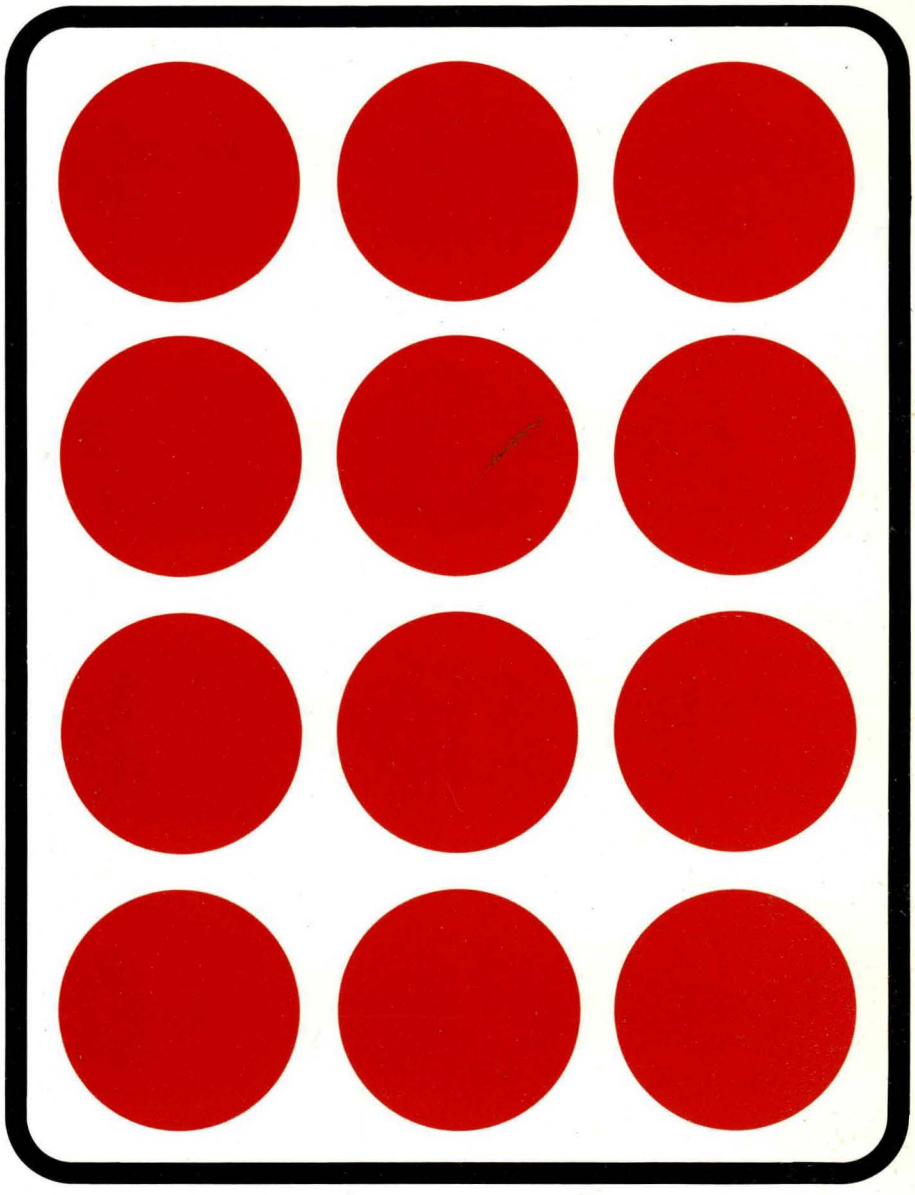
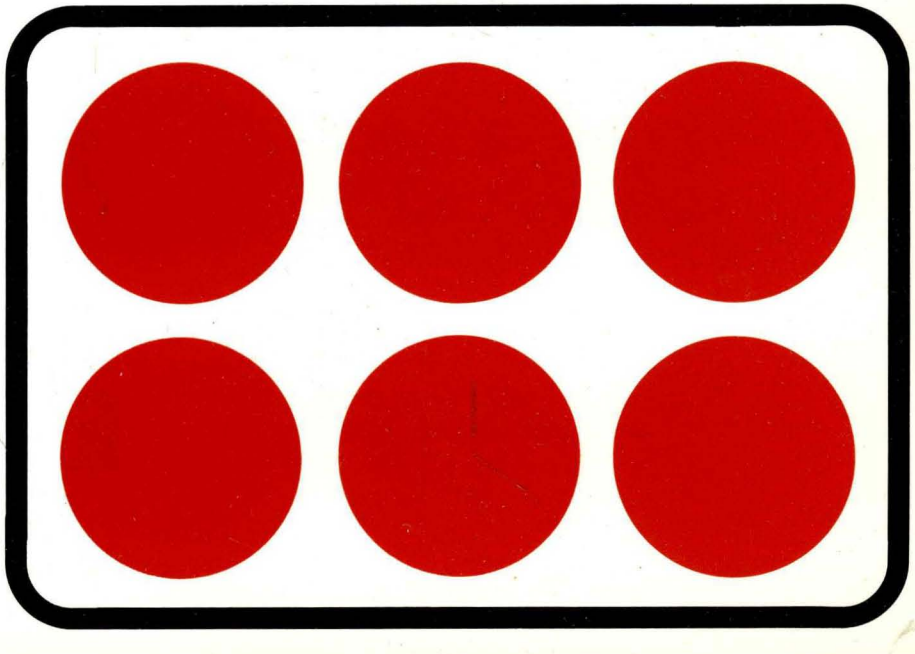


1980 DISK/TREND® REPORT

FLEXIBLE DISK DRIVES



1980 DISK/TREND® REPORT

FLEXIBLE DISK DRIVES

September, 1980

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FOREWORD

The DISK/TREND has reached its fourth birthday, and it contains data on more companies, more products and a much larger industry than previous editions.

As regular users know, the DISK/TREND Report is published in two sections. This volume covers flexible disk drives, and a separate report published in July covered moving head rigid disk drives.

A large number of regular subscribers 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 is still the same

Users continue to say that the basic DISK/TREND format is what they want, so it has been kept essentially the same in 1980, to provide continuity and to make the report as helpful as possible to regular users. Here are a few new items to watch for:

* A special projection for the use of 96 TPI in 5.25 inch flexible disk drives has been added. The projection has been placed in the 5.25 inch, two sided drive section, since this product group is expected to make much heavier use of 96 TPI than the one sided drives.

* As an experiment this year, information on OEM prices has been added to the specification section. A new line in that section contains the United States OEM price for 500 units for most OEM floppy drives intended for distribution in 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. Drives which use a single actuator mechanism to control head movement on two separate flexible disks are also counted as two spindles.

SUMMARY

Industry size

1979 flexible disk drive shipments increased at approximately the rate projected in last year's DISK/TREND Report, with worldwide revenues reaching $790,100,000, up 65.5% over 1978. The industry shipped a combined total of 1,353,200 flexible disk drives of all configurations in 1979.

The original 8 inch, one side floppy drive continued to lead in unit shipments for 1979, but other formats have established growth rates which are expected to lead to higher eventual shipping rates. 5.25 inch, one side drives are already challenging for unit shipment leadership, and the two sided versions of both 8 and 5.25 inch drives are growing even more rapidly.

As expected, the recession has not caused any major problem for the industry in maintaining the expected growth rate in total revenues, but its effects have caused a softening in demand for flexible disk drives to be used in low end systems, principally in the personal computer market.

Worldwide shipments of all floppy drive configurations are estimated at over two million units for 1980, with revenues in the same year topping one billion dollars for the first time. The floppy success story is expected to continue, with the 1983 DISK/TREND projection for worldwide unit shipments at 5,106,300 and revenues at $2,510,200,000.

TABLE 1

CONSOLIDATED WORLDWIDE SHIPMENTS

ALL EXISTING FLEXIBLE DISK DRIVE GROUPS

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	172.3	254.1	215.8	310.9	273.7	391.5	347.3	497.7	402.2	575.6
Other U.S. Captive	83.7	121.8	110.7	157.7	148.4	212.5	205.4	296.0	284.9	417.3
TOTAL U.S. CAPTIVE	256.0	375.9	326.5	468.6	422.1	604.0	552.7	793.7	687.1	992.9
PCM	.1	.1	.6	.6	1.6	2.0	2.2	3.3	3.5	5.5
OEM	172.3	211.1	258.6	324.3	330.0	420.6	418.2	544.6	520.3	693.3
TOTAL U.S. NON-CAPTIVE	172.4	211.2	259.2	324.9	331.6	422.6	420.4	547.9	523.8	698.8
TOTAL U.S. SHIPMENTS	428.4	587.1	585.7	793.5	753.7	1,026.6	973.1	1,341.6	1,210.9	1,691.7
Non-U.S. Manufacturers										
Captive	8.9	127.0	10.0	175.6	23.3	254.9	33.1	354.4	48.4	483.1
PCM	--	--	--	--	--	--	--	--	--	--
OEM	18.4	76.0	33.8	133.7	35.9	180.2	50.9	245.0	70.0	335.4
TOTAL NON-U.S. SHIPMENTS	27.3	203.0	43.8	309.3	59.2	435.1	84.0	599.4	118.4	818.5
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	455.7	790.1	629.5	1,102.8	812.9	1,461.7	1,057.1	1,941.0	1,329.3	2,510.2

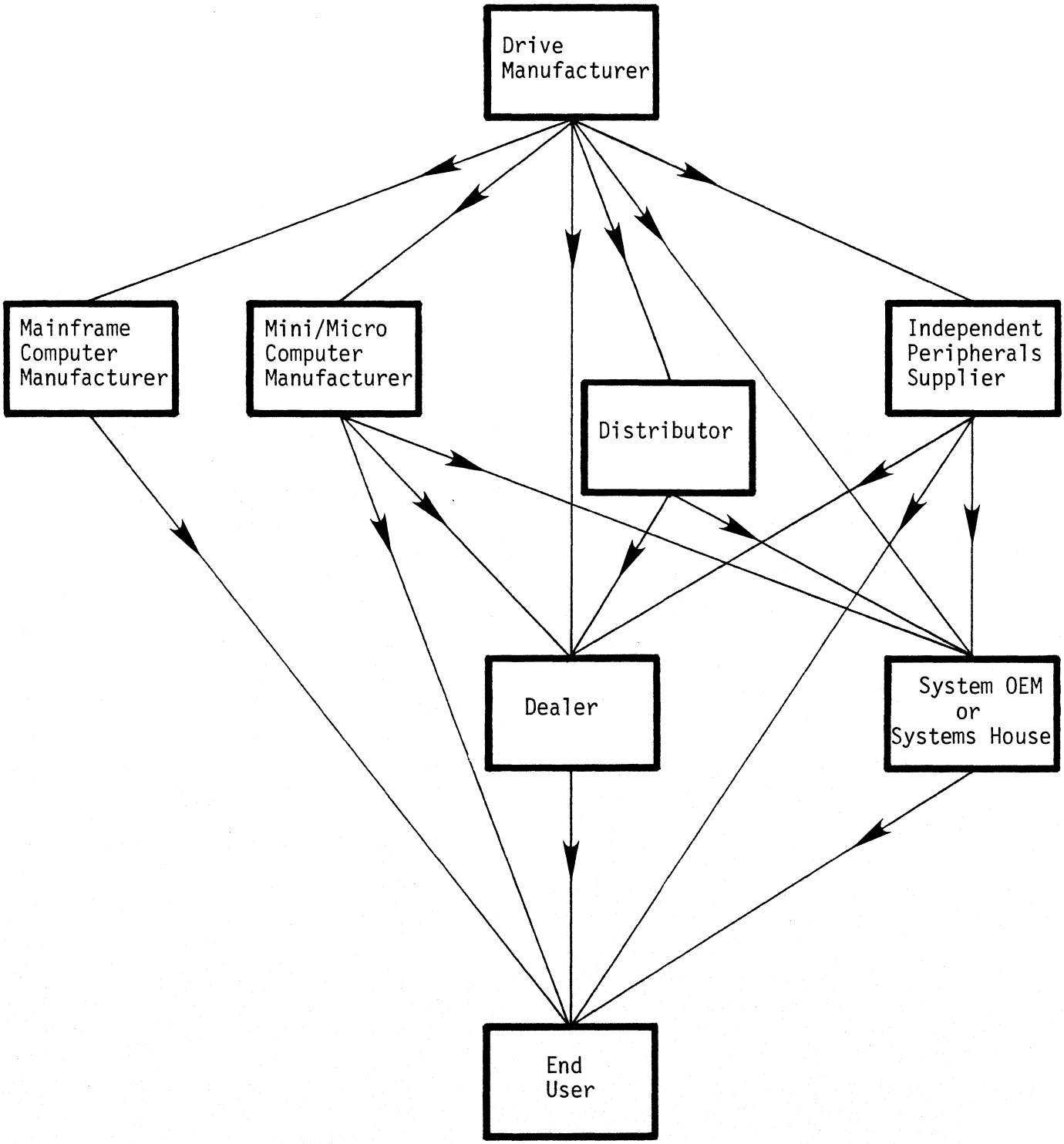
Industry structure

The worldwide total of flexible disk drive manufacturers has grown again this year, to 44. Since last year, the number of U.S. manufacturers has increased to 25, and the number of Japanese firms is up to 11. The total number of European manufacturers is down slightly, to 8.

