143 MB Fixed Head Option F: 1.95
REMOVABLE	F: 35/70	--	--	--	--	--	--
Capacity per track (Bytes)	F: 16,736	U: 15,100	U: 15,100	F: 10,200	F: 10,200	F: 10,200	F: 10,200
Data surfaces per spindle	3/6	2	4	1	2	2	2
Heads per data surface	2	1	1	2	2	2/1	2/1
Tracks per surface	696/2	231	231	129	129	129/65	129/65
TPI	300	200	200	48	48	48	48
BPI	5636	7300	7300	3706	3706	3706	3706
RPM	2964	3557	3557	3425	3425	3425	3425
Average positioning time (msec)	20	70	70	190	190	190	190
Average rotational delay (msec)	10.1	8.4	8.4	8.8	8.8	8.8	8.8
Average access time (msec)	30.1	78.4	78.4	198.8	198.8	198.8	198.8
Data transfer rate (KBytes/sec)	1976	889	889	618	618	618	618
FIRST CUSTOMER SHIPMENT	1976	4/80	4/80	1976	1976	1976	1976
U.S. OEM PRICE FOR 100 UNITS	--	$1150 (1000 units)	$1200 (1000 units)	--	--	--	--
COMMENTS		OEM Stepping Motor Actuator	OEM Stepping Motor Actuator	OEM	OEM	OEM	OEM

MANUFACTURER	HITACHI. LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.
DRIVE	MFD 135-4	MFD 135-8	MFD 135-F	DK 62-10	DK 62-20	DK 62-40	DK 62-80
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	3340	3340	3340	3340	3340	3340	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE			0.21 MB Fixed Head Option	0.144 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: 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	U: 86.6 F: 73.9
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 14,500	F: 14,500	F: 14,500	F: 15,360	F: 15,360	F: 15,360	F: 15,360
Data surfaces per spindle	2	4	4	1	2	4	8
Heads per data surface	2	2	2/2/2/1	2	2	2	2
Tracks per surface	129/128	129/128	129/128	604	604	604	604
TPI	48	48	48	300	300	300	300
BPI	5241	5241	5241	5570	5570	5570	5570
RPM	3450	3450	3450	2964	2964	2964	2964
Average positioning time (msec)	100	100	100	40	40	37	37
Average rotational delay (msec)	8.7	8.7	8.7	10.1	10.1	10.1	10.1
Average access time (msec)	108.7	108.7	108.7	50.1	50.1	47.1	47.1
Data transfer rate (KBytes/sec)	875	875	875	889	889	889	889
FIRST CUSTOMER SHIPMENT	1979	1979	1979	1977	1977	1979	1979
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS	OEM	OEM	OEM	OEM	OEM	OEM	OEM

MANUFACTURER	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HOKUSHIN ELECTRIC WORKS, LTD.	HOKUSHIN ELECTRIC WORKS, LTD.	HOKUSHIN ELECTRIC WORKS, LTD.	HOKUSHIN ELECTRIC WORKS, LTD.
DRIVE	H-8594-22	H-8595-12 H-8595-22 H-8595-32	H-8597-12 H-8597-22	CD-3100H	CD-3300	CD-4400	CD-5100S
DISK/TREND GROUP	9	9	9	1	1	1	1
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	2315	2315	5440	5440
TECHNOLOGY TYPE, DRIVE	3344	3350	2X3350	2314	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: 280	F: 317.5	F: 635	--	U: 3.0	U: 6.0	--
REMOVABLE	--	--	--	U: 3.0	U: 3.0	U: 6.0	U: 6.0
Capacity per track (Bytes)	F: 16,736	F: 19,069	F: 19,069	U: 7,500	U: 7,500	U: 7,500	U: 7,500
Data surfaces per spindle	15	15	20	2	4	4	2
Heads per data surface	2	2	2	1	1	1	1
Tracks per surface	1114	1110	1666	203	203	408	408
TPI	478	478	720	100	100	200	200
BPI	5636	6425	6425	2200	2200	2200	2200
RPM	2964	3600	3600	1500	1500	2400	2400
Average positioning time (msec)	20	20	20	70	70	38	40
Average rotational delay (msec)	10.1	8.4	8.4	20	20	12.5	12.5
Average access time (msec)	30.1	28.4	28.4	90	90	50.5	52.5
Data transfer rate (KBytes/sec)	885	1198	1198	195	195	312.5	312.5
FIRST CUSTOMER SHIPMENT	1979	1979	10/80	1972	1972	1975	1979
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS			2 Independent Actuators				

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-5200S	CD-5300S	CD-5400S	CD-5100	CD-5200	CD-5300	CD-5400
DISK/TREND GROUP	1	2	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: 12.0	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	6	8	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)	40	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)	52.5	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	1979	1979	1979	1979	1979	1979	1979
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS							

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-2400	CD-2800	CD-8005	CD-8010	CD-8020	CD-8030	CD-6030
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	2314	3330-11	3340	3340	3350	3350	3350
NOMINAL DISK DIAMETER	14"	14"	200 mm	200 mm	200 mm	200 mm	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 6.0	U: 12.0	U: 6.6	U: 13.2	U: 21.2	U: 35.3	U: 33.9
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 7,500	U: 15,000	U: 15,000	U: 15,000	U: 13,440	U: 13,440	U: 20,160
Data surfaces per spindle	2	2	2	4	3	5	2
Heads per data surface	1	1	1	1	1	1	2/1
Tracks per surface	408	408	221	221	526	526	1122
TPI	200	200	180	180	480	480	480
BPI	2200	4400	7474	7474	6646	6646	6430
RPM	1500	1500	3600	3600	3600	3600	3125
Average positioning time (msec)	70	70	53	53	50	50	45
Average rotational delay (msec)	20	20	8.3	8.3	8.3	8.3	9.7
Average access time (msec)	90	90	61.3	61.3	58.3	58.3	54.7
Data transfer rate (KBytes/sec)	195	390.5	900	900	800	800	1040
FIRST CUSTOMER SHIPMENT	1976	1977	3/80	3/80	1981	1981	1981
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS			Stepping Motor Actuator				

MANUFACTURER	HOKUSHIN ELECTRIC WORKS, LTD.	HOKUSHIN ELECTRIC WORKS, LTD.	IBM	IBM	IBM	IBM	IBM
DRIVE	CD-6060	CD-6150	1131	2310	5444-1	5444-2/3	5444-A1
DISK/TREND GROUP	8	8	1	1	1	1	1
MEDIA: Manufacturer's number	--	--	2315	2315	5440	5440	5440
Generic type	Fixed	Fixed	2315	2315	5440	5440	5440
TECHNOLOGY TYPE, DRIVE	3350	3350	2310	2310	5444	5444	5444
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 67.9	U: 158.5	--	--	F: 1.22	F: 2.45	F: 1.22
REMOVABLE	--	--	F: 1.024	F: 1.024	F: 1.22	F: 2.45	F: 1.22
Capacity per track (Bytes)	U: 20,160	U: 20,160	F: 2,560	F: 2,560	F: 6,144	F: 6,144	F: 6,144
Data surfaces per spindle	2	4	2	2	4	4	4
Heads per data surface	2/1	2/1	1	1	1	1	1
Tracks per surface	2246	2246	200	200	100	200	100
TPI	960	960	100	100	100	100	100
BPI	6430	6430	1100	1100	2200	2200	2200
RPM	3125	3125	1500	1500	1500	1500	1500
Average positioning time (msec)	45	40	520	520	153	269	86
Average rotational delay (msec)	9.7	9.7	20	20	20	20	20
Average access time (msec)	54.7	49.7	540	540	173	289	106
Data transfer rate (KBytes/sec)	1040	1040	97.5	97.5	199	199	199
FIRST CUSTOMER SHIPMENT	1981	1982	11/65	11/65	1970	1970	1971
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS			1130	1130	System/3	System/3	System/3

HOKUSHIN IBM

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	5444-A2	5022-1	5022-2	5447-A1	5447-A2	2311-1	2311-11
DISK/TREND GROUP	1	1	1	1	1	--	--
MEDIA: Manufacturer's number	5440	5440	5440	5440	5440	1316	1316
Generic type	5440	5440	5440	5440	5440	1316	1316
TECHNOLOGY TYPE, DRIVE	5444	5444	5444	5444	5444	2311	2311
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	F: 2.45	F: 2.45	F: 2.45	F: 2.45	F: 7.35	--	--
REMOVABLE	F: 2.45	F: 2.45	F: 2.45	F: 2.45	F: 2.45	F: 7.25	F: 5.4
Capacity per track (Bytes)	F: 6,144	F: 6,144	F: 6,144	F: 6,144	F: 6,144	F: 3,625	F: 2,700
Data surfaces per spindle	4	4	4	4	8	10	10
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	200	200	200	200	200	203	203
TPI	100	100	100	100	100	100	100
BPI	2200	2200	2200	2200	2200	1100	1100
RPM	1500	1500	1500	1500	1500	2400	2400
Average positioning time (msec)	126	269	126	126	126	75	75
Average rotational delay (msec)	20	20	20	20	20	12.5	12.5
Average access time (msec)	146	289	146	146	146	87.5	87.5
Data transfer rate (KBytes/sec)	199	199	199	199	199	156	156
FIRST CUSTOMER SHIPMENT	1971	1971	1971	1976	1976	6/65	11/70
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS	System/3	System/7	System/7	System/3	System/3	System/360	System/360

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	2311-12	2314-1	2314-A 2314-B 2312 2319	5445	3330-1	3330-11	3340-A2 3340-B1, B2
DISK/TREND GROUP	--	3	3	3	5	5	6
MEDIA: Manufacturer's number	1316	2316	2316	2316	3336-1	3336-11	3348-35
Generic type	1316	2316	2316	2316	3336-1	3336-11	3348-35
TECHNOLOGY TYPE, DRIVE	2311	2314	2314	2314	3330-1	3330-11	3340
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	--	--	--	--	--
REMOVABLE	F: 2.7	F: 29.176	F: 29.176	F: 20.48	F: 100.018	F: 200.036	F: 34.9(S/370)
Capacity per track (Bytes)	F: 2,700	F: 7,294	F: 7,294	F: 5,120	F: 13,030	F: 13,030	F: 16,736
Data surfaces per spindle	10	20	20	20	19	19	3
Heads per data surface	1	1	1	1	1	1	2
Tracks per surface	103	203	203	203	411	815	696/2
TPI	100	100	100	100	192	370	300
BPI	1100	2200	2200	2200	4040	4040	5636
RPM	2400	2400	2400	2400	3600	3600	2964
Average positioning time (msec)	60	75	60	60	30	30	25
Average rotational delay (msec)	12.5	12.5	12.5	12.5	8.3	8.3	10.1
Average access time (msec)	72.5	87.5	72.5	72.5	38.3	38.3	35.1
Data transfer rate (KBytes/sec)	156	312.5	312.5	312.5	806	806	885
FIRST CUSTOMER SHIPMENT	11/70	4/65	A-8/69 B, 2319-12/70	6/72	8/71	1973	11/73
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS	System/360	System/360 System/370	System/360 System/370	System/3	System/370 303X Series 4341	System/370 303X Series 4341	System/370 System/7 303X Series 4341

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	3340-A2 3340-B1, B2	3340-A2 3340-B1, B2	3340-C2	5022-3	5022-4	5448	5320-XX1
DISK/TREND GROUP	6	6	6	7	7	7	7
MEDIA: Manufacturer's number	3348-70	3348-70F	3348-70	--	--	--	--
Generic type	3348-70	3348	3348	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3340	3340	3340	2314	2314	2314	Gulliver
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	--	F: 2.45	F: 2.45	F: 9.8	F: 3.210
REMOVABLE	F: 69.8(S/370)	.502 F. Head F: 69.388	F: 50.872	--	--	--	--
Capacity per track (Bytes)	F: 16,736	F: 16,736	F: 16,736	F: 6,144	F: 6,144	F: 6,144	F: 15,360
Data surfaces per spindle	6	6	6	2	2	8	1
Heads per data surface	2	2	2	1	1	1	2
Tracks per surface	696/2	696/2	696/2	200	200	200	209
TPI	300	300	300	100	100	100	300
BPI	5636	5636	5636	2200	2200	2200	5636
RPM	2964	2964	2964	1500	1500	1500	2964
Average positioning time (msec)	25	25	25	269	126	126	50.4
Average rotational delay (msec)	10.1	10.1	10.1	20	20	20	10.1
Average access time (msec)	35.1	35.1	35.1	289	146	146	60.5
Data transfer rate (KBytes/sec)	885	885	885	199	199	199	889
FIRST CUSTOMER SHIPMENT	11/73	11/73	11/73	1971	1971	1Q77	4Q76
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS	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	System/32

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	5320-XX2	5320-XX3	5320-XX4	4962-1 4962-2	4962-1F 4962-2F	4962-3 4962-4	4963-29A 4963-29B
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	Piccolo
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	210 mm
PERFORMANCE					0.122 MB Fixed Heads		
Total capacity (MBytes) FIXED	F: 5.053	F: 9.170	F: 13.778	F: 9.308	F: 9.308	F: 13.962240	F: 29.327360
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 15,360	F: 15,360	F: 15,360	F: 15,360	F: 15,360	F: 15,360	F: 16,384
Data surfaces per spindle	1	1	2	1	1	2	5
Heads per data surface	2	2	2/1	2	2	2/1	1
Tracks per surface	329	597	598/299	606	F: 8 M: 606	606	359
TPI	300	300	300	300	300	300	450
BPI	5636	5636	5636	5636	5636	5636	8530
RPM	2964	2964	2964	2964	2964	2964	3125
Average positioning time (msec)	70	72.5	72.5	40	40	40	27
Average rotational delay (msec)	10.1	10.1	10.1	10.1	10.1	10.1	9.6
Average access time (msec)	80.1	82.6	82.6	50.1	50.1	50.1	36.6
Data transfer rate (KBytes/sec)	889	889	889	889	889	889	1031
FIRST CUSTOMER SHIPMENT	1/75	1/75	2Q76	4Q76	4Q76		2/79
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS	System/32	System/32	System/32	Series/1	Series/1	Series/1	Series/1

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	4963-23A 4963-23B	4963-64A 4963-64B	4963-58A 4963-58B	5340-XX1	5340-XX2	5340-XX3	5340-XX4
DISK/TREND GROUP	7	8	8	7	7	7	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	Piccolo	Piccolo	Piccolo	Gulliver	Gulliver	Gulliver	Piccolo
NOMINAL DISK DIAMETER	210 mm	210 mm	210 mm	14"	14"	14"	210 mm
PERFORMANCE							
Total capacity (MBytes) FIXED	0.131 MB Fixed Heads F: 23.461888	F: 64.520192	0.131 MB Fixed Heads F: 58.654720	F: 8.616960	F: 13.271040	Drive consists of 2 spindles F: 27.156480	F: 63.905792
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 16,384	F: 16,384	F: 15,360	F: 15,360	F: 15,360	F: 16,384
Data surfaces per spindle	5	11	11	2	2	2	11
Heads per data surface	1	1	1	2/1	2/1	2/1	1
Tracks per surface	359	359	359	402/201	604/302	604/302	359
TPI	450	450	450	300	300	300	450
BPI	8530	8530	8530	5636	5636	5636	8530
RPM	3125	3125	3125	2964	2964	2964	3125
Average positioning time (msec)	27	27	27	35	40	40	27
Average rotational delay (msec)	9.6	9.6	9.6	10.1	10.1	10.1	9.6
Average access time (msec)	36.6	36.6	36.6	45.1	50.1	50.1	36.6
Data transfer rate (KBytes/sec)	1031	1031	1031	889	889	889	1031
FIRST CUSTOMER SHIPMENT	2/79	2/79	2/79	1/78	1/78	1/78	1/79
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS	Series/1	Series/1	Series/1	System/34	System/34	System/34	System/34

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	5340-XX5	5381 - All Models	8130-A21 8140-A31 A41, A51 A61, A71	8130-A22 8140-A32 A42, A52 A62, A72	8130-A23 8140-A33 A43, A53 A63, A73	8130-A24 8140-A34 A44, A54 A64, A74	8140-B51 B61 B71
DISK/TREND GROUP	8	8	7	7	8	8	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	Piccolo	Piccolo	Piccolo	Piccolo	Piccolo	Piccolo	Piccolo
NOMINAL DISK DIAMETER	210 mm	210 mm	210 mm	210 mm	210 mm	210 mm	210 mm
PERFORMANCE	Drive consists of 2 spindles			.131072 MB Fixed Heads		.131072 MB Fixed Heads	.131072 MB Fixed Heads
Total capacity (MBytes) FIXED	F: 128.425984	F: 64.520192	F: 29.327360	F: 23.461888	F: 64.520192	F: 58.654720	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	5	5	11	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	8/79	3Q79	3Q79	3Q79	3Q79	4Q80
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS	System/34	System/38 5381 Processor available with up to six disk spindles	8100 System	8100 System	8100 System	8100 System	8100 System

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	8140-B52 B62 B72	8101-A11	8101-A13	3310-A1 3310-A2 3310-B1 3310-B2	5525-020 5525-030	5525-040 5525-050	3344-B2 3344-B2F
DISK/TREND GROUP	8	7	8	8	7	8	9
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	Piccolo	Piccolo	Piccolo	Piccolo	Piccolo	Piccolo	3350
NOMINAL DISK DIAMETER	210 mm	210 mm	210 mm	210 mm	210 mm	210 mm	14"
PERFORMANCE	.131072 MB Fixed Heads						1.004 MB Fixed Head Option
Total capacity (MBytes) FIXED	F: 123.174912	F: 29.327360	F: 64.520192	F: 64.520192	F: 29.327360	F: 64.520192	F: 279.558
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 16,384	F: 16,384	F: 16,384	F: 16,384	F: 16,384	F: 16,736
Data surfaces per spindle	11	5	11	11	5	11	15
Heads per data surface	1	1	1	1	1	1	2
Tracks per surface	359	359	359	359	359	359	1114
TPI	450	450	450	450	450	450	478
BPI	8530	8530	8530	8530	8530	8530	5636
RPM	3125	3125	3125	3125	3125	3125	2964
Average positioning time (msec)	27	27	27	27	27	27	25
Average rotational delay (msec)	9.6	9.6	9.6	9.6	9.6	9.6	10.1
Average access time (msec)	36.6	36.6	36.6	36.6	36.6	36.6	35.1
Data transfer rate (KBytes/sec)	1031	1031	1031	1031	1031	1031	885
FIRST CUSTOMER SHIPMENT	4Q80	3Q79	3Q79	3/79	2/80	11/80	2Q76
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS	8100 System Dual Spindle	8100 System	8100 System	4331		5520 Admin. System -050 Model is Dual Spindle	System/370 System/3 303X Series 4341

MANUFACTURER	IBM	IBM	IBM	IBM	INTERNATIONAL MEMORIES, INC.	INTERNATIONAL MEMORIES, INC.	ISOTIMPEX
DRIVE	3350-A2 3350-B2 3350-C2	3370-A1 3370-A11 3370-B1 3370-B11	3375-A1 3375-B1	3380-A4 3380-AA4 3380-B4	7710	7720	ISOT 1370
DISK/TREND GROUP	9	9	9	9	7	7	1
MEDIA: Manufacturer's number	--	--	--	--	--	--	ES-5269
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	5440
TECHNOLOGY TYPE, DRIVE	3350	3370	3370	3380	3340	3340	2314
NOMINAL DISK DIAMETER	14"	14"	*	*	200 mm	200 mm	14"
PERFORMANCE	1.144 MB Fixed Head Option			2.8 MB Fixed Head Option			
Total capacity (MBytes) FIXED	F: 317.5	F: 571.392	F: 819.7	F: 1260	U: 11.12	U: 20.5	F: 2.45
REMOVABLE	--	--	--	--	--	--	F: 2.45
Capacity per track (Bytes)	F: 19,069	F: 31,744	*	*	U: 10,800	U: 10,800	F: 6,144
Data surfaces per spindle	15	12	*	*	3	5	4
Heads per data surface	2	2	*	*	1	1	1
Tracks per surface	1110	1500	*	*	350	380	203
TPI	478	635	*	*	300	300	100
BPI	6425	8128 FRPI**	*	*	5868	6000	2200
RPM	3600	2964	2964	3600	3600	3600	2400
Average positioning time (msec)	25	20	19	16	35	35	45
Average rotational delay (msec)	8.4	10.1	10.1	8.3	8.3	8.3	12.5
Average access time (msec)	33.4	30.1	29.1	24.3	33.3	33.3	57.5
Data transfer rate (KBytes/sec)	1198	1859	1859	3000	648	648	312
FIRST CUSTOMER SHIPMENT	1Q76	10/79	3Q81	1Q81	1/79	1/80	1976
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	$1900	$2290	--
COMMENTS	System/370 303X Series 4341	43X1 Series System/38 **12,134 Net BPI	4331 Group 2 4341 303X Series	303X Series 370/158, 158-3 370/168, 168-3			

* Not announced

MANUFACTURER	ISOTIMPEX	ISOTIMPEX	ISOTIMPEX	ISOTIMPEX	ISOTIMPEX	ISOTIMPEX	ISS/UNIVAC
DRIVE	ES-5052	SM 5400-02 SM 5400-03	SM 5400-00 SM 5400-01	ES-5061	ES-5066 ES-5067.01 ES-5067.02	ES-5067	Univac 8415
DISK/TREND GROUP	--	1	1	3	5	5	2
MEDIA: Manufacturer's number	ES-5053	ES-5269	ES-5269	ES-5261	ES-5266.01	ES-5267	F 1215-00
Generic type	1316	5440	5440	2316	3336-1	3336-11	5440
TECHNOLOGY TYPE, DRIVE	2311	2314	2314	2314	3330-1	3330-11	3330-11
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	--	--	U: 3.125	--	--	--	F: 24.8
REMOVABLE	F: 7.25	U: 3.125	U: 3.125	F: 29	F: 100	F: 200	F: 8.3
Capacity per track (Bytes)	F: 3,625	U: 7,812	U: 7,812	F: 7,294	F: 13,030	F: 13,030	F: 10,240
Data surfaces per spindle	10	4	4	20	19	19	3 Fixed 2 Removable
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	203	204	204	203	411	815	815 Fixed 411 Removable
TPI	100	100	100	100	192	370	370 Fixed 185 Removable
BPI	1100	2200	2200	2200	4040	4040	4040
RPM	2400	2400/1500	2400/1500	2400	3600	3600	2800
Average positioning time (msec)	70	50	50	50	30	30	33
Average rotational delay (msec)	12.5	12.5/20	12.5/20	12.5	8.3	8.3	10.7
Average access time (msec)	82.5	62.5/70	62.5/70	62.5	38.3	38.3	43.7
Data transfer rate (KBytes/sec)	156	312/195	312/195	312	806	806	625
FIRST CUSTOMER SHIPMENT	1971	1979	1979	1976	1980	1980	2/77
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS							

MANUFACTURER	ISS/UNIVAC	ISS/UNIVAC	ISS/UNIVAC	ISS/UNIVAC	ISS/UNIVAC	ISS/UNIVAC	ISS/UNIVAC
DRIVE	Univac 8418-92	Univac 8418-94	Univac 8419	733-10 7330-10	733-11 7330-11	7330-12	717
DISK/TREND GROUP	4	4	4	5	5	5	8
MEDIA: Manufacturer's number	F 1216-01	F 1216-02		--	--	--	--
Generic type	SMD	SMD	SMD	3336-1	3336-11	3336 (Spec)	Fixed
TECHNOLOGY TYPE, DRIVE	3330-11	3330-11	3330-11	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: 72.3	F: 100	F: 200	F: 317.5	--
Capacity per track (Bytes)	F: 10,240	F: 10,240	F: 16,800	F: 13,030	F: 13,030	F: 19,069	U: 19,968
Data surfaces per spindle	7	7	7	19	19	19	3
Heads per data surface	1	1	1	1	1	1	2
Tracks per surface	411	815	815	411	815	887	1120
TPI	370	370	370	192	370	402	476
BPI	4040	4040	5050	4040	4040	6965	6366
RPM	2800	2800	2800	3600	3600	3600	3600
Average positioning time (msec)	27	33	33	27	27	30	35
Average rotational delay (msec)	10.7	10.7	10.7	8.3	8.3	8.3	8.3
Average access time (msec)	37.7	43.7	43.7	35.3	35.3	38.3	43.3
Data transfer rate (KBytes/sec)	625	625	784	806	806	1260	1198
FIRST CUSTOMER SHIPMENT	11/75	3/76	12/80	5/75	2/75	1977	
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS			System 80	Equivalent to Univac 8430	Equivalent to Univac 8433	Equivalent to Univac 8434	