The distribution patterns for flexible disk drives continue to evolve. As illustrated in Figure 1, OEM drives are resold by firms performing a variety of functions: Mainframe, minicomputer and microcomputer manufacturers integrate floppy drives into systems and subsystems; independent peripherals suppliers add controllers and other auxiliary hardware to provide complete subsystems; systems OEMs build floppies into standardized system products; systems houses combine floppy drives with other purchased hardware and proprietary software in specialized systems; distributors perform the traditional wholesaling function; and dealers market floppy drives and small systems through retail stores and local sales staffs.

The newest addition to this complex pattern is the distributor of electronic components. The pioneer distribution arrangement for the last few years has been the Shugart Associates agreement with Hamilton Avnet, providing a national distribution channel completely separate from the Shugart direct selling organization. That program has proven to be highly successful, tapping a growing market of small OEMs, systems houses and dealers too small for cost effective direct sales coverage by the manufacturer. Other manufacturers have negotiated similar distribution arrangements.

Figure 1
NON-CAPTIVE MARKETING STRUCTURE
FLEXIBLE DISK DRIVES



Marketing channels

As noted in the specific product sections, the DISK/TREND estimates of IBM flexible disk drive shipments have been completely revised this year, as a result of a comprehensive review of drive requirements for IBM systems. The net result is significantly higher estimates for IBM shipments during the years covered by this report. It is now estimated that IBM realized $254.1 million from flexible disk drives in 1979, 32.2% of the industry worldwide total. It must be noted that this total is based on arbitrary unit price estimates for floppy drives used with various IBM systems, since the drives are not priced separately in most systems. As in previous DISK/TREND projections, it is assumed that IBM's share of worldwide flexible disk drive revenues will continually decline, due to a higher growth rate for shipments by manufacturers of other captive and OEM drives.

The share of worldwide revenues held by OEM drives has been increasing for several years, due to the rapid growth of newer configurations sold primarily by manufacturers of OEM drives. Starting in 1981, however, the OEM share is expected to start a slow decline, as volume shipments to some major OEMs are diverted to internal manufacturing programs.

The U.S. manufacturers are expected to drop from 74.3% of worldwide revenues in 1979 to 67.4% in 1983. The largest portion of the growth expected from non-U.S. manufacturers will come from Japanese firms, which have already established extensive production capability for 8 inch, two sided drives, and are rapidly moving into 5.25 inch drives.

TABLE 2

CONSOLIDATED WORLDWIDE SHIPMENTS

ALL EXISTING FLEXIBLE DISK DRIVE GROUPS

MARKET CLASS 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	254.1	32.2	310.9	28.2	391.5	26.8	497.7	25.6	575.6	22.9
Other U.S. Captive	121.8	15.4	157.7	14.3	212.5	14.5	296.0	15.2	417.3	16.6
PCM	.1		.6	.1	2.0	.1	3.3	.2	5.5	.2
OEM	211.1	26.7	324.3	29.4	420.6	28.8	544.6	28.1	693.3	27.6
Total U.S. Mfgr's.	587.1	74.3	793.5	72.0	1,026.6	70.2	1,341.6	69.1	1,691.7	67.4
Non-U.S. Manufacturers										
Captive	127.0	16.1	175.6	15.9	254.9	17.4	354.4	18.3	483.1	19.2
PCM	--	--	--	--	--	--	--	--	--	--
OEM	76.0	9.6	133.7	12.1	180.2	12.3	245.0	12.6	335.4	13.4
Total Non-U.S. Mfgr's.	203.0	25.7	309.3	28.0	435.1	29.8	599.4	30.9	818.5	32.6
Worldwide Total	790.1	100.0	1,102.8	100.0	1,461.7	100.0	1,941.0	100.0	2,510.2	100.0

Product mix

As the flexible disk drive industry becomes more complex, with new manufacturers every year and significant new applications being constantly developed, the technology has evolved into several product configurations with strong market demand. Today's volume leader is still the original 8 inch, one side floppy format introduced by IBM in 1973, but that product's growth rate has been surpassed by other formats.

8 inch, two sided drives have had a difficult adolescence, but have now established a growth rate expected to be adequate to pass up 8 inch, one side drive shipments at the end of 1981. By that time the one sided 8 inch drives will be declining, with the result that the 1983 DISK/TREND projection shows two side drives shipping at three times the level of one sided drives.

During the last few years, 5.25 inch, one side drives have established a spectacular growth rate, but a softening in demand for personal computer applications during the first half of 1980 will result in a more gentle upward slope on the growth curve for 1980. 5.25 inch, one side drives will reestablish more aggressive growth in 1981. However, two sided versions of the 5.25 inch floppy drive family are expected to grow at a faster rate through 1983, boosted by the sales appeal of the new 96 TPI versions.

OEM market

OEM shipment trends will be similar to the toal market, but in floppy drives the OEM market leads the total industry in timing. 8 inch, one side drives will peak sooner, and 5.25 inch two sided drives will grow faster.

Figure 2
CHANGING PRODUCT MIX
WORLDWIDE FLEXIBLE DISK DRIVE SHIPMENTS
CONSOLIDATED REVENUE

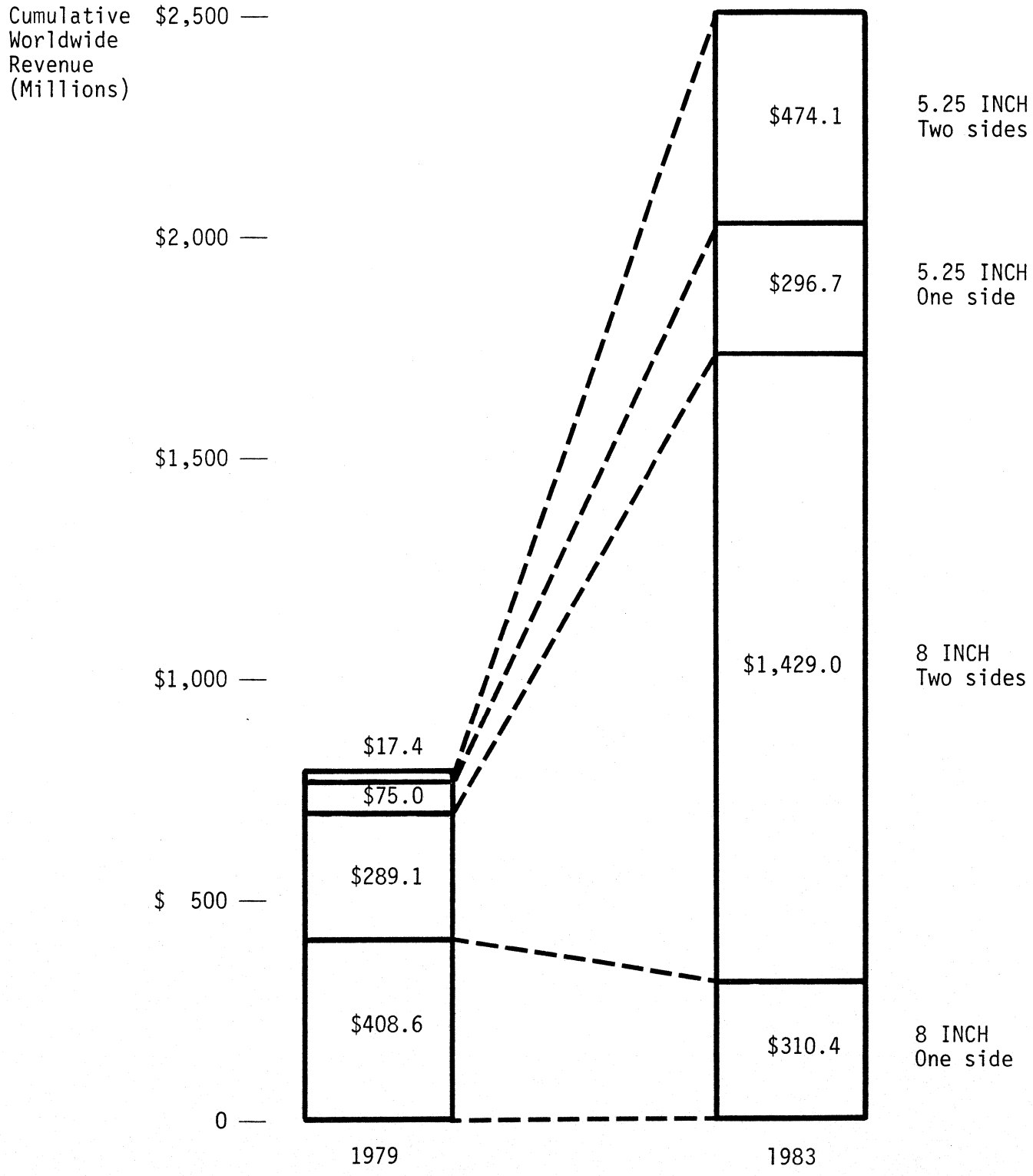


TABLE 3

WORLDWIDE SHIPMENTS

PRODUCT CATEGORY SUMMARY

ALL MANUFACTURERS

Units: Thousands / Dollars: $ Million		1979 Shipments Ship	1979 Shipments Δ%	1980 Ship	1980 Δ%	1981 Ship	1981 Δ%	1982 Ship	1982 Δ%	1983 Ship	1983 Δ%
8 INCH DRIVES											
One Side	Units	637.7	+19.5	743.8	+16.6	752.1	+1.1	675.3	-10.2	529.8	-21.5
	$M	408.6	+15.8	431.7	+5.7	426.5	-1.2	384.3	-9.9	310.4	-19.2
Two Sides	Units	218.5	+208.2	472.6	+116.3	734.8	+55.5	1,161.4	+58.1	1,675.3	+44.2
	$M	289.1	+188.5	512.2	+77.2	739.7	+44.4	1,075.1	+45.3	1,429.0	+32.9
8 INCH TOTAL	Units	856.2	+41.6	1,216.4	+42.1	1,486.9	+22.2	1,836.7	+23.5	2,205.1	+20.1
	$M	697.7	+54.0	943.9	+35.3	1,166.2	+23.6	1,459.4	+25.1	1,739.4	+19.2
5.25 INCH DRIVES											
One Side	Units	426.4	+234.2	558.1	+30.9	811.9	+45.5	1,080.1	+33.0	1,320.1	+22.2
	$M	75.0	+208.6	101.3	+35.1	168.1	+65.9	237.4	+41.2	296.7	+25.0
Two Sides	Units	70.6	--	228.9	+224.2	475.0	+107.5	859.6	+81.0	1,581.1	+83.9
	$M	17.4	--	57.6	+231.0	127.4	+121.2	244.2	+91.7	474.1	+94.1
5.25 INCH TOTAL	Units	497.0	+288.6	787.0	+58.4	1,286.9	+63.5	1,939.7	+50.7	2,901.2	+49.6
	$M	92.4	+278.7	158.9	+72.0	295.5	+86.0	481.6	+63.0	770.8	+60.0
TOTAL ALL DRIVES											
	Units	1,353.2	+84.7	2,003.4	+48.0	2,773.8	+38.5	3,776.4	+36.1	5,106.3	+35.2
	$M	790.1	+65.5	1,102.8	+39.6	1,461.7	+32.5	1,941.0	+32.8	2,510.2	+29.3