MANUFACTURER	ISS/UNIVAC	ISS/UNIVAC	ISS/UNIVAC	ISS/UNIVAC	ISS/UNIVAC	ISS/UNIVAC	ISS/UNIVAC
DRIVE	717	717	Univac 8402-50	Univac 8402-75	Univac 8402-100	Univac 8417	7350
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	3350	3350	3350	3350	3350	3350	3350
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE	1.2 MB Fixed Head Option	1.2 MB Fixed Head Option				.86 MB Fixed Head Option	
Total capacity (MBytes) FIXED	U: 110	U: 154	F: 50	F: 75	F: 100	F: 118.2	F: 317.5
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 19,968	U: 19,968				F: 19,900	F: 19,069
Data surfaces per spindle	5	7	3	5	7	7	15
Heads per data surface	2	2	2	2	2	2	2
Tracks per surface	1120	1120				1100	1110
TPI	476	476	476	476	476	476	478
BPI	6366	6366	6366	6366	6366	6366	6366
RPM	3600	3600	3600	3600	3600	3400	3600
Average positioning time (msec)	35	35	35	35	35	35	23
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3	8.82	8.3
Average access time (msec)	43.3	43.3	43.3	43.3	43.3	43.82	31.3
Data transfer rate (KBytes/sec)	1198	1198	1198	1198	1198	1130	1198
FIRST CUSTOMER SHIPMENT			3/81	3/81	3/81	12/80	4Q77
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS			BC/7-900	BC/7-900	BC/7-900	System 80	PCM 3350

MANUFACTURER	ISS/UNIVAC	ISS/UNIVAC	KENNEDY COMPANY	KENNEDY COMPANY	KENNEDY COMPANY	KENNEDY COMPANY	KENNEDY COMPANY
DRIVE	Univac 8450	Univac 8470	7000 Series	7000 Series	7000 Series	5301-14	5302-42
DISK/TREND GROUP	9	9	7	7	7	7	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3350	3350	3340	3340	3340	3340	3340
NOMINAL DISK DIAMETER	14"	14"	210 mm	210 mm	210 mm	14"	14"
PERFORMANCE		1.524 MB Fixed Head Option					
Total capacity (MBytes) FIXED	F: 336.3	F: 564.48	U: 4.032	U: 12.096	U: 20.16	U: 14.112	U: 42.336
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 21,060	F: 28,224	U: 11,520	U: 11,520	U: 11,520	U: 20,160	U: 20,160
Data surfaces per spindle	15	16	1	3	5	1	3
Heads per data surface	2	2	1	1	1	2	2
Tracks per surface	1110	1250	350	350	350	700	700
TPI	478	538	300	300	300	300	300
BPI	6695	11,134*	5280	5280	5280	6000	6000
RPM	3600	3600	3600	3600	3600	3000	3000
Average positioning time (msec)	23	23	50	50	50	45	45
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3	10	10
Average access time (msec)	31.3	31.3	58.3	58.3	58.3	55	55
Data transfer rate (KBytes/sec)	1198	2097	688	688	688	1000	1000
FIRST CUSTOMER SHIPMENT	2Q78	6/80	1Q80	1Q80	1Q80	1Q78	1Q78
U.S. OEM PRICE FOR 100 UNITS	--	--	$1680	$1840	$2120	$2560	$2960
COMMENTS		1100/60 *Net BPI	Rotary Actuator	Rotary Actuator	Rotary Actuator	Rotary Actuator	Rotary Actuator

MANUFACTURER	KENNEDY COMPANY	MEMOREX	MEMOREX	MEMOREX	MEMOREX	MEMOREX	MEMOREX
DRIVE	5303-70	201	3670-1/2	3675	677-0X	677-30	3640
DISK/TREND GROUP	8	2	5	5	5	5	6
MEDIA: Manufacturer's number	--	2001 Special Front Loading Cartridge	Mark X	Mark XI	Mark XI	Mark XIII	Data Mark
Generic type	Fixed		3336-1	3336-11	3336-11	3336-11	3348
TECHNOLOGY TYPE, DRIVE	3340	3350	3330-1	3330-11	3330-11	3330-11	3340
NOMINAL DISK DIAMETER	14"	200 mm	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 70.56	U: 12.5	--	--	--	--	--
REMOVABLE	--	U: 12.5	F: 100	F: 200	U: 208.18	U: 309.5	F: 35/70
Capacity per track (Bytes)	U: 20,160	U: 19,968	F: 13,030	F: 13,030	U: 13,440	U: 20,160	F: 16,736
Data surfaces per spindle	5	4	19	19	19	19	3/6
Heads per data surface	2	1	1	1	1	1	2
Tracks per surface	700	312	411	815	815	823	348/696
TPI	300	*	192	384	370	384	300
BPI	6000	*	4040	4040	4040	6060	5636
RPM	3000	3600	3600	3600	3600	3600	2964
Average positioning time (msec)	45	30	27	27	28.5	28.5	20
Average rotational delay (msec)	10	8.3	8.3	8.3	8.3	8.3	10.1
Average access time (msec)	55	38.3	35.3	35.3	36.8	36.8	30.1
Data transfer rate (KBytes/sec)	1000	1200	806	806	806	1209	885
FIRST CUSTOMER SHIPMENT	1Q78	1Q81	10/74	1976	1977	3Q80	1977
U.S. OEM PRICE FOR 100 UNITS	$3360	--	--	--	$8830	$9450	--
COMMENTS	Rotary Actuator	Embedded Servo * Not announced	PCM 3330-1	PCM 3330-11			PCM 3340 Mfg. by Nippon Peripherals, Ltd.

MANUFACTURER	MEMOREX	MEMOREX	MEMOREX	MEMOREX	MEMOREX	MEMOREX	MEMOREX
DRIVE	101	102	601-50	612-56	601-75	612-84	3644
DISK/TREND GROUP	7	7	8	8	8	8	9
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3340	3340	3340	3350	3340	3350	3350
NOMINAL DISK DIAMETER	200 mm	200 mm	14"	14"	14"	14"	14"
PERFORMANCE							1.004 MB Fixed Head Option
Total capacity (MBytes) FIXED	U: 11.7	U: 23.4	U: 50.288	U: 56	U: 75.432	U: 84	F: 279.558
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 12,288	U: 12,288	U: 17,960	U: 20,160	F: 17,960	U: 20,160	F: 16,736
Data surfaces per spindle	4	4	4	4	6	6	15
Heads per data surface	1	1	2	2	2	2	2
Tracks per surface	244	244	700	700	700	700	1114
TPI	195	195	300	300	300	300	480
BPI	6100	6100	5636	6350	5636	6350	5636
RPM	2964	2964	2964	3600	2964	3600	2964
Average positioning time (msec)	70	70	32	32	32	32	25
Average rotational delay (msec)	10.1	10.1	10.1	8.3	10.1	8.3	10.1
Average access time (msec)	80.1	80.1	42.1	40.3	42.1	40.3	35.1
Data transfer rate (KBytes/sec)	592.8	592.8	885	1209	885	1209	885
FIRST CUSTOMER SHIPMENT	2Q80	1Q81	1977	1/80	1977	1/80	7/78
U.S. OEM PRICE FOR 100 UNITS	$1560	--	$4175	$4175	$4740	$4740	--
COMMENTS	Stepping Motor Actuator	Stepping Motor Actuator					PCM 3344

MANUFACTURER	MEMOREX	MEMOREX	MEMOREX	MICROCOMPUTER SYSTEMS CORP.	MICROCOMPUTER SYSTEMS CORP.	MICROCOMPUTER SYSTEMS CORP.	MICRODATA
DRIVE	3650-A2 3650-B2 3650-C2	3652-A2 3652-B2 3652-C2	659	MSC-8100	MSC-8100	MSC-8100	2853 9100 7407
DISK/TREND GROUP	9	9	9	7	7	7	1
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	5440
TECHNOLOGY TYPE, DRIVE	3350	2X3350	2X3350	3340	3340	3340	2314
NOMINAL DISK DIAMETER	14"	14"	14"	200 mm	200 mm	200 mm	14"
PERFORMANCE	1.144 MB Fixed Head Option	1.144 MB Fixed Head Option					
Total capacity (MBytes) FIXED	F: 317.5	F: 635	U: 677.8	U: 6.4	U: 12.7	U: 19.1	--
REMOVABLE	--	--	--	--	--	--	U: 2.5
Capacity per track (Bytes)	F: 19,069	F: 19,069	U: 20,160	U: 12,500	U: 12,500	U: 12,500	U: 7,812
Data surfaces per spindle	15	15	15	2	4	6	2
Heads per data surface	2	2	2	1	1	1	1
Tracks per surface	1110	2220	2220	256	256	256	204
TPI	480	960	935	*	*	*	100
BPI	6425	6425	6350	*	*	*	2200
RPM	3600	3600	3600	3125	3125	3125	1500
Average positioning time (msec)	25	25	22	30	30	30	35
Average rotational delay (msec)	8.3	8.3	8.3	9.7	9.7	9.7	20
Average access time (msec)	33.3	33.3	30.3	39.7	39.7	39.7	55
Data transfer rate (KBytes/sec)	1198	1198	1207	625	625	625	200
FIRST CUSTOMER SHIPMENT	4Q77	3Q79	4Q80	4Q80	4Q80	4Q80	1974
U.S. OEM PRICE FOR 100 UNITS	--	--	$13,500	--	--	--	--
COMMENTS	PCM 3350	PCM 3350 Double Density		Subsystem with FD *Not Announced	Subsystem with FD *Not Announced	Subsystem with FD *Not Announced	2400 RPM Option

MANUFACTURER	MICRODATA	MICRODATA	MICRODATA	MICRODATA	MICRODATA	MICRODATA	MICRODATA
DRIVE	2854 9101 7403	2855 9200 7405	2856 9201 7401	Reflex 7501	Reflex 7502	Reflex 7503	4721
DISK/TREND GROUP	1	1	1	7	8	8	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	5440	5440	5440	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	2314	2314	2314	3340	3340	3340	3350
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	1.2 MB Fixed Head Option
Total capacity (MBytes) FIXED	--	U: 2.5	U: 5.0	U: 12.5	U: 37.6	U: 62.7	U: 113.1
REMOVABLE	U: 5.0	U: 2.5	U: 5.0	--	--	--	--
Capacity per track (Bytes)	U: 7,812	U: 7,812	U: 7,812	U: 17,920	U: 17,920	U: 17,920	U: 20,160
Data surfaces per spindle	2	4	4	1	3	5	5
Heads per data surface	1	1	1	2	2	2	2
Tracks per surface	408	204	408	700	700	700	1122
TPI	200	100	200	300	300	300	478
BPI	2200	2200	2200	5636	5636	5636	6427
RPM	1500	1500	1500	2964	2964	2964	3530
Average positioning time (msec)	35	35	35	30	30	30	30
Average rotational delay (msec)	20	20	20	10.1	10.1	10.1	8.5
Average access time (msec)	55	55	55	40.1	40.1	40.1	38.5
Data transfer rate (KBytes/sec)	200	200	200	885	885	885	1175
FIRST CUSTOMER SHIPMENT	1975	1974	1975	1977	1977	1975	2Q79
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS	2400 RPM Option	2400 RPM Option	2400 RPM Option				

MANUFACTURER	MICRODATA	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
DRIVE	4722	1201-I	1202-I	1203-I	1221-I	1222-I	1223-I
DISK/TREND GROUP	8	7	7	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"	200 mm	200 mm	200 mm	200 mm	200 mm	200 mm
PERFORMANCE							
Total capacity (MBytes) FIXED	1.2 MB Fixed Head Option U: 158.3	U: 6.96 MFM U: 8.911 EPM	U: 20.88 U: 26.73	U: 34.8 U: 44.56	F: 7.13	F: 21.38	F: 35.64
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 20,160	U: 12,000 MFM U: 15,364 EPM	U: 12,000 MFM U: 15,364 EPM	U: 12,000 MFM U: 15,364 EPM	F: 12,288	F: 12,288	F: 12,288
Data surfaces per spindle	7	1	3	5	1	3	5
Heads per data surface	2	1	1	1	1	1	1
Tracks per surface	1122	580	580	580	580	580	580
TPI	478	478	478	478	478	478	478
BPI	6427	6735 MFM 8623* EPM	6735 MFM 8623* EPM	6735 MFM 8623* EPM	8623*	8623*	8623*
RPM	3530	3600	3600	3600	3600	3600	3600
Average positioning time (msec)	30	42	42	42	42	42	42
Average rotational delay (msec)	8.5	8.3	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.5	50.3	50.3	50.3	50.3	50.3	50.3
Data transfer rate (KBytes/sec)	1175	720 MFM 921.9 EPM	720 MFM 921.9 EPM	720 MFM 921.9 EPM	921.9 EPM	921.9 EPM	921.9 EPM
FIRST CUSTOMER SHIPMENT	2Q79	11/79	11/79	11/79	11/79	11/79	11/79
U.S. OEM PRICE FOR 100 UNITS	--	$1350	$1782	$2068	$1950	$2382	$2668
COMMENTS							

*8623 EPM is recorded at 5749 FRPI

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION
DRIVE	M802F M802S	M803F M803S	M2850F	M2851F	M2836A	M2837	M2838F
DISK/TREND GROUP	1	2	4	4	5	5	5
MEDIA: Manufacturer's number	370111	802029	50-802282	80-802282	J20045	J20134	J20789
Generic type	5440	5440	Trident/SMD	Trident/SMD	3336-1	3336-11	3336-11
TECHNOLOGY TYPE, DRIVE	2314	3330-1	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: 6.375	U: 12.75	--	--	--	--	--
REMOVABLE	U: 6.375	U: 12.75	U: 54.7	U: 82.1	F: 100	F: 200	U: 312.1
Capacity per track (Bytes)	U: 7,812	U: 15,624	U: 13,440	U: 20,160	F: 13,030	F: 13,030	U: 20,160
Data surfaces per spindle	4	4	5	5	19	19	19
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	408	408	815	815	411	815	815
TPI	200	200	370	370	192	370	370
BPI	2211	4420	4040	6060	4040	4040	6060
RPM	2400	2400	3600	3600	3600	3600	3600
Average positioning time (msec)	45	45	30	30	30	30	30
Average rotational delay (msec)	12.5	12.5	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	57.5	57.5	38.3	38.3	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	312.5	625	806	1209	806	806	1209
FIRST CUSTOMER SHIPMENT	1974	1976	1977	1978	1973	1976	1979
U.S. OEM PRICE FOR 100 UNITS	--	--	$5289	$5592	--	--	--
COMMENTS							

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	NEW WORLD COMPUTER CO., INC.
DRIVE	M2883-10	M2883-20	M2883-40	M-2883-60	M-2884-1	M-2884-2	Mikro-Disc VIII-1
DISK/TREND GROUP	7	7	8	8	8	8	7
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3340	3340	3340	3340	3350	3350	20 Transducer Head,Oxide Disk
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	210 mm
PERFORMANCE							
Total capacity (MBytes) FIXED	0.81 MB Fixed Head Option U: 13.47	0.81/2.42 F. Head Option U: 26.93	0.81/2.42 F. Head Option U: 53.86	0.81 MB Fixed Head Option U: 80.8	2.42 MB Fixed Head Option U: 86.12	U: 129.18	U: 1.8
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 20,160	U: 20,160	U: 20,160	U: 20,160	U: 11,300
Data surfaces per spindle	1	2	4	6	4	6	1
Heads per data surface	2	2	2	2	2	2	20
Tracks per surface	678	678	678	678	1088	1088	160
TPI	286	286	286	286	480	480	100
BPI	6060	6060	6060	6060	6060	6060	7200
RPM	2964	2964	2964	2964	2964	2964	3600
Average positioning time (msec)	38	38	38	38	38	38	18.3
Average rotational delay (msec)	10.1	10.1	10.1	10.1	10.1	10.1	8.3
Average access time (msec)	48.1	48.1	48.1	48.1	48.1	48.1	26.6
Data transfer rate (KBytes/sec)	996	996	996	996	996	996	675
FIRST CUSTOMER SHIPMENT	4Q78	4Q78	4Q78	4Q78	1980	1980	--
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	$1100
COMMENTS							Stepping Motor Actuator

MITSUBISHI

NEW WORLD

MANUFACTURER	NEW WORLD COMPUTER CO., INC.	NEW WORLD COMPUTER CO., INC.	NIPPON ELECTRIC COMPANY	NIPPON ELECTRIC COMPANY	NIPPON ELECTRIC COMPANY	NIPPON ELECTRIC COMPANY	NIPPON ELECTRIC COMPANY
DRIVE	Mikro-Disc VIII-1TF	Mikro-Disc V-1TF	N7711	N7715	DKU 312/314 N7735	N276 N7741	N277 N7745
DISK/TREND GROUP	7	7	1	1	3	5	5
MEDIA: Manufacturer's number	--	--	N9710	N9715	--	--	--
Generic type	Fixed	Fixed	5440	5440	2316	3336-1	3336-11
TECHNOLOGY TYPE, DRIVE	16 Transducer Hd., Plated Disk	8 Transducer Hd., Plated Disk	2314	2314	2314	3330-1	3330-11
NOMINAL DISK DIAMETER	210 mm	130 mm	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 4.2	U: 1.8	F: 2.45	F: 4.9	--	--	--
REMOVABLE	--	--	F: 2.45	F: 4.9	F: 58.352	F: 100	F: 200
Capacity per track (Bytes)	U: 16,500	U: 14,100	F: 6,144	F: 6,144	F: 7,294	F: 13,030	F: 13,030
Data surfaces per spindle	1	1	4	4	20	19	19
Heads per data surface	20	8	1	1	1	1	1
Tracks per surface	256	128	204	407	407	411	815
TPI	200	200	100	200	200	192	370
BPI	9000	9000	2200	2200	2200	4040	4040
RPM	3600	3600	2400	2400	2400	3600	3600
Average positioning time (msec)	28.3	28.3	30	30	30	30	30
Average rotational delay (msec)	8.3	8.3	12.5	12.5	12.5	8.3	8.3
Average access time (msec)	36.6	36.6	42.5	42.5	42.5	38.3	38.3
Data transfer rate (KBytes/sec)	988	848	312.5	312.5	312.5	806	806
FIRST CUSTOMER SHIPMENT	2Q80	3Q80	4/74	8/75	9/75	7/73	11/75
U.S. OEM PRICE FOR 100 UNITS	$1100	$900	--	--	--	--	--
COMMENTS	Stepping Motor Actuator	Stepping Motor Acutator			OEM		

NEW WORLD NIPPON ELECTRIC

MANUFACTURER	NIPPON ELECTRIC COMPANY	NIPPON ELECTRIC COMPANY	NIPPON ELECTRIC COMPANY	NIPPON ELECTRIC COMPANY	NIPPON ELECTRIC COMPANY	NIPPON ELECTRIC COMPANY	NIPPON PERIPHERALS LIMITED
DRIVE	D-1210 N7721	D-1220 N7722	D-1240 N7723	N7751	D-1510	N7755	NP31-A1 NP31-A2 NP31-B1 NP31-B2
DISK/TREND GROUP	7	8	8	9	9	9	8
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3350	3350	3350	3350	3350	2X3350	Piccolo
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	210 mm
PERFORMANCE							
Total capacity (MBytes) FIXED	0.48/0.96 MB F. Head Option U: 20.8	0.48/0.96 MB F. Head Option U: 41.5	0.48/0.96 MB F. Head Option U: 83.1	1.144 MB Fixed Head Option F: 317.5	1.19 MB Fixed Head Option U: 331.5	F: 635	F: 64.5
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 19,968	U: 19,968	U: 19,968	F: 19,069	U: 19,968	F: 19,069	F: 16,384
Data surfaces per spindle	1	2	4	15	15	15	11
Heads per data surface	2	2	2	2	2	2	1
Tracks per surface	1062	1062	1062	1122	1122	2244	360
TPI	480	480	480	480	480	960	465
BPI	6370	6370	6370	6400	6400	6400	8530
RPM	3600	3600	3600	3600	3600	3600	3125
Average positioning time (msec)	40	40	40	20	20	20	27
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3	8.3	9.6
Average access time (msec)	48.3	48.3	48.3	28.3	28.3	28.3	36.6
Data transfer rate (KBytes/sec)	1198	1198	1198	1198	1198	1198	1031
FIRST CUSTOMER SHIPMENT	9/78	9/78	9/78	12/77	5/78	1979	4Q80
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS	OEM				OEM		PCM 3310

MANUFACTURER	NIPPON PERIPHERALS LIMITED	NIPPON PERIPHERALS LIMITED	NIPPON PERIPHERALS LIMITED	NIPPON PERIPHERALS LIMITED	NORTHERN TELECOM SYSTEMS	NORTHERN TELECOM SYSTEMS	OKIDATA
DRIVE	NP30	NP20	NP24	NP25-A2 NP25-B2 NP25-C2	4518	4520 4521	3301
DISK/TREND GROUP	8	6	9	9	7	7	7
MEDIA: Manufacturer's number	--	NP-21-35/70	--	--	--	--	--
Generic type	Fixed	3348 Data Module	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	Piccolo	3340	3350	3350	2314	2314	3350
NOMINAL DISK DIAMETER	210 mm	14"	14"	14"	14"	14"	14"
PERFORMANCE			1.004 MB Fixed Head Option	1.144 MB Fixed Head Option			0.80 MB Fixed Head Option
Total capacity (MBytes) FIXED	U: 115	--	F: 279.558	F: 317.499	F: 5.3	F: 10.7	U: 13.47
REMOVABLE	--	F: 35/70	--	--	--	--	--
Capacity per track (Bytes)	U: 19,800	F: 16,736	F: 16,736	F: 19,069	F: 6,656	F: 13,312	U: 20,160
Data surfaces per spindle	11	3/6	15	15	2	2	1
Heads per data surface	1	2	2	2	1	1	2
Tracks per surface	532	696/2	1114	1110	400	400	678
TPI	544	300	480	480	200	200	286
BPI	9000	5636	5636	6425	2200	4400	6122
RPM	3125	2964	2964	3600	2400	2400	2964
Average positioning time (msec)	28	20	20	20	50	50	38
Average rotational delay (msec)	9.6	10.1	10.1	8.3	12.5	12.5	10.1
Average access time (msec)	37.6	30.1	30.1	28.3	62.5	62.5	48.1
Data transfer rate (KBytes/sec)	1031	885	885	1198	312.5	625	996
FIRST CUSTOMER SHIPMENT	4Q80	1976	1977	1977	1975		7/77
U.S. OEM PRICE FOR 100 UNITS	$3600	--	--	--	--	--	$2820
COMMENTS	OEM SMD Interface	3340 PCM	3344 PCM	3350 PCM	445 System	Add-On Drives for 445 System	

NIPPON PERIPHERALS NORTHERN TELECOM OKIDATA

MANUFACTURER	OKIDATA	OKIDATA	OKIDATA	OKIDATA	OKIDATA	PERKIN ELMER	PERKIN ELMER
DRIVE	3302	3303	3304	3305	3306	VF-2221 VT-2221	VF-2222 VT-2222
DISK/TREND GROUP	7	8	8	8	8	1	1
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	2315/5440	2315/5440
TECHNOLOGY TYPE, DRIVE	3350	3350	3350	3350	3350	2314	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	0.80 MB Fixed Head Option U: 26.94	0.80 MB Fixed Head Option U: 40.39	0.80 MB Fixed Head Option U: 53.86	0.80 MB Fixed Head Option U: 67.33	0.80 MB Fixed Head Option U: 80.8	U: 6.25	U: 6.25
REMOVABLE	--	--	--	--	--	U: 6.25	U: 6.25
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 20,160	U: 20,160	U: 20,160	U: 7,812	U: 7,812
Data surfaces per spindle	2	3	4	5	6	4	4
Heads per data surface	2	2	2	2	2	1	1
Tracks per surface	678	678	678	678	678	408	408
TPI	286	286	286	286	286	200	200
BPI	6122	6122	6122	6122	6122	2200	2200
RPM	2964	2964	2964	2964	2964	1500	2400
Average positioning time (msec)	38	38	38	38	38	35	35
Average rotational delay (msec)	10.1	10.1	10.1	10.1	10.1	20	12.5
Average access time (msec)	48.1	48.1	48.1	48.1	48.1	55	47.5
Data transfer rate (KBytes/sec)	996	996	996	996	996	195	312.5
FIRST CUSTOMER SHIPMENT	7/77	7/77	7/77	7/77	7/77	2Q80	2Q80
U.S. OEM PRICE FOR 100 UNITS	$3100	$3320	$3595	$3800	$3885	F - $3500 T - $3450	F - $3500 T - $3450
COMMENTS							

OKIDATA

PERKIN ELMER

MANUFACTURER	PERKIN ELMER	PERTEC	PERTEC	PERTEC	PERTEC	PERTEC	PERTEC
DRIVE	VT-2422	D3311/D3312	D3321/D3322	D3331/D3332	D3341/D3342	D3421/D3422	D3441/D3442
DISK/TREND GROUP	2	1	1	1	1	1	1
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	5440	5440	5440	2315	2315	5440	2315
TECHNOLOGY TYPE, DRIVE	3330-1	2314	2314	2314	2314	2314	2314
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 12.5	--	U: 3.17	--	U: 3.17	U: 6.34	U: 6.34
REMOVABLE	U: 12.5	U: 3.17	U: 3.17	U: 3.17	U: 3.17	U: 6.34	U: 6.34
Capacity per track (Bytes)	U: 15,625	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	2	4	4	4
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	408	203	203	203	203	406	406
TPI	200	100	100	100	100	200	200
BPI	4400	2200	2200	2200	2200	2200	2200
RPM	2400	1500/2400	1500/2400	1500/2400	1500/2400	1500/2400	1500/2400
Average positioning time (msec)	35	35	35	35	35	40	40
Average rotational delay (msec)	12.5	20/12.5	20/12.5	20/12.5	20/12.5	20/12.5	20/12.5
Average access time (msec)	47.5	55/47.5	55/47.5	55/47.5	55/47.5	60/52.5	60/52.5
Data transfer rate (KBytes/sec)	625	195/312.5	195/312.5	195/312.5	195/312.5	195/312.5	195/312.5
FIRST CUSTOMER SHIPMENT	2Q80						
U.S. OEM PRICE FOR 100 UNITS	$3825	--	$3660	--	$3660	$3900	$3900
COMMENTS							