Figure 3

CHANGING PRODUCT MIX

WORLDWIDE FLEXIBLE DISK DRIVE SHIPMENTS
ALL MANUFACTURERS

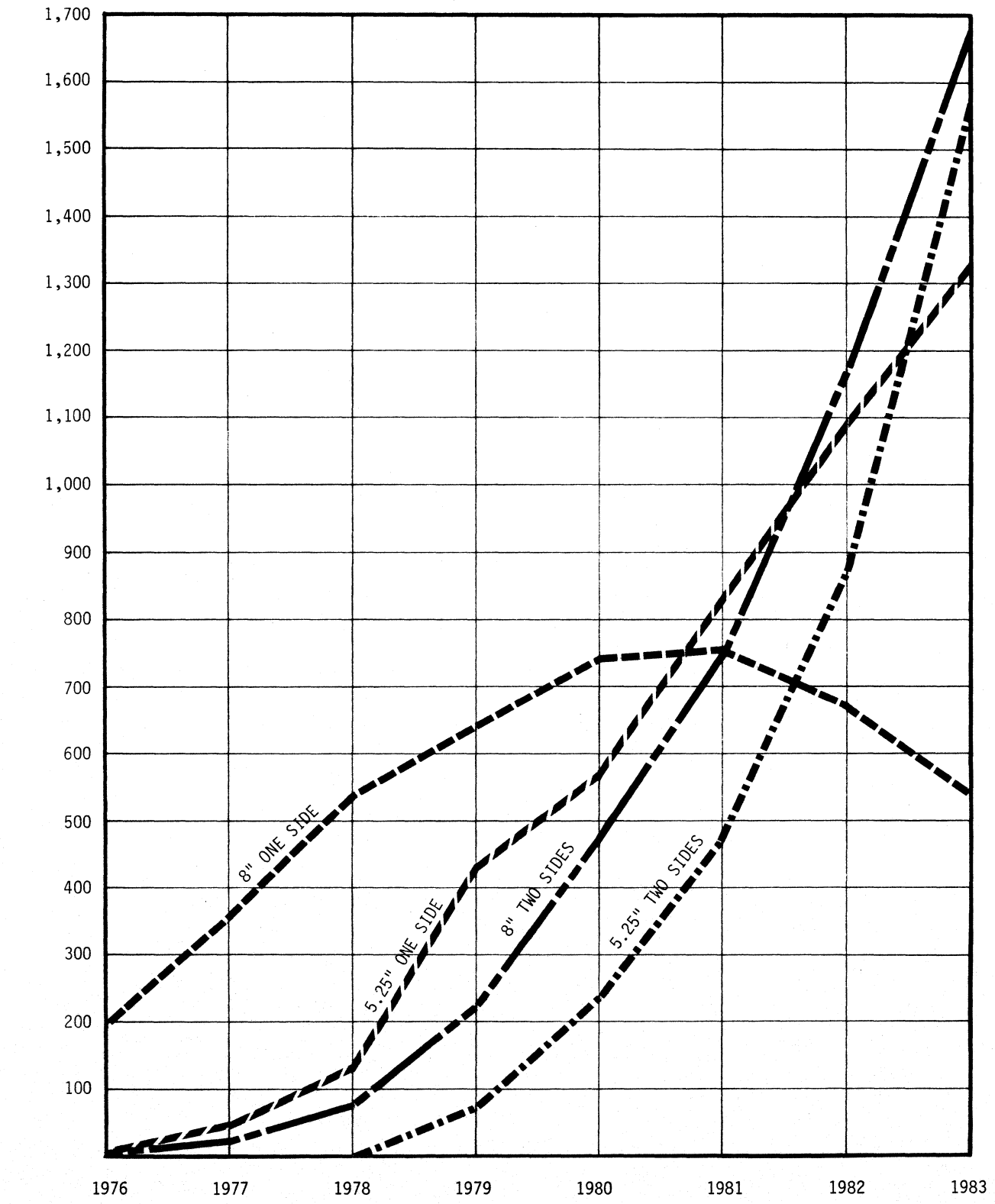


TABLE 4

WORLDWIDE SHIPMENTS

PRODUCT CATEGORY SUMMARY

MANUFACTURERS OF OEM DRIVES

Units: Thousands / Dollars: $ Million		1979 Shipments Ship	1979 Shipments Δ%	1980 Ship	1980 Δ%	1981 Ship	1981 Δ%	1982 Ship	1982 Δ%	1983 Ship	1983 Δ%
8 INCH DRIVES											
One Side	Units	447.1	+20.7	534.1	+19.5	521.3	-2.4	447.8	-14.1	327.2	-26.9
	$M	146.9	+13.3	171.8	+17.0	163.5	-4.8	138.0	-15.6	99.7	-27.8
Two Sides	Units	107.5	+245.7	292.2	+171.8	468.8	+60.4	775.2	+65.4	1,146.8	+47.9
	$M	51.0	+207.2	135.0	+164.7	207.5	+53.7	326.3	+57.3	466.0	+42.8
8 INCH TOTAL	Units	554.6	+38.1	826.3	+49.0	990.1	+19.8	1,223.0	+23.5	1,474.0	+20.5
	$M	197.9	+35.4	306.8	+55.0	371.0	+20.9	464.3	+25.1	565.7	+21.8
5.25 INCH DRIVES											
One Side	Units	422.4	+236.0	547.1	+29.5	743.7	+35.9	939.6	+26.3	1,108.9	+18.0
	$M	71.8	+213.5	93.6	+30.4	119.7	+27.9	145.7	+21.7	167.3	+14.8
Two Sides	Units	70.6	--	228.9	+224.2	457.9	+100.0	792.5	+73.1	1,381.9	+74.4
	$M	17.4	--	57.6	+231.0	110.1	+91.1	179.6	+63.1	295.7	+64.6
5.25 INCH TOTAL	Units	493.0	+291.3	776.0	+57.4	1,201.6	+54.8	1,732.1	+44.1	2,490.8	+43.8
	$M	89.2	+287.8	151.2	+69.5	229.8	+52.0	325.3	+41.6	463.0	+42.3
TOTAL ALL DRIVES											
	Units	1,047.6	+98.6	1,602.3	+52.9	2,191.7	+36.8	2,955.1	+34.8	3,964.8	+34.2
	$M	287.1	+69.7	458.0	+59.5	600.8	+31.2	789.6	+31.4	1,028.7	+30.3