PERKIN ELMER PERTEC

MANUFACTURER	PERTEC	PERTEC	PERTEC	PERTEC	PHILIPS DATA SYSTEMS, B.V.	PHILIPS DATA SYSTEMS, B.V.	PHILIPS DATA SYSTEMS, B.V.
DRIVE	D3461/D3462	D3481/D3482	D1451/D1452	D8000	X1215	X1216	X1217
DISK/TREND GROUP	2	2	7	7	1	1	2
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	5440	2315	Fixed	Fixed	5440	5440	5440
TECHNOLOGY TYPE, DRIVE	2314	2314	2314	3350	2314	2314	3330-1
NOMINAL DISK DIAMETER	14"	14"	14"	210 mm	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 19.03	U: 19.03	U: 6.34	U: 20.33	F: 2.5	F: 5.0	F: 10.0
REMOVABLE	U: 6.34	U: 6.34	--	--	F: 2.5	F: 5.0	F: 10.0
Capacity per track (Bytes)	U: 7,812	U: 7,812	U: 7,812	U: 14,400	F: 5,632	F: 5,632	F: 10,240
Data surfaces per spindle	8	8	2	3	4	4	4
Heads per data surface	1	1	1	1	1	1	1
Tracks per surface	406	406	406	466	204	407	407
TPI	200	200	200	476	100	200	200
BPI	2200	2200	2200	6688	2200	2200	4040
RPM	1500/2400	1500/2400	1500/2400	3600	2400	2400	2400
Average positioning time (msec)	40	40	70	50	35	35	35
Average rotational delay (msec)	20/12.5	20/12.5	20/12.5	8.3	12.5	12.5	12.5
Average access time (msec)	60/52.5	60/52.5	90/82.5	58.3	47.5	47.5	47.5
Data transfer rate (KBytes/sec)	195/312.5	195/312.5	195/312.5	870	312.5	312.5	538
FIRST CUSTOMER SHIPMENT	1977	1977		12/79	1974	1976	1975
U.S. OEM PRICE FOR 100 UNITS	$4680	$4680	--	$1980	--	--	--
COMMENTS			Also available as 12.68 MB: D1461/D1462 (4 surfaces)				

PERTEC

PHILIPS

MANUFACTURER	PHILIPS DATA SYSTEMS, B.V.	PHILIPS DATA SYSTEMS, B.V.	PHILIPS DATA SYSTEMS, B.V.	PHILIPS DATA SYSTEMS, B.V.	PRIAM	PRIAM	PRIAM
DRIVE	X1240	X1237	X1250	X1220	Diskos 570	Diskos 1070	Diskos 2050
DISK/TREND GROUP	2	4	7	7	7	7	7
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	CMD-Type Cartridge	Special 6-High Pack	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3330	3330-1	3340	3340	3340	3340	3350
NOMINAL DISK DIAMETER	14"	14"	14"	14"	200 mm	200 mm	200 mm
PERFORMANCE							
Total capacity (MBytes) FIXED	F: 20.02	--	U: 9.62	F: 20.02	U: 5.4	U: 10.8	U: 21.2
REMOVABLE	F: 20.02	F: 40.0	--	--	--	--	--
Capacity per track (Bytes)	F: 14,592	F: 10,240	U: 20,830	F: 14,592	U: 15,000	U: 15,000	U: 13,440
Data surfaces per spindle	4	8	2	2	2	4	3
Heads per data surface	1	1	1	2	1	1	1
Tracks per surface	700	407	231	700	187	187	526
TPI	300	200	100	300	180	180	480
BPI	6540	4040	6356	6540	7475	7475	6646
RPM	3000	2400	720	3000	3564	3564	3600
Average positioning time (msec)	35	35	144	35	53	53	50
Average rotational delay (msec)	10.0	12.5	41.67	10.0	8.4	8.4	8.3
Average access time (msec)	45.0	47.5	185.67	45.0	61.4	61.4	58.3
Data transfer rate (KBytes/sec)	1305	538	250	1305	900	900	800
FIRST CUSTOMER SHIPMENT	1980	1975	1979	1979	7/80	7/80	2Q80
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	$1395	$1565	$2200
COMMENTS	Embedded Servo; Linear Actuator		Stepping Motor Actuator; FD Interface	Embedded Servo; Rotary Actuator	Stepping Motor Actuator; Mfg. by Hokushin	Stepping Motor Actuator; Mfg. by Hokushin	Linear Motor Actuator

PHILIPS PRIAM

MANUFACTURER	PRIAM	PRIAM	PRIAM	PRIAM	SHUGART ASSOCIATES	SHUGART ASSOCIATES	SHUGART ASSOCIATES
DRIVE	Diskos 3450	Diskos 3350	Diskos 6650	Diskos 15450	SA 1002	SA 1004	SA 4004
DISK/TREND GROUP	7	8	8	8	7	7	7
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3350	3350	3350	3350	3340	3340	3340
NOMINAL DISK DIAMETER	200 mm	14"	14"	14"			14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 35.3	U: 33.9	U: 67.9	U: 158.5	U: 5.33	U: 10.67	0.144 MB Fixed Head Option U: 14.5
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 13,440	U: 20,160	U: 20,160	U: 20,160	U: 10,400	U: 10,400	U: 18,000
Data surfaces per spindle	5	2	2	4	2	4	2
Heads per data surface	1	2/1	2/1	2/1	1	1	2
Tracks per surface	526	1122	2246	2246	256	256	404
TPI	480	480	960	960	172	172	172
BPI	6646	6430	6430	6430	6270	6270	5534
RPM	3600	3125	3125	3125	3125	3125	2964
Average positioning time (msec)	50	45	45	40	70	70	65
Average rotational delay (msec)	8.3	9.7	9.7	9.7	9.6	9.6	10.1
Average access time (msec)	58.3	54.7	54.7	49.7	79.6	79.6	75.1
Data transfer rate (KBytes/sec)	800	1040	1040	1040	542.5	542.5	887.5
FIRST CUSTOMER SHIPMENT	2Q80	8/79	3Q80	3Q81	4Q79	4Q79	3Q78
U.S. OEM PRICE FOR 100 UNITS	$2750	$2000	$2530	$3340	$1140	$1400	$1325
COMMENTS	Linear Motor Actuator	Linear Motor Actuator	Linear Motor Actuator	Linear Motor Actuator	Stepping Motor Actuator	Stepping Motor Actuator	Stepping Motor Actuator

PRIAM

SHUGART ASSOCIATES

MANUFACTURER	SHUGART ASSOCIATES	SHUGART ASSOCIATES	SHUGART TECHNOLOGY	SIEMENS	SIEMENS	SIEMENS	SIEMENS
DRIVE	SA 4008	SA 4104	ST 506	3455	3465	3468	3470
DISK/TREND GROUP	7	8	7	5	5	5	9
MEDIA: Manufacturer's number	--	--	--	V26374-Q7	V26374-Q9	--	--
Generic type	Fixed	Fixed	Fixed	Special	Special	3336-11	Fixed
TECHNOLOGY TYPE, DRIVE	3340	3340	3350	3330-1	3330-11	3330-11	3350
NOMINAL DISK DIAMETER	14"	14"	130 mm	14"	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	0.144 MB Fixed Head Option U: 29	0.144 MB Fixed Head Option U: 58	U: 6.38	--	--	--	1.115 MB Fixed Head Option F: 420.25
REMOVABLE	--	--	--	F: 71.8	F: 143.6	F: 303.2	--
Capacity per track (Bytes)	U: 18,000	U: 18,000	U: 10,417	F: 19,750	F: 19,750	F: 19,750	F: 16,384
Data surfaces per spindle	4	8	4	9	9	19	19
Heads per data surface	2	2	1	1	1	1	2
Tracks per surface	404	404	153	404	808	808	1350
TPI	172	172	255	192	384	384	590
BPI	5534	5534	7690	6060	6060	6060	6060
RPM	2964	2964	3600	2400	2400	2400	2400
Average positioning time (msec)	65	65	170	25	25	25	20
Average rotational delay (msec)	10.1	10.1	8.3	12.5	12.5	12.5	12.5
Average access time (msec)	75.1	75.1	178.3	37.5	37.5	37.5	32.5
Data transfer rate (KBytes/sec)	887.5	887.5	625	806	806	806	806
FIRST CUSTOMER SHIPMENT	3Q78	4Q80	7/80	9/75	12/76	1977	10/78
U.S. OEM PRICE FOR 100 UNITS	$1800	$2500	$1100	--	--	--	--
COMMENTS	Stepping Motor Actuator	Stepping Motor Actuator	Stepping Motor Actuator				

SHUGART ASSOCIATES SHUGART TECHNOLOGY SIEMENS

MANUFACTURER	SLI INDUSTRIES	SLI INDUSTRIES	SLI INDUSTRIES	SLI INDUSTRIES	STORAGE TECHNOLOGY CORPORATION	STORAGE TECHNOLOGY CORPORATION	STORAGE TECHNOLOGY CORPORATION
DRIVE	Cheyenne	Cheyenne	Cheyenne	Cheyenne	2707	2710	2720
DISK/TREND GROUP	7	7	8	8	8	8	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	200 mm	200 mm	200 mm	200 mm	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 7.35	U: 22.0	U: 36.7	U: 51.4	F: 39.0	F: 91.1	F: 195.1
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	U: 11,200	U: 11,200	U: 11,200	U: 11,200	F: 17,920	F: 17,920	F: 17,920
Data surfaces per spindle	1	3	5	7	2	4	8
Heads per data surface	1	1	1	1	2/1	2/1	2/1
Tracks per surface	656	656	656	656	1452	1452	1452
TPI	478	478	478	478	555	555	555
BPI	6409	6409	6409	6409	6706	6706	6706
RPM	3600	3600	3600	3600	2198	2198	2198
Average positioning time (msec)	35	35	35	35	27	27	27
Average rotational delay (msec)	8.3	8.3	8.3	8.3	15.0	15.0	15.0
Average access time (msec)	43.3	43.3	43.3	43.3	42.0	42.0	42.0
Data transfer rate (KBytes/sec)	602	602	602	602	768	768	768
FIRST CUSTOMER SHIPMENT	4Q80	4Q80	4Q80	4Q80	2Q80	2Q80	2Q80
U.S. OEM PRICE FOR 100 UNITS	$3640	$3943	$4242	$4541	$4370	$4600	$5625
COMMENTS							

SLI

STORAGE TECHNOLOGY

MANUFACTURER	STORAGE TECHNOLOGY CORPORATION	STORAGE TECHNOLOGY CORPORATION	STORAGE TECHNOLOGY CORPORATION	STORAGE TECHNOLOGY CORPORATION	STORAGE TECHNOLOGY CORPORATION	TANDON MAGNETIC	TANDON MAGNETIC
DRIVE	8400	8800	8350-A2 8350-B2 8350-C2	8650-A2 8650-B2	8360-A2 8360-B2	172-1-DC	172-2-DC
DISK/TREND GROUP	9	9	9	9	9	7	7
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
TECHNOLOGY TYPE, DRIVE	3330	3330	3350	2X3350	2X3350	3350	3350
NOMINAL DISK DIAMETER	14"	14"	14"	14"	14"	130 mm	130 mm
PERFORMANCE			1.144 MB Fixed Head Option	1.144 MB Fixed Head Option	1.144 MB Fixed Head Option		
Total capacity (MBytes) FIXED	F: 400	F: 800	F: 317.5	F: 635	F: 317.5	U: 2.156	U: 4.313
REMOVABLE	--	--	--	--	--	--	--
Capacity per track (Bytes)	F: 13,030	F: 13,030	F: 19,069	F: 19,069	F: 19,069	U: 10,418	U: 10,418
Data surfaces per spindle	114 Per Drive	114 Per Drive	15	15	15	2	4
Heads per data surface	1	1	2	2	2	1	1
Tracks per surface	552	552	1110	2220	1110	104	104
TPI	238	238	480	957	957	172	172
BPI	4040	4040	6425	6425	6425	7690	7690
RPM	3600	3600	3600	3600	3600	3600	3600
Average positioning time (msec)	30	30	25	25	18	155	155
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	33.3	33.3	26.3	163.3	163.3
Data transfer rate (KBytes/sec)	806	806	1198	1198	1198	625	625
FIRST CUSTOMER SHIPMENT	2/75	2/75	4/77	5/79	2Q81	4Q80	4Q80
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS	PCM	PCM	PCM	PCM	PCM	Stepping Motor Actuator	