Figure 4

CHANGING PRODUCT MIX

WORLDWIDE FLEXIBLE DISK DRIVE SHIPMENTS
MANUFACTURERS OF OEM DRIVES

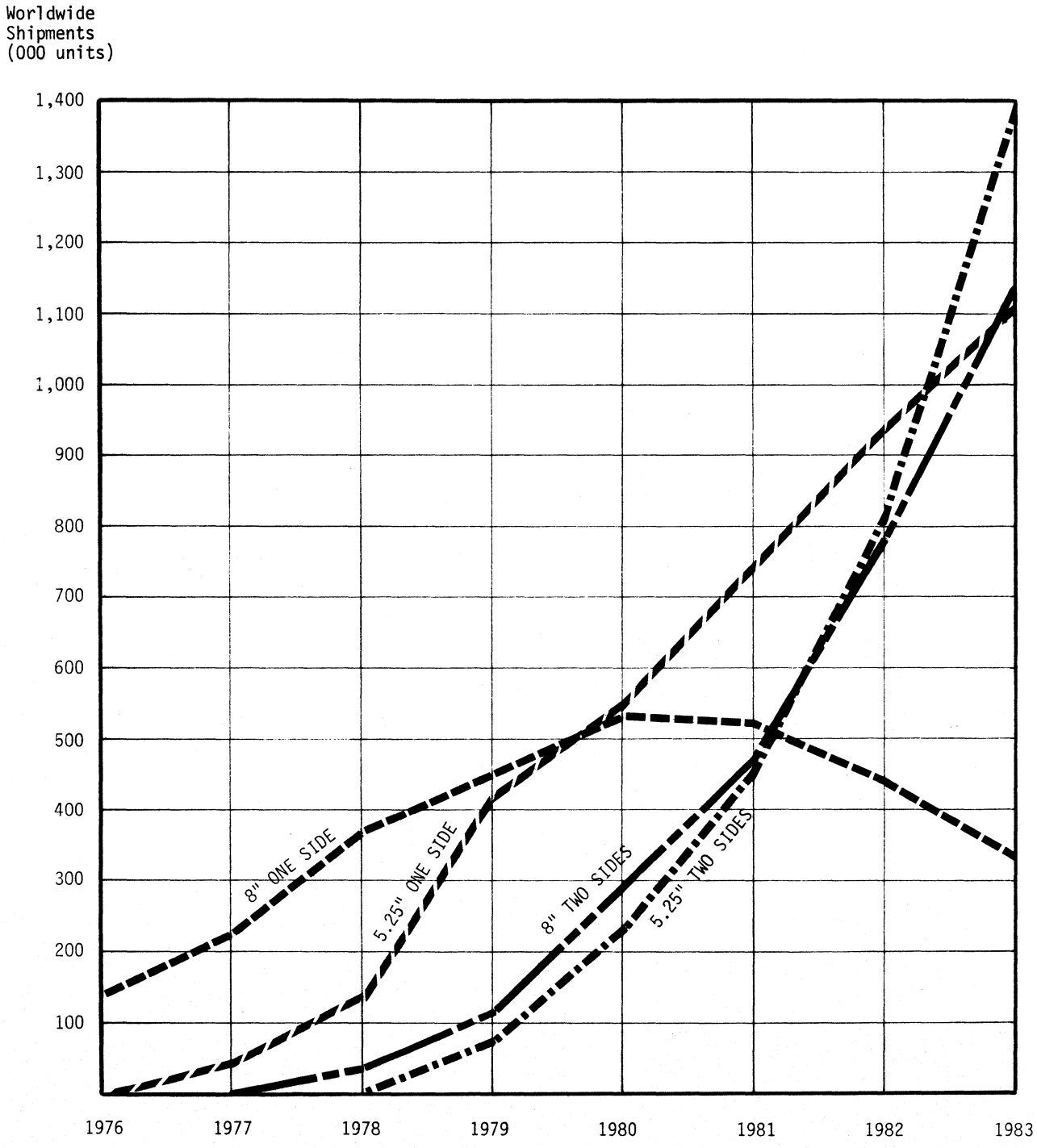


TABLE 5

1979 ESTIMATED MARKET SHARES

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

	CAPTIVE		OEM*		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%
U.S. MANUFACTURERS						
Burroughs	21.6	4.3	--	--	21.6	2.7
Caldisk	1.8	.4	5.5	1.9	7.3	.9
Control Data	14.2	2.8	20.6	7.2	34.8	4.4
Datapoint	8.0	1.6	--	--	8.0	1.0
Digital Equipment	51.6	10.3	--	--	51.6	6.5
IBM	254.1	50.5	--	--	254.1	32.2
Memorex	--	--	9.5	3.3	9.5	1.2
Micropolis	--	--	8.5	3.0	8.5	1.1
Micro Peripherals	--	--	7.3	2.5	7.3	.9
Northern Telecom	8.0	1.6	--	--	8.0	1.0
PerSci	--	--	5.3	1.8	5.3	.7
Pertec	6.1	1.2	5.4	1.9	11.5	1.5
Qume	--	--	4.3	1.5	4.3	.5
Remex	--	--	5.3	1.8	5.3	.7
Shugart Associates	2.5	.5	120.1	41.8	122.6	15.5
Sykes Datatronics	4.8	1.0	--	--	4.8	.6
Tandon Magnetics	--	--	14.8	5.2	14.8	1.9
Other U.S.	3.2	.6	4.6	1.6	7.8	1.0
U.S. Total	375.9	74.8	211.2	73.5	587.1	74.3
NON-U.S. MANUFACTURERS						
BASF	--	--	17.1	6.0	17.1	2.2
Hitachi	6.2	1.2	9.7	3.4	15.9	2.0
Matsushita	--	--	7.4	2.6	7.4	1.0
Mitsubishi	13.3	2.6	6.4	2.2	19.7	2.5
Nippon Electric Company	27.9	5.6	--	--	27.9	3.5
Olivetti	60.4	12.0	--	--	60.4	7.6
Siemens	--	--	9.6	3.3	9.6	1.2
Toshiba	13.4	2.7	4.3	1.5	17.7	2.3
YE Data	.7	.1	14.5	5.1	15.2	1.9
Other Non-U.S.	5.1	1.0	7.0	2.4	12.1	1.5
Non-U.S. Total	127.0	25.2	76.0	26.5	203.0	25.7
WORLDWIDE TOTAL	502.9	100.0	287.2	100.0	790.1	100.0

*Includes PCM.

TABLE 6

CURRENT PRODUCT LINES

MANUFACTURERS OF FLEXIBLE DISK DRIVES

Code:
C = Captive
P = PCM
O = OEM

U.S. MANUFACTURERS	TYPE	DISK/TREND PRODUCT GROUP: 10 8 INCH ONE SIDE	11 8 INCH TWO SIDES	12 5.25 INCH ONE SIDE	13 5.25 INCH TWO SIDES
Burroughs	C,O		X		
Caldisk	C,O	X	X	X	X
Control Data	C,P,O	X	X	X	
Data Master	O			X	X
Data Point	C	X			
Decitek	O	X	X		
Digital Equipment	C	X			
Hewlett-Packard	C				X
IBM	C	X	X		
Innotronics	O	X			
Memorex	O	X			
MFE	O	X	X		
Micro Peripherals	O	X	X	X	X
Micropolis	O			X	X
Northern Telecom	C	X			
PerSci	O	X	X		
Pertec	C,O	X	X	X	X
Qume	O		X		X
QYX	C			X	
Remex	O	X	X		
Shugart Associates	C,O	X	X	X	X
Sykes Datatronics	C	X			
Tandon Magnetics	O			X	X
Texas Peripherals	C	X		X	
T & E Equipment	O			X	
JAPANESE MANUFACTURERS					
Alps	O			X	X
Canon	C,O			X	X
Hitachi	C,O	X	X		
Matsushita	C,O	X	X	X	X
Mitsubishi	C,O	X	X		
Nippon Electric Company	C		X		
Oki Electric	C	X			
Ricoh	C	X	X		
TEAC	O		X	X	X
Toshiba	C,O	X	X	X	X
YE Data	C,O	X	X		X
EUROPEAN MANUFACTURERS					
BASF	O	X	X	X	X
Data Recording Equipment	O	X	X		
Isotimpex	O	X		X	
Logabax	C	X			
MERA/Metronex	C,O	X			
Olivetti	C	X	X	X	
Siemens	O	X	X	X	X
Videoton	C,O	X			

Application mix

Small business systems continue to overshadow all other application areas in total worldwide unit shipments. 40.9% of all floppy drives shipped in 1979 were used with small business systems, and further growth is expected. However, during the period through 1983 the product mix in this application will change drastically, with one side drives declining and two sided drives sharply increasing their share.

The traditional business data processing applications have repeatedly demonstrated a voracious appetite for storage capacity, and small computers are no exception. 5.25 inch, two sided drives, especially those with 96 TPI, are expected to dominate desktop small business system requirements for floppy storage, and 8 inch, two sided drives will be the choice for systems that are physically larger. Two sided drives in both sizes will frequently be used as companions to small fixed rigid disk drives.

Word processing has grown rapidly to second place in overall floppy drive usage, with 22.2% of the worldwide total in 1979. 8 inch, one side drives appear to have considerable staying power in this application because of the difficulty in switching existing word processing users with libraries of 8 inch, one side drives to newer floppy formats. Both of the 5.25 inch product groups are expected to attain major shares of the word processing market by 1983, however, due to their size and cost advantages.

Other applications are expected to follow established patterns, with key trends being heavy 5.25 inch, one side drive penetration of the personal computer market and continued 8 inch, one side usage for data interchange with a variety of terminals.

TABLE 7

FLEXIBLE DISK DRIVE APPLICATION PROJECTION

CONSOLIDATED WORLDWIDE SHIPMENTS

	1979 Estimate					1983 Projection				
	ALL FDD	8" ONE SIDE	8" TWO SIDES	5.25" ONE SIDE	5.25" TWO SIDES	ALL FDD	8" ONE SIDE	8" TWO SIDES	5.25" ONE SIDE	5.25" TWO SIDES
SMALL BUSINESS SYSTEMS										
Units (000)	553.1	216.8	141.2	165.7	29.4	2,159.3	63.9	1,194.6	145.2	755.6
Share %	40.9%	34.0%	64.6%	38.9%	41.6%	42.3%	12.1%	71.3%	11.0%	47.8%
MINI-MICRO COMPUTER SYSTEMS										
Units (000)	172.4	99.9	30.9	31.7	9.9	459.0	84.7	188.1	116.2	70.0
Share %	12.7%	15.7%	14.1%	7.4%	14.0%	9.0%	16.0%	11.2%	8.8%	4.4%
TERMINALS										
Units (000)	143.0	93.8	35.5	10.1	3.6	343.2	159.4	117.3	37.0	29.5
Share %	10.6%	14.7%	16.3%	2.4%	5.1%	6.7%	30.1%	7.0%	2.8%	1.9%
WORD PROCESSING										
Units (000)	299.9	193.2	5.2	90.3	11.2	1,234.1	188.3	119.0	422.4	504.4
Share %	22.2%	30.3%	2.4%	21.2%	15.9%	24.2%	35.5%	7.1%	32.0%	31.9%
HOBBY/PERSONAL COMPUTERS										
Units (000)	157.2	17.7	1.7	121.7	16.1	797.2	10.6	8.4	579.5	198.7
Share %	11.6%	2.8%	.8%	28.5%	22.8%	15.6%	2.0%	.5%	43.9%	12.6%
OTHER APPLICATIONS										
Units (000)	27.6	16.3	4.0	6.9	.4	113.5	22.9	47.9	19.8	22.9
Share %	2.0%	2.5%	1.8%	1.6%	.6%	2.2%	4.3%	2.9%	1.5%	1.4%
TOTAL, ALL APPLICATIONS										
Units (000)	1,353.2	637.7	218.5	426.4	70.6	5,106.3	529.8	1,675.3	1,320.1	1,581.1
Share %	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

TECHNICAL REVIEW

Competing technologies

So far, the most effective competitors to existing flexible disk drive configurations have been new flexible disk drive configurations. The 8 inch, one side drives introduced by IBM in 1973 have been losing market share rapidly in the last few years -- entirely to newer floppy drive configurations, offering various combinations of higher capacity, smaller physical size and lower price.

The fundamental reason for the resounding commercial success of the flexible disk drive configurations now available has been the combination of low cost, random access and media removability. The elimination of any of these three features would open the door to competitive recording devices in floppy's major markets.

Any data recording technology, to be an effective competitor to floppies, will have to exceed floppies' capabilities in providing low cost, random access and media removability -- or find emerging applications where these features are less critical. These are the leading candidates to displace floppies in some of their existing and potential future application areas:

* Magnetic bubbles: Countless trade publication articles in the last five years have suggested that replacement of big chunks of the flexible disk drive market by magnetic bubbles was imminent. This obviously has not happened, and there has been considerable internal analysis within the management groups responsible for various magnetic bubble programs as to why displacement of rigid and/or flexible disks has not taken place. It appears that the conclusions reached by most magnetic bubble manufacturers are 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 disk drives, both rigid and floppy, are an impossible target for head-on attack 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 suitability for on line storage requirements considered too small for most rigid or floppy drives. 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 all rigid disk drives and most flexible disk drives -- and will lack floppy's key advantage of cheap removable media.

The battle between magnetic bubbles and floppy disk drives, if it ever occurs, will probably be timed for late in this decade. In the meantime, relatively peaceful coexistence is predicted, with the supposed competitors expected to be frequently paired on the same systems.

* Small rigid disk drives: It is an absolute certainty that the new generations of small fixed and fixed/removable disk drives will displace a large number of flexible disk drives. Most of these small rigid disks are well suited to occupy the same physical space as equivalent floppy drives, either 8 or 5.25 inch, yet provide higher capacities and faster access.

  The probable effect will be to displace the first floppy drive in many two-floppy drive systems. The second floppy drive will remain in many systems to perform the usual backup, program distribution and interchange functions.

  It is believed that the total number of small systems using the new small rigid disks during the next few years will be very large. It must be remembered, however, that the total floppy drive industry is growing at a startling rate, with a total shipment level many times the amount of any potential displacement by small rigid disk drives. Thus, the total effect of these new drives on the floppy drive indus-

try is not expected to cause any major disruption in the growth rate and will be scarcely noticed by most floppy drive manufacturers.

* Tape drives: 1/4" tape cartridge drives and digital cassette drives have been in general use as long as floppies have, but at much lower total production levels, with a narrower range of applications. The key disadvantage compared to floppies has been lack of direct access to individual records, plus generally higher prices for the 1/4" cartridge drives.

  However, the use of small, low cost fixed disk drives is creating a backup requirement on many systems that flexible disk drives are prepared to satisfy only in a limited way. The problem for floppies is one of inadequate capacity to hold the contents of rigid disks on a single floppy media unit. There usually isn't any problem when systems have the capability to back up rigid disks selectively, so that the backup requirement can be limited to individual files and/or the data revised since the last backup cycle. However, the majority of small systems lack selective backup capability, and the entire rigid disk must periodically be backed up to protect valuable files.

  The larger capacity of some 1/4" tape cartridge drives (up to 20 MB, at OEM prices comparable to floppy drives) has created a new area of competition with floppy drives for backup of small rigid disks. At this time, the tape cartridge drives appear to have a clear functional advantage in backing up the low capacity 5.25 fixed disk drives announced to date, due to size, price and similar controller requirements. But floppies and 1/4" tape cartridges will have to fight it out in the mid-range.

Floppy drive enhancements

It is possible that the new developments in flexible disk drives may come from technical approaches completely different from today's commercial products, as well as in evolutionary improvements to established drive configurations. Here are the areas to watch:

* Double bit density: IBM introduced its recording scheme for double linear density in late 1977, and it is now the defacto standard for the industry. The industry trend is now strongly toward use of OEM drives using this standard, and the industry has seen considerable activity in controller design intended to use the IBM standard, including single chip controllers.

The next question is whether the industry will attempt to double the linear density again with oxide coated floppy media. And the answer seems to be that the drive manufacturers are dissatisfied with the quality of the very thin coatings which would have to be used to achieve adequate resolution for the high recording densities required. Combined with the technical problem is the fact that there is no industry standard for the media or recording method -- and the conclusion is a low probability that there will be a doubling of capacity with oxide media.

The more likely prospect is introduction of a diskette coated with a magnetic material capable of the resolution and higher coercivity needed for operation at 10,000 to 15,000 BPI. A possibility is the use of chromium dioxide, believed to be used by IBM in the "Bright" project, currently under development. The Bright drive could have a capacity of 3-5 MB, and be producible at costs similar to today's 8 inch, two sided drives, if increases in track density are held to modest levels.

* Double track density: Most of today's floppy drives use an "open loop" head positioning system, in which a stepping motor positions heads to predetermined locations without using prerecorded information on the media to achieve precise positioning. The industry has probably reached the effective limits of this method, however, at 96 TPI for 5.25 inch floppy media and a lower limit for 8 inch diskettes. The difficulty is that changes in temperature and humidity cause dimensional changes in the floppy media plastic substrate, to the extent that a method for correcting the head position to the actual track location is needed at higher TPI.

  Several flexible disk drive manufacturers have been developing "closed loop" head positioning systems intended to operate at significantly higher TPI, and Burroughs introduced such a drive in 1980. It is expected that such drives would inevitably have a much higher cost than today's floppy drives, and probably should be thought of primarily as competitors in the market now being developed by low end fixed rigid disk drives, and as backup devices.

* Two sided drives: The industry has had a painful experience in taming the two sided drive to the extent that adequate reliability is provided and manufacturing costs are tolerable. Although many changes in hardware and media have been made by most drive manufacturers, the biggest controversy has involved recording heads. The "IBM style" involves simultaneous loading and retracting of the heads on both sides of the diskette. The "Tandon style" uses one static head, while the other head loads and retracts. These two types, plus some variations, are in use by various drive manufacturers, with varying success in achieving quantity production.

At this time the Tandon style is used in a majority of 8 inch drives shipped and in most of the 5.25 inch drives.

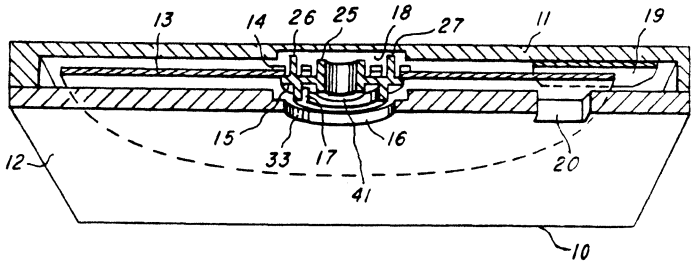
* Revolutionary changes: It is expected that smaller, larger, faster and cheaper flexible disk drives will be produced -- but the real questions involve when, and by whom? Any system OEM with an adequate market for the firm's systems could conceivably develop and introduce a specialized floppy drive with the expectation that the program could be justified by a captive system requirement. It is a different matter, however, for OEM drives, and the industry's penchant for media standardization and hardware second sourcing have stacked the cards against most introductions by anything less than IBM. Some of the possibilities are:

  (1) A smaller floppy drive. A likely product would be something like the IBM "Spark" project, involving a 3-5 inch floppy with capacity of about 125 kilobytes. Such a product would be smaller and cheaper than the 5.25 inch, one side drive, and would divert business from that format when OEM versions became available. Spark has obvious application in the intelligent typewriter and personal computer markets, but the IBM introduction may not come until 1983.

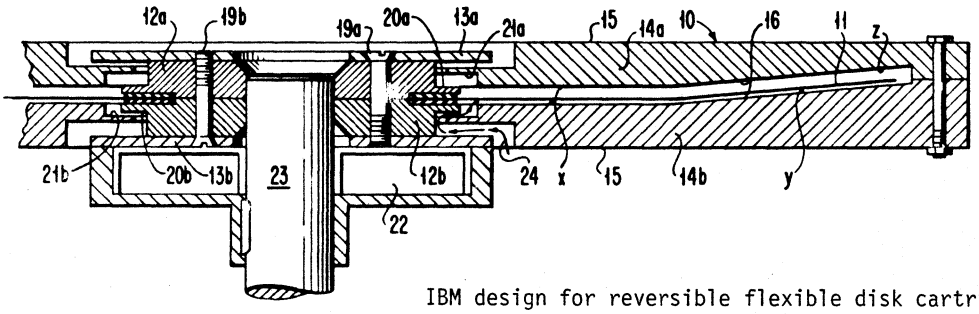
  (2) Faster, larger floppy drives. It is possible that flexible disks may be used in high performance disk drives offering access times and capacities comparable to many rigid disk drives. Both IBM and Texas Instruments have been issued patents covering disk cartridges and methods for guiding flexible disks in non-planar revolving patterns to obtain a relatively non-flexible shape for the disk while revolving. IBM has had several projects in the area, under a variety of names: "Sprat", "Bluegill", "Sonora" and "Sabino". These projects have involved flexible disks in the 6 to 8 inch range, using rigid plastic cartridges in which the flexible disks spin at speeds adequate to support flying heads. The transfer rates are in the normal rigid disk drive range, and capacities vary from 4.5 to 15 MB. At this time, an early introduction for any of these IBM projects does not seem likely. Meanwhile, a new firm, Iomega Corporation, has been formed by some of the veterans from the IBM programs, and plans to introduce a drive in 1981 using comparable technology, offering performance and capacity similar to the small fixed rigid disk drives now being introduced.

Figure 5

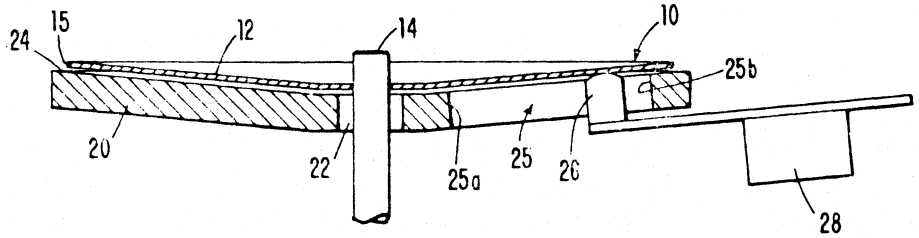
ILLUSTRATIONS FROM SELECTED PATENTS



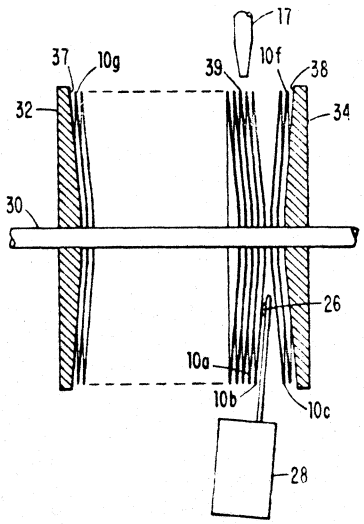
Texas Instruments design for flexible disk cartridge
U.S. PATENT 4,175,274 November 20, 1979



IBM design for reversible flexible disk cartridge
U.S. PATENT 4,159,494 June 26, 1979



IBM design for single flexible disk and stack of flexible disks in frusto-conical configuration
U.S. PATENT 4,208,683 June 17, 1980



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 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 the OEM market class 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, Burroughs or Olivetti 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 by any disk drive manufacturer, except that sales or leases of internally manufactured drives by computer manufacturers or system OEMs primarily for use with their own systems are excluded. All OEM shipments are included in the non-captive category. Examples:

* Shipments by Pertec or Caldisk are non-captive, except for drives sold with systems by parent companies or subsidiaries.

* CDC 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; to be included in this category, drives must be supplied in plug compatible configurations for installation with systems sold by other manufacturers. Although the PCM category currently consists primarily of drives intended for use with IBM systems, such as Series/1, it may include any drives which are suitably equipped to be connected without additional hardware to systems of all types, including minicomputers and small business systems.

OEM: Floppy 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: 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 shipment totals.

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

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

U.S./non-U.S. manufacturers: Manufacturers are classified U.S. or non-U.S., depending on the location of the firm's headquarters, regardless of the location of individual manufacturing plants. Examples:

* IBM, MFE and Burroughs are considered U.S. manufacturers, even though each firm manufactures some of its disk drives in non-U.S. locations.

* Siemens, which manufactures flexible disk drives in California and Mexico, is considered a non-U.S. manufacturer. Siemens acquired General Systems International's flexible disk product line in early 1978 and the Wangco flexible disk product line in early 1979; shipments before the Siemens acquisitions are classified as originating from U.S. manufacturers.

* BASF is considered a non-U.S. manufacturer, although the firm manufactures flexible disk drives in the U.S. as well as in Germany.

Revenue: Based on sale of disk drives alone, as normally sold by individual manufacturers, without auxiliary hardware or spare parts. When sold as an integral part of a system or subsystem, the value of the disk drive alone has been estimated for DISK/TREND purposes. Sale prices are actual public sale transaction prices, whether at captive end user, PCM, or OEM levels. All projected prices are in 1980 constant dollars.

Spindles: The basic unit used in counting disk drives. One spindle consists of the disk drive mechanism required to utilize a single disk or stack of disks operated as a unit, whether disks are fixed, completely removable, or a combination of fixed and removable. All DISK/TREND unit

totals are counted in spindles, even though some drive configurations include more than one spindle. On an arbitrary basis, drives which utilize a single actuator mechanism to control head movement on two separate flexible disks are counted as two spindles.

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 and revised encoding schemes are anticipated in DISK/TREND forecasts.

* Innovations such as two sided recording, 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 manufacturers of medium and large scale computers. 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 or Data General, etc., and the emerging manufacturers of microprocessor-based systems, such as Intel and National Semiconductor.

System OEMs/system houses: (1) OEMs which manufacture a system requiring floppy drives, such as Apple, Vydec or Tektronix. (2) Systems houses, of any size, which combine finished components and custom software to offer complete systems to end users.

Independent peripherals suppliers: Specialized manufacturers which buy drives, add controllers, interfaces, power supplies and other equipment or software, and offer complete subsystems to end users, system OEMs and system houses. Examples are Data Systems Design and Advanced Electronic Design.

Distributors, dealers, end users: (1) Distributors which perform the classic wholesaler function, such as Hamilton Avnet. (2) Dealers which act as local trading area outlets, frequently with stores suitable for walk-in trade, such as Byte shops, Computerland stores and Tandy's Radio Shack stores. (3) Direct sales to end users, usually of plug compatible drives, by the disk drive manufacturer.