STORAGE TECHNOLOGY

TANDON

MANUFACTURER	TANDON MAGNETICS	TANDON MAGNETICS	TANDON MAGNETICS	TANDON MAGNETICS	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION
DRIVE	172-3-DC	254-1-DC	254-2-DC	254-3-DC	MK-200R	DSU-450	MK-100F
DISK/TREND GROUP	7	7	7	7	2	5	7
MEDIA: Manufacturer's number	--	--	--	--	--	--	--
Generic type	Fixed	Fixed	Fixed	Fixed	5440	3336-11	Fixed
TECHNOLOGY TYPE, DRIVE	3350	3350	3350	3350	3330-1	3330-11	3340
NOMINAL DISK DIAMETER	130 mm	130 mm	130 mm	130 mm	14"	14"	14"
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 6.375	U: 3.188	U: 6.375	U: 9.564	F: 10	--	U: 12.0 F: 10.2
REMOVABLE	--	--	--	--	F: 10	F: 200	--
Capacity per track (Bytes)	U: 10,418	U: 10,418	U: 10,418	U: 10,418	F: 13,030	F: 13,030	F: 16,384
Data surfaces per spindle	6	2	4	6	4	19	1
Heads per data surface	1	1	1	1	1	1	2
Tracks per surface	104	153	153	153	417	815	630
TPI	172	254	254	254	188	370	318
BPI	7690	7690	7690	7690	4040	4040	5940
RPM	3600	3600	3600	3600	3600	3600	2800
Average positioning time (msec)	155	176	176	176	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)	163.3	184.3	184.3	184.3	38.3	38.3	50.8
Data transfer rate (KBytes/sec)	625	625	625	625	806	806	896
FIRST CUSTOMER SHIPMENT	4Q80	4Q80	4Q80	4Q80	1977	1975	1977
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS							

TANDON TOSHIBA

MANUFACTURER	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION	VERMONT RESEARCH	WESTERN DYNEX	WESTERN DYNEX	WESTERN DYNEX
DRIVE	MK-300F	MK80F-10	MK80F-30	5017	DD-6121	DD-6221	DD-6122
DISK/TREND GROUP	8	7	8	2	1	1	1
MEDIA: Manufacturer's number	--	--	--	VRC5517	--	--	--
Generic type	Fixed	Fixed	Fixed	5440	2315/5440	2315/5440	2315/5440
TECHNOLOGY TYPE, DRIVE	3340	Piccolo	Piccolo	3330-11	2314	2314	2314
NOMINAL DISK DIAMETER	14"	8"	8"	14"	14"	14"	14"
PERFORMANCE	.262 MB Fixed Head Option						
Total capacity (MBytes) FIXED	U: 36.0 F: 30.6	U: 14.5	U: 38.3	F: 26.2	--	U: 3.13	--
REMOVABLE	--	--	--	F: 26.2	U: 3.13	U: 3.13	U: 6.25
Capacity per track (Bytes)	F: 16,384	U: 20,160	U: 20,160	F: 12,800	U: 7,812	U: 7,812	U: 7,812
Data surfaces per spindle	3	2	5	4	2	4	2
Heads per data surface	2	1	1	1	1	1	1
Tracks per surface	630			1032	203	203	406
TPI	318	450	450	500	100	100	200
BPI	5940	8700	8700	4000	2200	2200	2200
RPM	2800	3600	3600	3165	1500/2400	1500/2400	1500/2400
Average positioning time (msec)	40	40	40	35	35	35	35
Average rotational delay (msec)	10.8	8.3	8.3	9.5	20/12.5	20/12.5	20/12.5
Average access time (msec)	50.8	48.3	48.3	44.5	55/47.5	55/47.5	55/47.5
Data transfer rate (KBytes/sec)	896	1200	1200	763.8	195/312.5	195/312.5	195/312.5
FIRST CUSTOMER SHIPMENT	1977	1980	1980	1975	1972	1972	1973
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--	--	--
COMMENTS		SMD Interface	SMD Interface	Embedded Servo			

TOSHIBA

VERMONT RESEARCH

WESTERN DYNEX

MANUFACTURER	WESTERN DYNEX	WESTERN DYNEX					
DRIVE	DD-6222	DD-4000					
DISK/TREND GROUP	1	7					
MEDIA: Manufacturer's number	--	--					
Generic type	2315/5440	Fixed					
TECHNOLOGY TYPE, DRIVE	2314	2314					
NOMINAL DISK DIAMETER	14"	14"					
PERFORMANCE							
Total capacity (MBytes) FIXED	U: 6.25	U: 12.5					
REMOVABLE	U: 6.25	--					
Capacity per track (Bytes)	U: 7,812	U: 7,812					
Data surfaces per spindle	4	4					
Heads per data surface	1	1					
Tracks per surface	406	406					
TPI	200	200					
BPI	2200	2200					
RPM	1500/2400	1500/2400					
Average positioning time (msec)	35	70					
Average rotational delay (msec)	20/12.5	20/12.5					
Average access time (msec)	55/47.5	90/82.5					
Data transfer rate (KBytes/sec)	195/312.5	195/312.5					
FIRST CUSTOMER SHIPMENT	1973	1980					
U.S. OEM PRICE FOR 100 UNITS	$2755						
COMMENTS							

MANUFACTURER PROFILES

1980 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 drive 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 1979 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

1979 disk sales: None

Alpha Data announced a family of moving head fixed disk drives using 14 inch plated disks at the 1979 NCC. They were never actually shipped, however, and the firm now indicates the drives are being developed further, with a product announcement to come. Alpha Data is a ten year old privately held manufacturer of head-per-track disk drives.

AMPEX CORPORATION
Memory Products Division
10435 North Tantau Avenue
Cupertino, CA 95014 408/255-4800

1979 disk sales: $18,400,000
1979 total net sales: $372,414,000 Net income: $27,351,000

The Ampex disk drive operation is oriented completely to the OEM market, with internally manufactured 80 MB and 300 MB SMDs the key products, supplemented with resale of disk drives manufactured by others. A strong European marketing organization provides a major portion of Ampex' disk revenues, but the firm has never fully exploited its potential in the U.S. market, despite changes in marketing responsibility. Early in 1980, an acquisition of Ampex by Signal Companies, Inc., was announced, only to fall through later.

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

1979 disk sales: $9,200,000
1979 total net sales: $555,040,000 Net income: $23,654,000

The Ball disk drive program is built around the 1976 start-up of a Trident-type drive program, which has since been evolved into an SMD look-alike. The activity is now oriented to the OEM market, and has achieved a high growth rate, with Europe being a sales bright spot. The firm is adding higher capacity SMDs and fixed Winchester drives -- with good prospects for the future.

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

1979 disk sales: $417,000,000
1979 total net sales: $2,785,429,000 Net income: $305,536,000

Burroughs is the second largest manufacturer of captive disk drives, with disk production facilities at Westlake Village, California; Winnipeg, Canada; Glenrothes, Scotland; Guadalajara, Mexico; and Sao Paulo, Brazil. In addition to well established programs for disk cartridge drives, Trident type drives, large disk pack drives, and fixed disk drives using older 3330 technology, the firm is now introducing its first Winchester technology drives. Burroughs is also making a serious attempt to initiate OEM sales for the Winchester drive and a newly introduced high capacity floppy drive, in addition to captive applications.

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

1979 disk sales: $84,900,000
1979 total net sales: $7,027,000,000 Net income: $563,100,000

Following the Xerox acquisition of Calcomp's rigid disk drive operations in early 1979, one of the pioneer independent disk drive manufacturers reappeared under its original name, Century Data Systems. A great deal of activity has followed, including emphasis on building up production and marketing capability for Trident (SMD type), Hunter (CMD type) and Marksman (small fixed disk) product families. In addition, Century has assumed responsibilities for the Diablo line of disk cartridge drives, which are still manufactured at the Diablo Hayward, California, plant. It appears that Xerox intends to fully develop the Century potential in the high performance OEM disk drive market, with the expectation of further product development and a larger future organization.

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

1979 disk sales: $714,800,000
1979 total net sales: $2,248,600,000 Net income: $124,200,000

Control Data's role in the disk drive industry continues to grow more important every year. The firm's disk drive revenue increased sharply again in 1979, in all market classes. OEM revenues are up, on the strength of excellent increases for the disk cartridge, SMD, CMD and large disk pack lines. PCM revenues are up in 3350 equivalent drives, representing a major increase in CDC's market share in the plug compatible business. And the captive drive area is also growing fast. Control Data provides 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. In 1979, these captive shipments of several types of high performance drives grew to new heights. In 1980 Control Data introduced the Lark 8 inch disk cartridge drive, expected to be the forerunner of a series of major 8 inch OEM disk drives to follow over the next few years. In addition, MPI is expected to be well positioned to offer new high performance drives using thin film head technology similar to that of IBM's new fixed disk drives. The Control Data disk drive activities will clearly continue to be the model which many smaller organizations will attempt to emulate.

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

1979 disk sales: None

Dastek has received substantial attention within the disk drive industry since its 1978 founding by four ex-IBMers. The industry has been intrigued by the firm's potential in developing markets for the thin film head technology in which the founders were known to possess state of the art expertise. During 1980, Dastek announced an OEM disk drive with capacities from 200 to 400 MB, using thin film heads operating at 12,772 BPI. Also during 1980, the firm became active in marketing thin film heads to other disk drive manufacturers. It is assumed that the market's reaction to these programs will determine the main thrust for Dastek in the future.

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

1979 disk sales: $96,800,000
1979 total net sales: $507,483,000 Net income: $49,814,000

Data General's internal disk drive program was initiated in the mid-1970s and has made the company self-sufficient in rigid disk drives. In addition to the existing disk cartridge drives, SMDs, 3330 type drives, and small fixed Winchester drives, Data General within the last year has added a 6000 BPI version of its 3330 type drive and a new 25 MB fixed Winchester drive.

DATA PERIPHERALS
Subsidiary of Computer & Communications Technology Corporation
3310 Montgomery Drive
Santa Clara, CA 95051 408/496-0916

1979 disk sales: None
1979 total net sales: $34,241,000 Net income: $2,264,000

Data Peripherals was formed in 1979 to develop and manufacture an 8 inch disk cartridge drive, and is owned by CCT, the parent company of Information Magnetics, a major manufacturer of magnetic recording heads. Although not formally announced yet, the firm's DP-100 "Lynx" drive is planned as a removable-only disk cartridge drive with 11 MB capacity on 200 mm disks, using embedded servo. The plans anticipate prototypes in first quarter of 1981, with full production in third quarter of that year. Although Data Peripherals is entering a market segment in which they will have to complete directly against Control Data's Lark, and higher capacity versions to come later, the organization is staffed with industry veterans who have an excellent chance to get the company off to a good start.

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

1979 disk sales: $25,400,000
1979 total net sales: $232,101,000 Net income: $25,246,000

Datapoint's Sunnyvale operation manufactures disk cartridge drives for captive use with the Datapoint systems, under a manufacturing license from the old Wangco firm. Datapoint has also manufactured floppy drives in Texas for several years, under an early Shugart Associates license, and more recently has established a joint venture company with Tandy Corporation, which will manufacture floppy drives in Odessa, Texas.

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

1979 disk sales: $130,400,000
1979 total net sales: $1,804,092,000 Net income: $178,434,000

DEC's revenues from manufacture of moving head disk drives are still obtained entirely from various disk cartridge drive configurations. Drive manufacturing is now centered primarily at Colorado Springs, with the established RK06/RK07 program supplemented by a very rapid build-up of the larger volume RL01/RL02 program. The firm has also been developing fixed Winchester drives, still unannounced, and plans to initiate internal manufacture of disk media at Colorado Springs. The firm continues to buy SMDs from Control Data and larger disk pack drives from Memorex. Volume purchases of large fixed disk drives for support of its larger general purpose computer systems have not yet been initiated.

DISK MEMORY TECHNOLOGY, INC.
P.O. Box 19814
Portland, OR 97219 503/643-1887

DMT manufactures an unusual moving head drive using multiple head sliders in a drive with a single fixed 225 mm plated disk. The drive uses a stepping motor actuator, with a maximum capacity up to 9 MB. In addition to an OEM version, the drive is offered with interfaces equivalent to several industry standard drives.