FLEXIBLE DISK DRIVES, 8 INCH, ONE SIDE

1980 DISK/TREND REPORT

FLEXIBLE DISK DRIVES, 8 INCH, ONE SIDE

Coverage

Examples of flexible disk drives in this group include:

IBM	3740, System 32/34
Caldisk	142M, 142M1
Control Data	9404, 9404B
Datapoint	9381
Data Recording Equipment	7100
Decitek	DF-8000/S
Digital Equipment	RX01, RX02
Hitachi	FDD 101A
Innotronics	410, 420
Isotimpex	ES 5074
Logabax	LX45D
Matsushita	JK-880
Memorex	651, 550
MERA/Metronex	PLX45D
MFE	500
Micro Peripherals	41
Mitsubishi	M 892
Northern Telecom	4505
Olivetti	FDU 6102
Per Sci	277
Pertec	FD 410, FD 510
Remex	RFD 2000
Ricoh	RD-2
Shugart Associates	SA 800
Siemens	FDD 100-8
Sykes Datatronics	7150, 9150
Toshiba	ND-10S
Videoton	MFM-2
YE Data	YD-74C

This category includes all drives designed to use single sided flexible disks of nominal 8 inch diameter, including both "soft sector" and "hard sector" drives. Most soft sector drives are designed to use IBM compatible media, with a single index hole. Hard sector drives use additional holes in the disks to identify sectors and include both the Memorex 651 format and the more widely used Shugart formats.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1979	1980	1981	1982	1983
U.S. manufacturers	288.8	306.8	310.2	290.3	243.4
All manufacturers	408.6	431.7	426.5	384.3	310.4

Worldwide shipments of 8 inch, one side drives continued to increase in 1979, but at a slower rate than in previous years. The trend is continuing in 1980, with expected worldwide shipments of 743,800 units, representing only a 16.6% annual increase. Growth in revenues is falling off even faster, due to the continuing decline in average selling prices.

The current DISK/TREND 1979 and 1980 estimates for this product group are lower than the projections used in last year's report. The major difference is in shipment levels for OEM drives, which have been impacted by increased usage of two sided drives by system OEMs. DISK/TREND estimates for IBM shipments have been adjusted upward, based on a reevaluation of IBM floppy drives used with all systems.

In 1979, small business systems continued as the largest application area for 8 inch, one side drives, with 34% of worldwide shipments. Word processing was also a major application area, with 30.3% of worldwide shipments. Many word processing OEMs with large customer bases already using 8 inch, one sided drives have found it impractical to switch to 5.25 inch drives because of existing customer diskette libraries, and the overall growth of word processing has meant increased shipments for 8 inch, one side drives.

Shugart Associates increased its share of the non-captive market in 1979, with 56.5% of worldwide shipments -- a total of 252,500 drives.

Shugart's increased strength in this product group is probably due, ironically, to the firm's well publicized problems with two sided drives. During this period, the aggressive Shugart marketing organization found it necessary to continue emphasis on 8 inch, one side drives, rather than push two sided drives it could not deliver in adequate quantities. Control Data increased its share slightly, but most other manufacturers finished 1979 with slightly smaller market shares.

Marketing trends

8 inch, one side drives are now expected to reach their worldwide production peak in 1981, about a year later than previously forecasted. The current growth is caused by industry problems in achieving adequate production of two sided drives, but that factor is steadily disappearing as shipment levels of two sided drives continually build up to significant quantities. The DISK/TREND projection for 1981 shows a slight increase of worldwide shipments, amounting to only 1.1%, with pronounced declines for 1982 and 1983.

However, OEM shipments of drives in this group are expected to decline starting in 1981, with a 2.4% drop, to 521,300 units worldwide. Shipments of OEM drives are expected to decline more rapidly than those for the product group as a whole, as system OEMs buying drives from outside manufacturers turn more rapidly to two sided drives than system manufacturers with investments in captive one side drive programs.

Although non-U.S. captive drive manufacturers are switching to two sided drives faster than their U.S. counterparts, U.S. captive shipments of 8 inch, one side drives are also expected to decline after 1982.

The exception is IBM, which continues to use one side drives on a wide variety of terminals and word processing systems. IBM uses one side drives on the Displaywriter, a low cost standalone display-based word processing system announced in 1980, plus the existing 3730 and Office System/6 word processing systems.

The tug of war between experience curve reductions in price and the effects of inflation will continue. Partially due to the maturing condition of this product group, the DISK/TREND estimate of future declines in OEM average prices has been tempered slightly. OEM prices for the group now appear to be dropping about 6% with each doubling of cumulative industry shipments. Lack of rapid growth and inflationary pressure on most mechanical and electronic components purchased by drive manufacturers, has permanently changed the pricing curve for this product group.

Future OEM market positions probably won't change during the next few years, at least for the leaders. Shugart Associates' share is likely to remain at about half the worldwide OEM market, and Control Data's share will probably stay at about one tenth of the total. Market shares held by others may shift somewhat, since the smaller shipment levels involved are sensitive to changes in buying patterns by single system OEMs.

Technical trends

New technology under development by flexible disk drive manufacturers will probably not be introduced initially in this product group. Higher track density, faster head positioning mechanisms and improved media are expected to be used first on two sided drives. However, it is always

possible that the benefits of some of these expected improvements may later show up in this product group, as manufacturers strive for commonality in parts and subassemblies.

In the meantime, the trend to operation of drives in this group at double density continues, aided by availability of single chip controllers from several sources. Most OEM drives have been capable of either standard or double density operation for several years, and low cost controllers have been the key to cheap capacity increases by numerous OEMs. It is probable that this phenomenon has somewhat reduced the pressure to convert to two sided drives that would have been faced by many OEMs.

Forecasting trends

1. IBM usage of one side drives in new systems will be limited to selected terminals and word processing equipment.

2. Availability and perceived reliability of two sided drives will be adequate to insure their use on most capacity sensitive systems designed during 1981 and later.

3. 8 inch, one side drives will remain in wide usage for several application areas, including data entry and various other devices requiring media interchange in the IBM format.

4. Existing applications for 8 inch, one side drives in word processing systems will be partially replaced by 5.25 inch floppy drives and small rigid disk drives within the next few years.

TABLE 8

FLEXIBLE DISK DRIVES, 8 INCH, ONE SIDE

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	59.2	88.2	52.1	77.3	61.0	89.1	65.1	94.5	64.8	93.6
Other U.S. Captive	63.4	91.1	76.6	109.0	73.3	106.2	67.6	99.4	54.3	81.1
TOTAL U.S. CAPTIVE	122.6	179.3	128.7	186.3	134.3	195.3	132.7	193.9	119.1	174.7
PCM	--	--	--	--	--	--	--	--	--	--
OEM	86.4	109.5	96.7	120.5	92.0	114.9	76.8	96.4	54.6	68.7
TOTAL U.S. NON-CAPTIVE	86.4	109.5	96.7	120.5	92.0	114.9	76.8	96.4	54.6	68.7
TOTAL U.S. SHIPMENTS	209.0	288.8	225.4	306.8	226.3	310.2	209.5	290.3	173.7	243.4
Non-U.S. Manufacturers										
Captive	8.7	82.4	6.2	73.6	6.7	67.7	5.7	52.4	4.3	36.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	5.1	37.4	15.2	51.3	6.8	48.6	6.2	41.6	4.9	31.0
TOTAL NON-U.S. SHIPMENTS	13.8	119.8	21.4	124.9	13.5	116.3	11.9	94.0	9.2	67.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	222.8	408.6	246.8	431.7	239.8	426.5	221.4	384.3	182.9	310.4
OEM Average Price ($000)	.315	.329	.311	.322	.299	.314	.294	.308	.291	.305

TABLE 9

FLEXIBLE DISK DRIVES, 8 INCH, ONE SIDE

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	29.6	44.1	27.4	40.7	33.9	49.5	38.3	55.6	40.5	58.5
Other U.S. Captive	60.9	87.5	79.0	112.4	86.2	124.9	84.5	124.3	72.4	108.1
TOTAL U.S. CAPTIVE	90.5	131.6	106.4	153.1	120.1	174.4	122.8	179.9	112.9	166.6
PCM	--	--	--	--	--	--	--	--	--	--
OEM	277.4	351.6	320.0	398.9	311.7	389.6	264.8	332.3	190.4	239.5
TOTAL U.S. NON-CAPTIVE	277.4	351.6	320.0	398.9	311.7	389.6	264.8	332.3	190.4	239.5
TOTAL U.S. SHIPMENTS	367.9	483.2	426.4	552.0	431.8	564.0	387.6	512.2	303.3	406.1
Non-U.S. Manufacturers										
Captive	6.2	59.0	4.8	56.6	5.6	56.4	5.2	47.6	4.3	36.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	13.0	95.5	40.0	135.2	18.4	131.7	17.3	115.5	14.0	87.7
TOTAL NON-U.S. SHIPMENTS	19.2	154.5	44.8	191.8	24.0	188.1	22.5	163.1	18.3	123.7
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	387.1	637.7	471.2	743.8	455.8	752.1	410.1	675.3	321.6	529.8
Installed at Year End										
IBM	191.2	257.6	218.6	298.3	252.5	347.8	290.8	403.4	331.3	461.9
Non-IBM	937.6	1,630.2	1,381.4	2,333.3	1,803.3	3,035.9	2,175.1	3,655.6	2,456.2	4,126.9
WORLDWIDE TOTAL	1,128.8	1,887.8	1,600.0	2,631.6	2,055.8	3,383.7	2,465.9	4,059.0	2,787.5	4,588.8

TABLE 10

FLEXIBLE DISK DRIVES, 8 INCH, ONE SIDE

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	10.5	3.6	3.2	2.9	2.6	2.4
Mini/micro computer manufacturers	37.9	13.1	12.8	12.6	12.3	12.1
System OEMs/systems houses	206.9	71.2	70.5	69.5	68.4	67.0
Independent peripherals suppliers	21.3	7.3	8.2	9.2	10.3	11.5
Distributors, dealers, end users	13.9	4.8	5.3	5.8	6.4	7.0
TOTAL	290.4					

TABLE 11

FLEXIBLE DISK DRIVES, 8 INCH, ONE SIDE

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1979 Net Shipments To United States Destinations Units (000)	%	Worldwide Units (000)	%
Shugart Associates	214.6	73.9	252.5	56.5
Control Data	18.8	6.5	47.0	10.5
BASF	--	--	25.0	5.6
Memorex	21.6	7.4	24.0	5.3
Siemens	13.0	4.5	13.0	2.9
Caldisk	8.5	2.9	12.5	2.8
Toshiba	--	--	12.0	2.7
Mitsubishi	--	--	10.5	2.3
Hitachi	--	--	9.7	2.2
PerSci	6.8	2.3	8.0	1.8
Matsushita	--	--	8.0	1.8
YE Data	--	--	8.0	1.8
Other U.S.	7.1	2.5	7.6	1.7
Other Non-U.S.	--	--	9.3	2.1
	290.4	100.0	447.1	100.0

FLEXIBLE DISK DRIVES, 8 INCH, TWO SIDES

1980 DISK/TREND REPORT

FLEXIBLE DISK DRIVES, 8 INCH, TWO SIDES

Coverage

Examples of flexible disk drives in this group include:

IBM	4964, 4966, Series/34, 5120
BASF	6104
Burroughs	9489-11, 9489-21, MD 122
Caldisk	143M, 145M
Control Data	9406-1, 210-10
Data Recording Equipment	7200
Decitek	DF-8002/S
Hitachi	201, 401, 403
Matsushita	JK-885
MFE	700
Micro Peripherals	42
Mitsubishi	M 2893, M 2894
Nippon Electric Company	N7707, FD1160
Per Sci	299
Pertec	FD 650
Qume	Datatrak 8
Remex	RFD 4000
Ricoh	RD-2D
Shugart Associates	SA 850
Siemens	FD 200-8
TEAC	FD-100
Toshiba	ND-20A
YE Data	YD-174

Drives in this group include both soft and hard sectored versions. With one exception, all soft sectored drives in the group are designed to use IBM's recording formats for two sided flexible disks -- either Diskette 2 for standard density or Diskette 2D for double density. IBM's diskette magazine drive is also included in the group. The Burroughs drives use completely different recording formats, with the newest drive offering 3 MB per diskette.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1979	1980	1981	1982	1983
U.S. manufacturers	222.9	375.5	534.5	774.4	1,022.3
All manufacturers	289.1	512.2	739.7	1,075.1	1,429.0

Worldwide shipments of 8 inch, two sided drives are now growing rapidly, despite extensive negative coverage in the trade press and lingering technical problems experienced by several drive manufacturers. 1979 shipments reached 218,500 drives, and 1980 shipments are projected at 472,600, an increase of 116.3%.

1979 worldwide OEM shipments of drives in this product group fell short of last year's DISK/TREND projection by 27.3%, but the 107,500 net units shipped represented an increase of 245.7% over the previous year. The industry's technical problems still persisted for most manufacturers in 1979, but hardware reliability had given way to hardware producibility as the number one problem. Most manufacturers made extensive changes in product design and manufacturing methods in order to make possible high volume production at acceptable costs. The impact of these changes on shipments for 1980 has been dramatic, with worldwide OEM shipments expected to reach 292,200 drives.

DISK/TREND estimates of IBM shipments are now significantly higher than in previous years, due to an extensive reevaluation of IBM usage of flexible disk drives with all systems. IBM shipments of drives in this group are projected at 106,200 units in 1980. Shipments by other manufacturers of captive flexible disk drives are substantially in accordance with last year's DISK/TREND Report, with 1980 totals rising

to 25,900 for U.S. manufacturers and 47,900 for non-U.S. manufacturers. The higher comparative level for non-U.S. manufacturers is attributed to early emphasis on two sided drives by Japanese manufacturers.

Although Shugart Associates held the lead in non-captive drive shipments in this product group for 1979, the lead was a narrow one. The Shugart share of worldwide shipments at 18.1% was closely followed by YE Data with 15.5%, and by Control Data, Qume and Remex -- all of whom had over 9%.

Marketing trends

Despite its shaky start, this product group is now headed for several years of sharp increases in worldwide production. Average annual growth in worldwide unit shipments for the years 1979 through 1983 is expected to be 68.5%, with 1983 shipments reaching 1,675,300. In 1983, worldwide total revenues for the product group are projected at $1,429,000,000.

Worldwide OEM drive shipments are expected to exceed captive shipments for the first time in 1980, and this ratio is destined to grow to a dominant 68.5% for OEM drives in 1983. As with captive drives, the dynamic market for small business systems is forcing the rapid growth in shipments of OEM 8 inch, two sided drives. By 1983, 71.3% of floppy drives in this product group are expected to be used in small business systems, traditionally the most capacity-hungry floppy disk application area.

IBM's reliance on 8 inch, two sided drives is expected to continue through 1983. Among the significant new IBM systems shipped for the first time in 1980 using 8 inch, two sided floppy drives are the 5120

desktop computer, 5280 terminal system, 5520 administrative system and the delayed System/38. These applications, plus others to come, are expected to boost IBM's shipments to 241,000 units in 1983. Worldwide shipments by other captive manufacturers will increase at a faster rate than IBM's, finally exceeding IBM's annual total in 1983, at 283,100 drives. Non-U.S. manufacturers are expected to account for 60% of the other captive total.

Plug compatible shipments of drives in this group are expected to remain minor, with most PCM floppy drives actually included as part of subsystems with rigid disk drives.

The battle for OEM market shares will be heated as shipments grow during the next few years, with the key variable probably being the ability to ship reliable drives in adequate quantity. Shugart Associates' delay in reaching high volume production levels has provided an opportunity for several manufacturers to seize important shares of the U.S. market, particularly Control Data, Qume and Remex. It is unlikely that Shugart will be able to achieve the same type of dominance it holds with one side drives, even when production capacity becomes available.

Due to the manufacturers' belated recognition of actual production costs, average OEM prices are expected to display a rather gentle slide, at about the same 6% decline with each doubling of cumulative shipments that 8 inch, one side drives are showing.

Technical trends

It is clear that drives with higher capacities will be a significant part of this product group by 1983, but the specific technology to be

used will probably depend on IBM's actions. The IBM project considered most likely to have a major impact on the industry, if introduced, is the "Bright" program, a 3-5 MB 8 inch, two sided drive using a special chromium dioxide coated diskette. It is believed that Bright drives could be produced at a very small cost premium over today's drives. Another family of high performance flexible disk drives, using flying heads and disks in rigid cartridges, has been under development with project names such as "Sprat", "Bluegill", "Sonora" and "Sabino". These drives would have capacities from 4.5 MB to 15 MB, with access times, transfer rates and -- probably -- prices similar to those for rigid disks.

Several manufacturers of OEM drives stand ready to announce floppy drives in the 3 to 5 MB range, but are reluctant to act, lest IBM announce one of its development projects in an actual system. Such an introduction would set another defacto industry standard, and would likely cause any independent program to be aborted. In the meantime, the Burroughs 3 MB floppy drive (6 MB dual) is apparently headed for extensive use on Burroughs own small systems, but will probably attract a negligible OEM following.

Forecasting assumptions

1. Technical difficulties with two sided drives will continue to decline in importance as an inhibitor to market acceptance and as a problem in achieving high production levels.

2. Introduction of higher capacity flexible disk drives will not impact shipments of existing drives through at least 1982.

3. OEM average selling prices, which held a 49% differential above one sided drive prices in 1980, will decline to a 38% differential in 1983.

TABLE 12

FLEXIBLE DISK DRIVES, 8 INCH, TWO SIDES

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	113.1	165.9	163.7	233.6	212.7	302.4	282.2	403.2	337.4	482.0
Other U.S. Captive	17.1	27.5	28.5	42.4	48.8	75.0	73.8	117.1	104.3	170.9
TOTAL U.S. CAPTIVE	130.2	193.4	192.2	276.0	261.5	377.4	356.0	520.3	441.7	652.9
PCM	.1	.1	.6	.6	1.6	2.0	2.2	3.3	3.5	5.5
OEM	22.8	29.4	76.8	98.9	119.4	155.1	190.6	250.8	273.0	363.9
TOTAL U.S. NON-CAPTIVE	22.9	29.5	77.4	99.5	121.0	157.1	192.8	254.1	276.5	369.4
TOTAL U.S. SHIPMENTS	153.1	222.9	269.6	375.5	382.5	534.5	548.8	774.4	718.2	1,022.3
Non-U.S. Manufacturers										
Captive	.2	44.6	3.8	100.6	15.6	152.8	23.6	225.2	32.6	304.6
PCM	--	--	--	--	--	--	--	--	--	--
OEM	5.7	21.6	3.6	36.1	6.8	52.4	12.8	75.5	20.4	102.1
TOTAL NON-U.S. SHIPMENTS	5.9	66.2	7.4	136.7	22.4	205.2	36.4	300.7	53.0	406.7
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	159.0	289.1	277.0	512.2	404.9	739.7	585.2	1,075.1	771.2	1,429.0
OEM Average Price ($000)	.455	.474	.452	.462	.431	.443	.412	.421	.399	.406

TABLE 13

FLEXIBLE DISK DRIVES, 8 INCH, TWO SIDES

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	51.4	75.4	74.4	106.2	101.3	144.0	134.4	192.0	168.7	241.0
Other U.S. Captive	9.5	15.3	17.4	25.9	28.7	44.1	46.1	73.2	69.5	113.9
TOTAL U.S. CAPTIVE	60.9	90.7	91.8	132.1	130.0	188.1	180.5	265.2	238.2	354.9
PCM	.1	.1	.4	.4	1.2	1.5	1.7	2.5	2.8	4.4
OEM	51.9	66.8	170.9	220.0	279.0	362.3	466.0	613.2	689.3	919.0
TOTAL U.S. NON-CAPTIVE	52.0	66.9	171.3	220.4	280.2	363.8	467.7	615.7	692.1	923.4
TOTAL U.S. SHIPMENTS	112.9	157.6	263.1	352.5	410.2	551.9	648.2	880.9	930.3	1,278.3
Non-U.S. Manufacturers										
Captive	.1	20.2	1.8	47.9	7.8	76.4	12.4	118.5	18.1	169.2
PCM	--	--	--	--	--	--	--	--	--	--
OEM	10.8	40.7	7.1	72.2	13.9	106.5	27.5	162.0	45.6	227.8
TOTAL NON-U.S. SHIPMENTS	10.9	60.9	8.9	120.1	21.7	182.9	39.9	280.5	63.7	397.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	123.8	218.5	272.0	472.6	431.9	734.8	688.1	1,161.4	994.0	1,675.3
Installed at Year End										
IBM	81.8	120.0	156.2	226.2	257.5	370.2	391.9	562.2	560.6	803.2
Non-IBM	95.0	196.1	292.6	562.5	623.2	1,153.3	1,176.9	2,122.7	2,002.2	3,557.0
WORLDWIDE TOTAL	176.8	316.1	448.8	788.7	880.7	1,523.5	1,568.8	2,684.9	2,562.8	4,360.2

TABLE 14

FLEXIBLE DISK DRIVES, 8 INCH, TWO SIDES

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	4.6	7.3	7.7	8.1	8.5	8.9
Mini/micro computer manufacturers	16.6	26.4	26.5	26.1	25.5	24.9
System OEMs/systems houses	34.8	55.4	53.6	52.2	50.7	49.0
Independent peripherals suppliers	4.3	6.9	7.8	8.8	10.0	11.3
Distributors, dealers, end users	2.5	4.0	4.4	4.8	5.3	5.9
TOTAL	62.8					

TABLE 15

FLEXIBLE DISK DRIVES, 8 INCH, TWO SIDES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1979 Net Shipments To United States Destinations Units (000)	%	Worldwide Units (000)	%
Shugart Associates	16.6	26.4	19.5	18.1
YE Data	8.8	14.0	16.7	15.5
Control Data	5.6	8.9	13.9	12.9
Qume	10.9	17.4	10.9	10.1
Remex	9.0	14.3	10.0	9.3
Hitachi	--	--	8.5	7.9
MFE	5.0	8.0	6.3	5.9
Matsushita	--	--	4.9	4.6
Mitsubishi	--	--	3.7	3.4
Other U.S.	4.9	7.8	6.3	5.9
Other Non-U.S.	2.0	3.2	6.9	6.4
	62.8	100.0	107.6	100.0

FLEXIBLE DISK DRIVES, 5.25 INCH, ONE SIDE

1980 DISK/TREND REPORT

FLEXIBLE DISK DRIVES, 5.25 INCH, ONE SIDE

Coverage

Examples of flexible disk drives in this group include:

BASF	6106
Caldisk	14M1
Canon	MDD 6106
Control Data	9408
Datamaster	Megamaster 2
Isotimpex	Minifloppy
Matsushita	JK-874
Micro Peripherals	51, 91
Micropolis	1015-II, 1016-11
Olivetti	FD 501
Pertec	FD 200
Shugart Associates	SA 400, SA 410
Siemens	FDD 100-5
Tandon Magnetics	TM-100-1, TM-100-3
TEAC	FD-50A, FD-50E
T & E Engineering	A-40
Toshiba	ND-01

Shugart Associates established the basic standard for 5.25 inch, one side drives in 1976, with the SA 400, which originally was limited to 35 track operation at 48 TPI. Today, many manufacturers also offer 40 track 48 TPI drives in a variety of soft and hard sector configurations. Micropolis pioneered 100 TPI drives, starting in 1977, and has been joined during the last year by several manufacturers offering 96 TPI drives. In addition to Micropolis, Tandon Magnetics, Micro Peripherals, TEAC and Shugart Associates have announced 96 TPI drives, with other firms expected to make similar announcements by the end of 1980.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1979	1980	1981	1982	1983
U.S. manufacturers	61.3	72.1	100.8	132.0	160.0
All manufacturers	75.0	101.3	168.1	237.4	296.7

1980 has been the year in which the spectacular growth curve for 5.25 inch, one side drives was interrupted and in which major vertical integration programs started to change the OEM drive market permanently.