ELECTRONIC MEMORIES & MAGNETICS CORPORATION
Peripheral Products Division
1015 Timothy Drive
San Jose, CA 95133 408/298-7080

1979 disk sales: $7,500,000
1979 total net sales: $143,488,000 Net income: $2,605,000

EMM's disk drive manufacturing activities were acquired at the beginning of the 1970s with the acquisition of Caelus, a pioneer manufacturer of OEM disk cartridge drives. But with the maturing of the older disk cartridge technologies, and indifferent results from product development programs intended to produce newer products, EMM has decided to close down its disk operations. Manufacturing ceased at the end of 1979, and the firm is now selling the existing inventory.

HEWLETT-PACKARD COMPANY
Disk Memory Division
11403 Chinden Boulevard
Boise, ID 83707 208/376-6000

1979 disk sales: $122,600,000
1979 total net sales: $2,361,000,000 Net income: $203,000,000

Hewlett-Packard established a major disk drive manufacturing and development facility at Boise in 1977, and produces all of the disk drive requirements for its own computer systems internally. Products include several disk cartridge and disk pack drives, plus a small fixed Winchester drive. HP is expected to continue the development of its disk drive product line with a variety of high performance drives.

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

1979 disk sales: $803,100,000
1979 total net sales: $22,862,776,000 Net income: $3,011,259,000

IBM has disappointed its best friends, its stockholders, with indifferent financial results during the last year -- but the firm continues to provide a rigorous pace for the disk drive industry. As expected, introductions of its major new large fixed disk drives have continued, with the 3370 followed by the 3375 and 3380. It's expected that introductions at the high end will stop for a few years, with the possible exception of a fixed block architecture version of the 3380, when the "H" series of high-end computers is finally announced. In the low-to-middle range, the Piccolo 8 inch drives are now in high volume production, in use with no less than six computer systems. In IBM's world, the end of the removable disk has arrived, despite the fact that a significant portion of the rest of the industry still thinks that removability is not a bad idea.

It is now time for the rest of the industry to rally around IBM's new standards for thin film heads, improved disks, encoding schemes and control electronics. If the historical patterns repeat again, IBM's specific standards and techniques will clear up a lot of bickering over details, and enable dozens of manufacturers to get on with development of new hardware, knowing they are working with "industry standard" technology.

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

1979 disk sales: $4,000,000

Despite a hectic early history of management turnover and aborted financing arrangements, IMI has survived. Furthermore, it managed to start production of its pioneer 8 inch OEM drive in early 1979, in time to take advantage of a wave of industry interest in 8 inch Winchester drives, long before any competitors achieved quantity production. The company has added a 20 MB version to the original 11 MB drive, and has gradually scaled up production.

IRWIN INTERNATIONAL INDUSTRIES, INC.
2311 Green Road
Ann Arbor, MI 48105 313/663-3600

1979 disk sales: None

Irwin International was founded in late 1979 by Sam Irwin, ex-Sycor president, and other Sycor veterans, after the Northern Telecom acquisition early in 1979. The firm plans to introduce a subsystem based on a new 5.25 inch Winchester fixed disk drive, with evaluation units in early 1981 and production start at mid-year.

ISS/UNIVAC
Operating Unit of Sperry Univac Division
Sperry Corporation
3333 Scott Boulevard
Santa Clara, CA 95051 408/496-3333

1979 disk sales: $207,000,000
1979 total net sales: $4,179,319,000 Net income: $224,132,000

The ISS shipment level of drives for Univac systems continues to grow, but total disk drive revenues are only slightly ahead of the previous year. Activity in the PCM and OEM market classes continues to decline. After years of major shipments of large disk files for the IBM plug compatible market, principally through the Itel organization, the PCM shipments are declining rapidly due to Itel's sale of its computer business to National Advanced Systems. NAS appears to be relying on Hitachi for both big computers and big disk drives, and ISS' share is shrinking. The firm's OEM shipments are insignificant.

KENNEDY COMPANY
Subsidiary of Allegheny Ludlum Industries, Inc.
1600 South Shamrock Avenue
Monrovia, CA 91001 213/357-8831

1979 disk sales: $800,000
1979 total net sales: $1,568,904,000 Net income: $71,527,000

The Kennedy Company is a leading manufacturer of small tape drives, acquired in early 1979 by Allegheny Ludlum. The firm's first disk drive, a 14 inch fixed Winchester drive, was announced in 1977, with deliveries eventually starting in 1979. An 8 inch Winchester drive is expected to be in production by the end of the year. In addition to normal OEM marketing activities, Kennedy has recently launched an effort to sell disk subsystems using its 14 inch Winchester drive, aimed at the DEC PDP-11 and LSI-11 markets.

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

1979 disk sales: $139,200,000
1979 total net sales: $737,761,000 Net income: $31,544,000

For the last few years, Memorex has been selling more, but enjoying it less. Apparently, one of the results of the well-publicized trouble-shooting management that held the reins during the last half of the 1970s was a reduced ability to complete product development programs promptly. These problems, and internal costs which make it difficult for the firm to compete profitably as IBM lowers the pricing umbrella, have again thrown Memorex into the red. The loss for the first half of 1980 was $22,798,000. The next year or two looks rough for Memorex as IBM's

new generation of large disk files reduces the market available to PCM drives and as the company goes through the early market development for several new OEM disk drives.

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

1979 disk sales: None

Microcomputer Systems' disk controller business topped $10,000,000 in revenues in 1979, the first year that the firm announced internally manufactured disk drive products. Those drives, a 14 inch Winchester drive to be assembled from an SLI HDA kit and an 8 inch Winchester of unique design to be completely manufactured internally, have apparently been withdrawn. In the Spring of 1980, the firm announced a subsystem combining a floppy drive with an internally manufactured 8 inch Winchester drive, with delivery promised for late 1980.

MICRODATA CORPORATION
Subsidiary of McDonnell Douglas Corporation
17481 Red Hill Avenue
Irvine, CA 92714 714/540-1113

1979 disk sales: $38,500,000
1979 total net sales: $5,278,531,000 Net income: $199,103,000

Microdata was acquired by McDonnell Douglas in late 1979, with company statements indicating that the new parent will make possible major expansion of the Microdata computer systems business. The firm has dropped its marketing program for OEM peripherals, and disk drive activities are now concentrated on Microdata captive requirements. The company's substantial increase in disk drive revenues for 1979 is attributable to increased shipments of the Reflex 14 inch fixed Winchester drive.

MICROPOLIS CORPORATION
21329 Nordhoff Avenue
Chatsworth, CA 91311 213/709-3300

1979 disk sales: None

Micropolis is taking advantage of its success in marketing double track density 5.25 inch floppy drives two years ahead of its competition, to enter the formative market for 8 inch Winchester drives. After slipping early shipments for about six months to solve the usual Winchester start-up problems, the firm expects to ship in quantity during the second half of 1980. In addition to several OEM versions of its 8 inch drive, Micropolis also is offering the unit in a subsystem designed for the S-100 bus.

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

1979 disk sales: None

New World demonstrated at the 1979 NCC an unconventional 8 inch fixed disk drive using a moving head array of 20 ferrite transducers. Still without starting production, the firm also displayed a 5.25 inch drive at the 1980 NCC, also announcing availability of higher capacity versions using plated disks. New World is now supplying evaluation units and indicates that it plans to start quantity production in early 1981.

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

1979 disk sales: $48,500,000
1979 total net sales: $1,634,000,000 Net income: $97,474,000

The U.S. Northern Telecom computer operations were formed from the previous Sycor and Data 100 firms, in a messy consolidation that resulted in wholesale management defections and displacements. In the disk drive area, Sycor's 14 inch captive fixed disk drives and Data 100's disk cartridge line previously acquired from Iomec are still in production. In early 1980, the firm announced it plans to halt OEM sales for the disk cartridge drives by the end of 1980, and that it had terminated a license for manufacturing rights to the Okidata 14 inch Winchester drive. Northern Telecom has indicated its disk drive interests are limited to captive requirements. The firm's next disk drive introduction will probably be an 8 inch Winchester drive, long under development.

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

1979 disk sales: $5,800,000

The U.S. Okidata Corporation is now controlled by Oki Electric Industry Co., Ltd., of Tokyo, after an earlier existence as a joint venture with ownership shared with U.S. investors. Okidata was an early participant in the 14" Winchester drive market, shipping mostly 80 MB drives, starting in 1977. Manufacturing licenses were sold to Mitsubishi, now in production with similar products, and to Northern Telecom and Data Recording Equipment, neither of which is expected to produce their version of the Okidata drive. After increasing its production level in 1979, Okidata had to do some retrenching in mid-1980, since its major customer used the drives in systems which found their eventual application in the depressed automotive market.

ONTRAX CORPORATION
611 Vaqueros Avenue
Sunnyvale, CA 94086 408/245-5633

Ontrax is a startup company, founded in 1979 by industry veterans, to develop a concept for a new type of fast, highly accurate head positioning system. The firm plans to announce a high performance 8 inch fixed disk drive using its new actuator system.

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

1979 disk sales: $26,700,000
1979 total net sales: $733,002,000 Net income: $50,338,000

During 1980, Perkin Elmer updated the old Wangco line of disk cartridge drives and announced they will now carry the "Vanguard" family name. The firm has been successful in further developing its OEM markets for these drives, and continues to offer the only 20 MB disk cartridge drive in the U.S. OEM market. Captive disk drive usage remains relatively small. The future for Perkin Elmer's OEM disk drives is probably more development of disk cartridge formats, in areas such as the CMD and 8 inch drives.

PERTEC COMPUTER CORPORATION
Subsidiary of Triumph Werke Nurnberg AG
9600 Irondale Avenue
Chatsworth, CA 91311 213/882-0030

1979 disk sales: $47,500,000

In early 1980, Pertec was acquired by Triumph Werke Nurnberg, through its U.S. subsidiary, Triumph Adler, Inc. Exercising control over this process was Volkswagenwerke, which acquired 54% of Triumph Werke Nurnberg in 1979, later adding another 19% in 1980. Whatever Pertec's future role in the Volkswagen office of the future, the firm's line of disk cartridge and fixed disk drives using 2314 technology have continued to be sold successfully in the OEM market, with additional captive usage in Pertec systems. The firm plans to initiate production of its 8 inch Winchester drive in the second half of 1980.

PRIAM CORPORATION
3096 Orchard Drive
San Jose, CA 95134 408/946-4600

1979 disk sales: None

Priam is at midstream in its startup program, involving an attempt to become a major supplier of both 14 inch and 8 inch Winchester OEM disk drives. Shipments of 14 inch drives are well underway, and the firm's

linear motor actuator 8 inch drive is expected to be in production this year. Priam has also taken another step to broaden its product base quickly. It has entered into a cross licensing arrangement with Hokushin, a firm with an established line of OEM disk drives in the Japanese market, in which each of the two companies receives rights to make the other's Winchester disk products. Hokushin thus will make the Priam 14 and 8 inch high performance drives in Japan, and Priam will be able to make Hokushin's low-end 8 inch Winchester drives with stepping motor actuators. Priam will probably enter the U.S. market with the latter product in 1980 with drives made by Hokushin prior to its own production of the drive.

QUANTUM CORPORATION
120 Charcot Avenue
San Jose, CA 95131 408/262-1100

Quantum is an ambitious startup, planning to directly attack the market for low-end 8 inch Winchester disk drives already dominated by the Shugart SA 1000. The six founders, mostly with Shugart Associates, Memorex and IBM backgrounds, formed the company in March, 1980, and plan to initiate production in early 1981. The firm has obtained a heavy venture capital commitment, to enable it to proceed directly to quantity production, in an attempt to jump down the cost/price experience curve quickly. The founders have the backgrounds to carry off their gamble, and the industry will be watching Quantum closely for the results.

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

1979 disk sales: $4,800,000
1979 total net sales: $7,027,000,000 Net income: $563,100,000

Shugart Associate's half a million floppy drives in 1979 provided an excellent backdrop for the introduction of fixed Winchester drives designed to open up a new low end price area for rigid disk drives. Shipments of the 14 inch drive got off to a good start in 1979 and the 8 inch drive is off to an excellent start in 1980. Having set the sales and production pace for low end 14 and 8 inch drives, the firm is now being somewhat upstaged by that other company named Shugart. The earliest deliveries of 5.25 inch Winchester low end drives will be made by Shugart Technology, and industry observers assume that Shugart Associates also will inevitably offer an aggressive program in that product area.

SHUGART TECHNOLOGY
340 El Pueblo Road
Scotts Valley, CA 95066 408/438-6550

The exceptional early interest by the industry in low cost 8 inch Winchester disk drives stimulated the founders of Shugart Technology to gear up

an accelerated program to offer a 5.25 inch Winchester drive. Key to the strategy is the opportunity to offer a capacity and performance upgrade to the large and growing small computer market now using only 5.25 inch floppy drives. In a classic example of the California entrepreneurial startup, the firm decided to make the 5.25 inch drive in late 1979 and expects to ship limited quantities in the second half of 1980, with large scale production in 1981. Shugart Technology already has orders, and has sold a manufacturing license to Texas Instruments. All the company has to do now is deliver.

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

1979 disk sales: None

SLI's basic business is manufacturing voice coil actuators and other disk drive components. The company has also been active for the last few years in attempting to develop a market for a Winchester disk drive "kit", consisting of deck plate, spindle, rotary acutator, cover and related parts -- with electronics, final assembly and test the customer's responsibility. Lacking sales results from the kit approach, SLI has decided to offer a complete 8 inch OEM drive using its own products, with delivery planned for late 1980.

STORAGE TECHNOLOGY CORPORATION
2270 South 88th Street
Louisville, CO 80027 303/673-5151

1979 disk sales: $123,900,000
1979 total net sales: $479,453,000 Net income: $39,746,000

STC grabbed the leadership position in the PCM disk drive race in 1978, but found in 1979 that there is also a negative side to the PCM market. The company retained the PCM shipment leadership in 1979, but that was the year IBM lowered the price umbrella twice. The STC rear guard action of upgrading the product mix to double density drives, at better margins, will help ease the pain, so long as the 3350 stays in style. STC's new line of intelligent fixed Winchester drives for the OEM market is finally starting to ship, and the industry will at last have a chance to see how well the market accepts smart OEM drives.

TANDON MAGNETICS CORPORATION
9333 Oso Avenue
Chatsworth, CA 91311 213/933-6644

1979 disk sales: None

Tandon Magnetics is well known as the leading independent manufacturer of heads for floppy drives, and more recently as a fast growing manufacturer of 5.25 inch floppy drives for the OEM market. The company has

indicated that it will offer a 5.25 inch Winchester drive similar to the Shugart Technology design, which presumably will be interface and compatible with that drive. Evaluation units may be available by the end of 1980, with production next year.

TEXAS INSTRUMENTS, INC.
Terminals and Peripherals Division
P.O. Box 1444
Houston, TX 77001

1979 disk sales: None
1979 total net sales: $3,224,126,000 Net income: $172,891,000

TI hasn't admitted that it plans to manufacture a disk drive of any kind, yet. But it has confirmed that its Terminals and Peripherals Division has signed up for a manufacturing and marketing license with Shugart Technology, to cover that firm's new 6 MB 5.25 inch Winchester drive. The "when", "where" and "why" part of the story will have to come later.

3M Company
3M Center
Saint Paul, MN 55101 612/733-1110

1979 disk sales: None
1979 total net sales: $5,440,370,000 Net income: $655,211,000

3M has been trying for the last few years to find a good point of entry into the disk drive business. At least one investment in a startup went sour -- with the famous early infighting debacle at IMI. The firm is willing to admit it has "an effort to explore, evaluate and pursue market opportunities for Winchester technology disk drives." It is worth noting that most of the manufacturers of small Winchester drives are convinced 3M is developing drives to compete in that market area.

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

1979 disk sales: $500,000
1979 total net sales: $10,187,000 Net income: $1,515,000

VRC continues to exist primarily as a manufacturer of head-per-track drives. The firm's high capacity disk cartridge drive with embedded servo, introduced several years ago, is produced in low quantities, with the majority of sales in Europe.

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

1979 disk sales: $20,500,000

Western Dynex has managed to survive in the OEM disk cartridge drive business during a period in which other secondary manufacturers were dropping out of the industry. The firm's combination of low overhead and low prices has worked well during the mature phase of the disk cartridge product life cycle. But what happens during the decline phase?

Japanese Manufacturers (Exchange basis: 225 Yen = U.S. $1)

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

1979 disk sales: $174,400,000
1979 total net sales: $2,458,844,000 Net income: $65,080,000

Fujitsu is the leading Japanese computer manufacturer, now contending with IBM for the title of largest factor in the Japanese computer market. Most of the disk drives the firm manufactures are sold on a captive basis with its own mainframes, minicomputers and small business systems. Fujitsu's large disk pack drives are still the biggest disk revenue producers, but fixed disk drives in the 3350 class are coming up fast. Fujitsu shares ownership in Nippon Peripherals, Ltd., with Hitachi, and both firms look to NPL for development of high performance magnetic peripherals. Fujitsu has carried out its own development, however, of a high performance 8 inch Winchester drive, as well as a low end 8 inch drive with stepping motor actuator -- both products with good potential for increasing the firm's penetration of OEM disk markets.

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

1979 disk sales: $124,400,000
1979 total net sales: $11,442,302,000 Net income: $431,253,000

Less than a fifth of Hitachi's sales are provided by the computer industry, with the bulk of revenues generated by a diversified electrical and electronics business. The firm's high performance disk pack drives and fixed disk drives are marketed primarily with Hitachi mainframes, providing the major portion of the company's disk drive revenues. Though its joint ownership of NPL has resulted in design of standard 3350 type drives, Hitachi has supplemented them with its own 635 MB fixed disk drive with dual actuator. The OEM drives are concentrated in the smaller fixed disk area, marketed primarily in Japan, except for the 3350s sold to National Advanced Systems in the U.S.

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

1979 disk sales: $9,600,000
1979 total net sales: $145,867,000 Net income: $1,613,000

Hokushin, a manufacturer of industrial instruments, was the licensee for Diablo's disks and printers in Japan -- but had a problem when Diablo stopped further development of disk drives. Hokushin developed its own

high capacity disk cartridge drives for the Japanese OEM market, and has introduced in 1980 a low cost line of 8 inch Winchester drives with stepping motor actuators. These low end Winchester drives will also be licensed to the U.S. company Priam, and Hokushin has acquired rights to make the Priam drives in Japan.

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

1979 disk sales: $63,000,000
1979 total net sales: $4,527,609,000 Net income: $97,604,000

Mitsubishi Electric is a major electronic and electric products firm, with a computer operation which commands the leading share of the Japanese small business system market, in addition to larger systems. Except for large fixed disk drives, the firm is active in all significant disk drive product groups, but has not yet announced drives with disk diameters less than 14 inches. The firm makes the only SMD type drive in Japan, and is the leader in the Japanese OEM disk drive market. An OEM marketing program has also been initiated in the U.S.

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

1979 disk sales: $109,900,000
1979 total net sales: $3,511,644,000 Net income: $35,089,000

NEC is a major manufacturer of telecommunications, data processing and other electronic equipment. Computers account for about 20% of revenues, including mainframes, small business systems and minicomputers. Most of NEC's disk drive revenues are from captive drives, led by the company's large and medium size fixed disk drives. The firm has introduced a 635 MB captive drive, and has an active OEM program for 20, 40 and 80 MB Winchester drives in both Japan and the U.S.

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

1979 disk sales: $25,400,000

Fujitsu and Hitachi are the joint owners of NPL, which is charged with the responsibility to develop advanced disk drives and other magnetic peripherals. The resulting products may be sold by NPL, or the designs are sometimes adapted to the specific programs of the individual parent companies. The firm has duplicated every IBM drive since the 3340 -- the 3344, 3350, and 3310. The 3310 is the world's first announced PCM

version of the IBM Piccolo. In addition to captive requirements for the parent companies, NPL drives are sold in the PCM markets through Memorex (3340) and BASF (3340, 3344, 3350, 3310) in the United States and Europe, respectively. 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

1797 disk sales: $37,200,000
1979 total net sales: $7,569,640,000 Net income: $102,916,000

In addition to a broad line of minicomputers and small business systems, Toshiba is a Japanese industrial giant, active in consumer electric and electronic products, plus numerous industrial electronic products. Disk drives are manufactured mainly for captive use with Toshiba systems, plus a small OEM business. Active in large disk cartridge drives, disk pack drives and 14 inch Winchester drives, the firm also displayed an 8 inch Winchester drive at this year's Tokyo International Business Show, but the product has not yet been formally announced.

European Manufacturers (Exchange basis: Indicated for each firm)

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

1979 disk sales: $1,700,000
1979 total net sales: $14,138,872,000 Net income: $338,040,000
(Basis: DM 1.86 = U.S. $1)

BASF has made disk pack drives since the early 1970s as the result of a license from the old Century Data Systems for 2314 type drives. The firm has been developing a line of 14 inch Winchester drives in Germany and has a new operation in Los Gatos, California, producing 8 inch Winchester drives. The 8 inch drive, now shipping in growing quantities, is the first BASF attempt to penetrate the U.S. OEM drive market with a major program. In Europe, BASF has supplemented its declining PCM 2314 program with 3340, 3344, and 3350 PCM drives manufactured by Nippon Peripherals, Ltd. It is expected that the NPL version of the 3310 will be added to this program.

CII-HONEYWELL BULL
94, Avenue Gambetta
75960 Paris Cedex 20
France (1)360 02 22

1979 disk sales: $700,000
1979 total net sales: $1,206,090,000 Net income: $49,419,000
(Basis: FF 4.25 = U.S. $1)

Cii-Honeywell Bull's ownership is split 47% with Honeywell Information Systems, Inc., and the balance held by a mixture of French companies, the government and the public, with a realignment of the lineup pending. The firm is one of Europe's leading computer manufacturers, with internal manufacture of many peripherals. Internal production of older types of disk drives has been phased out, but the company has been pioneering a family of disk cartridge drives and fixed disk drives using 10.5 inch coated disks. In addition to captive usage, the firm has been pushing an OEM marketing program in both Europe and the United States, with the most significant sale to date to Datapoint.

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

1979 disk sales: None

After its 1977 startup, CPT first showed its 200 mm OEM fixed drive with plated disks at Hannover Fair in 1979. In addition to the origi-

nal 40 MB drive announcement, the firm added a 70 MB version at the 1980 Hannover Fair. The company now plans to ship in mid-1980 for the first time.

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

1979 disk sales: $20,000,000
(Basis: 1 Pound = U.S. $2.35)

The big event in DRE's life in recent years was the establishment of a joint venture with Magnetic Peripherals, Inc., the U.S. disk drive development and manufacturing company owned primarily by Control Data and Honeywell. A new firm, United Peripherals, Ltd., was established, with 24% held by MPI and 76% held by Data Recording Instruments, Ltd., the parent of DRE. UPL has taken over the DRE disk development and manufacturing facilities, and will manufacture the DRE products, primarily disk cartridge drives produced under Diablo license, plus selected new MPI products, such as the Hawk disk cartridge drive, the Phoenix cartridge module drive, and, eventually, the Lark 8 inch disk cartridge drive. DRE will be able to sell all of these products, and CDC's European sales operation will acquire a local manufacturing source for the CDC disk product line. In the meantime, DRE has already started production of an 8 inch Winchester drive, and is now actively developing the market for this additional drive, in addition to the newly added MPI products.

ISOTIMPEX
51, Chapaev St.
Sofia, Bulgaria

1979 disk sales: $12,500,000

Isotimpex disk drives, all copies of standard IBM configurations, are in wide use throughout Eastern Bloc countries. Disk drives are manufactured by Isot, the Bulgarian state computer organization, and are exported by Isotimpex, the foreign trade organization specializing in electronic products. Most of existing production is concentrated in disk cartridge drives, developed under a Wangco license, and 2314 compatible drives. Isotimpex indicates that it is also now shipping 3340 type drives.

PHILIPS DATA SYSTEMS
Subsidiary of N. V. Philips Gloeilampenfabrieken
Postbus 245
7300 AE Apeldoorn
The Netherlands (055) 330123

1979 disk sales: $36,200,000
1979 total net sales: $16,576,123,000 Net income: $308,701,000
(Basis: Fl 1.97 = U.S. $1)

Despite the fact that Philips is a major factor in the European minicomputer and small business system market, computer industry revenues contribute less than 5% of the company's total revenue. Disk drive programs are intended to support the firm's systems product lines. Philips introduced a new disk cartridge drive using CDC's CMD cartridge in a special recording scheme at the 1980 Hannover Fair. Existing products include older disk cartridge drives, disk pack drives and small fixed Winchester drives. The well-publicized Philips activity in development of optical disk systems apparently will not lead to any early usage on Philips own computer systems -- which are too small to require the probable capacity of initial optical disk drives.

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

1979 disk sales: $101,600,000
1979 total net sales: $15,069,575,000 Net income: $361,938,000
(Basis: DM 1.86 = U.S. $1)

The Siemens data processing revenues account for only about 5% of the company's total revenues -- but nevertheless Siemens is a major factor in the European mainframe market. All disk drives are sold on a captive basis with the firm's own computers. Products include several disk pack drives using a 6060 BPI version of 3330 technology, plus a large fixed disk drive. There has been no continuation of an OEM marketing program announced a few years ago for the same products.