In 1979, total worldwide shipments grew to 426,400 drives, an increase of 234.2% over 1978. However, the DISK/TREND estimate for 1980 is 558,100 units, representing growth of only 30.9% over 1979. The severe fall off in growth rate was caused by procurement gyrations by manufacturers of desktop computers. During the first half of 1980, most major manufacturers of very small business systems and personal computers sharply reduced monthly purchases of 5.25 inch flexible disk drives.

Although the explanations are somewhat murky, it appears that system OEMs had been building production capacity and contracting for floppy drives at a more rapid rate than their markets were growing. And, of course, it is likely that the recession, although not seriously affecting most of the computer industry, eroded some of the foundation for the personal computer boom. The net effect on floppy drive shipments was a sudden correction between supply and demand, eliminating most of the growth in 5.25 inch, one side drives in the first half of 1980. However, recovery has been swift. Most manufacturers are already back to their earlier production levels, or higher.

In addition to the established Qyx internal manufacturing program, major captive production programs for drives in this product group are being developed in the United States and elsewhere. Tandy Corporation and Datapoint have formed a joint venture company named Texas Peripherals for the purpose of manufacturing flexible disk drives for both parent firms. The new firm will start manufacture during 1981 of the 5.25 inch drives Tandy now purchases from Tandon Magnetics (and previously purchased from Shugart Associates). Apple has an unannounced program to manufacture floppy drives and heads in California, also presumably starting in 1981. Non-U.S. captive production is expected from Canon, Matsushita, Toshiba and Olivetti.

Despite start-up of non-U.S. manufacturing programs in several countries, U.S. firms still are expected to produce 73.9% of worldwide shipments in 1980. When drives produced in the U.S. by non-U.S. firms are counted, 85.9% of the worldwide total for 1980 will have been manufactured in the United States.

Shugart Associates held 60.6% of worldwide OEM shipments in 1979, with a startling 256,000 drives. Micropolis, Micro Peripherals and Siemens were in a dead heat for second place, with 30,000 drives each, for individual shares of 7.1%. BASF, Tandon Magnetics and Pertec were close behind, all with over 18,000 units.

Marketing trends

Shipments in this product group are expected to reestablish an aggressive growth pattern in 1981, before settling into somewhat slower annual growth by 1983. 1981 worldwide shipments are projected at 811,900 drives, growing to 1,320,100 in 1983.

Captive production will rise rapidly in 1981, driven by the Tandy and Apple system requirements. The current DISK/TREND estimates for U.S. captive shipments are regarded as conservative, with the actual number dependent upon manufacturers' strategies which are not yet clear.

The OEM market is expected to remain predominant. However, the annual growth rate for U.S. manufacturers of OEM drives is expected to drop from 1981's 28.0% to 8.9% in 1983 -- due to the development of U.S. captive manufacturing programs and competition from non-U.S. manufacturers for the OEM market. In contrast, the average annual growth rate projected for non-U.S. manufacturers of OEM drives in the years from 1981 through 1983 is 48%.

The Shugart Associates dominant position in worldwide OEM shipments is secure for now, but Micro Peripherals, Tandon Magnetics, Siemens, Micropolis, BASF and TEAC have all established large-scale production of 5.25 inch, one side drives. OEM average prices are destined to continue their decline, making drives in this group even more attractive to the low end applications in which they are widely used.

Technical trends

The major innovation in 5.25 inch drives for 1980 is the industry standardization of 96 TPI units, legitimatizing what users of Micropolis drives (at basically the same TPI) already know: They work. It is estimated that the proportion of one side 5.25 inch drives with 96 TPI capability will be low, however, as the emphasis in this product group will stay with low price, not added capacity. (See page DT13-5 for more detail on 96 TPI projections.)

The appetite by personal computer system manufacturers for the lowest possible disk drive price has led to unofficial release by Shugart Associates of evaluation units of the "SA 200" 5.25 inch drive. A joint project of Shugart and Matsushita, the SA 200 was designed to be the ultimate low cost 5.25 inch floppy drive. This drive is now being re-designed to incorporate some of the suggestions made by prospective OEM customers.

The lowest cost random access floppy drives will probably be introduced eventually, in sizes smaller than 5.25 inch diameter. A possible candidate is the IBM "Spark" project, which is intended to result in a 3-5 inch floppy with recording densities similar to today's standard floppy densities. Although not scheduled for introduction within the next two years, the prospective IBM drive could set an industry standard which would have wide applicability wherever low price and small size are the prime requirements -- such as in personal computer and smart typewriter applications. If actually introduced, the Spark drive and its OEM equivalents to follow, would seriously impact the existing market for 48 TPI, 5.25 inch, one side floppy drives.

Forecasting assumptions

1. Introduction of a smaller floppy format by a major industry manufacturer will not occur before 1983.

2. 5.25 inch, one side drives will continue to be the dominant choice for floppy applications sensitive to cost and physical size requirements, but will be displaced in most applications also requiring larger capacity by two sided 5.25 inch drives.

3. Additional manufacturers, both captive and OEM, will produce drives in this group in 1981.

TABLE 16

FLEXIBLE DISK DRIVES, 5.25 INCH, ONE SIDE

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	3.2	3.2	5.6	6.3	17.7	21.8	34.4	44.7	48.0	67.5
TOTAL U.S. CAPTIVE	3.2	3.2	5.6	6.3	17.7	21.8	34.4	44.7	48.0	67.5
PCM	--	--	--	--	--	--	--	--	--	--
OEM	49.8	58.1	55.4	65.8	65.6	79.0	71.6	87.3	74.9	92.5
TOTAL U.S. NON-CAPTIVE	49.8	58.1	55.4	65.8	65.6	79.0	71.6	87.3	74.9	92.5
TOTAL U.S. SHIPMENTS	53.0	61.3	61.0	72.1	83.3	100.8	106.0	132.0	122.9	160.0
Non-U.S. Manufacturers										
Captive	--	--	--	1.4	.8	26.6	2.3	47.0	5.0	61.9
PCM	--	--	--	--	--	--	--	--	--	--
OEM	7.0	13.7	11.3	27.8	14.6	40.7	18.7	58.4	21.7	74.8
TOTAL NON-U.S. SHIPMENTS	7.0	13.7	11.3	29.2	15.4	67.3	21.0	105.4	26.7	136.7
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	60.0	75.0	72.3	101.3	98.7	168.1	127.0	237.4	149.6	296.7
OEM Average Price ($000)	.168	.170	.167	.171	.157	.161	.151	.155	.147	.151

TABLE 17

FLEXIBLE DISK DRIVES, 5.25 INCH, ONE SIDE

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	4.0	4.0	8.0	9.0	28.3	34.9	59.9	77.8	87.2	122.8
TOTAL U.S. CAPTIVE	4.0	4.0	8.0	9.0	28.3	34.9	59.9	77.8	87.2	122.8
PCM	--	--	--	--	--	--	--	--	--	--
OEM	303.2	354.0	339.9	403.5	428.6	516.4	487.2	594.1	524.0	646.9
TOTAL U.S. NON-CAPTIVE	303.2	354.0	339.9	403.5	428.6	516.4	487.2	594.1	524.0	646.9
TOTAL U.S. SHIPMENTS	307.2	358.0	347.9	412.5	456.9	551.3	547.1	671.9	611.2	769.7
Non-U.S. Manufacturers										
Captive	--	--	--	2.0	1.0	33.3	3.1	62.7	7.1	88.4
PCM	--	--	--	--	--	--	--	--	--	--
OEM	35.0	68.4	58.5	143.6	81.8	227.3	110.6	345.5	134.0	462.0
TOTAL NON-U.S. SHIPMENTS	35.0	68.4	58.5	145.6	82.8	260.6	113.7	408.2	141.1	550.4
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	342.2	426.4	406.4	558.1	539.7	811.9	660.8	1,080.1	752.3	1,320.1
Installed at Year End										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	482.0	583.1	888.4	1,141.2	1,428.1	1,953.1	2,088.9	3,033.2	2,841.2	4,353.3
WORLDWIDE TOTAL	482.0	583.1	888.4	1,141.2	1,428.1	1,953.1	2,088.9	3,033.2	2,841.2	4,353.3

TABLE 18

FLEXIBLE DISK DRIVES, 5.25 INCH, ONE SIDE

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	4.6	1.4	1.5	1.7	1.9	2.1
Mini/micro computer manufacturers	26.8	7.9	7.1	6.4	5.8	5.2
System OEMs/systems houses	280.3	82.9	83.7	84.2	84.5	84.7
Independent peripherals suppliers	19.2	5.7	5.3	4.9	4.6	4.3
Distributors, dealers, end users	7.3	2.1	2.4	2.8	3.2	3.7
TOTAL	338.2					

TABLE 19

FLEXIBLE DISK DRIVES, 5.25 INCH, ONE SIDE

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1979 Net Shipments To United States Destinations Units (000)	%	Worldwide Units (000)	%
Shugart Associates	230.4	68.1	256.0	60.6
Micropolis	21.0	6.2	30.0	7.1
Micro Peripherals	25.5	7.5	30.0	7.1
Siemens	30.0	8.9	30.0	7.1
BASF	5.0	1.5	25.0	5.9
Tandon Magnetics	20.0	5.9	20.0	4.7
Pertec	6.3	1.9	18.0	4.3
TEAC	--	--	10.0	2.4
Other Non-U.S.	--	--	3.4	.8
	338.2	100.0	422.4	100.0

FLEXIBLE DISK DRIVES, 5.25 INCH, TWO SIDES

1980 DISK/TREND REPORT

FLEXIBLE DISK DRIVES, 5.25 INCH, TWO SIDES

Coverage

Examples of flexible disk drives in this group include:

BASF	6108
Caldisk	14M
Canon	MDD 6108
Control Data	9409
Datamaster	Megamaster 4
Matsushita	JK-875
Micro Peripherals	52, 92
Micropolis	1015-IV, 1016-IV
Pertec	FD 250
Qume	Datatrak 5
Shugart Associates	SA 450, SA 460
Siemens	FDD 200-5
Tandon Magnetics	TM-100-2, TM-100-4
Toshiba	ND-02D
YE Data	YD-274

Flexible disk drives in this group are mostly two sided versions of one sided drives, and follow the same pattern of 35 or 40 tracks per surface. The exceptions are the Qume and YE Data drives, which are available in two sided versions only. In addition to the basic 48 TPI drives, 96 TPI drives are now being offered by Micropolis, Tandon Magnetics, Micro Peripherals and Shugart Associates. Several other drive manufacturers are expected to announce 96 TPI drives by the end of 1980.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1979	1980	1981	1982	1983
U.S. manufacturers	14.1	39.1	81.1	144.9	266.0
All manufacturers	17.4	57.6	127.4	244.2	474.1

After token shipments during 1978, this product group finally became established as an active segment of the flexible disk drive industry in 1979, with 70,600 drives shipped worldwide. 5.25 inch, two sided drives are now the fastest growing floppy drive product group, with 1980 worldwide shipments projected at 228,900 drives, up 224.2% over 1979.

So far, OEM drives constitute 100% of the 5.25 inch, two sided shipments. Numerous system OEMs active in the desktop computer area have responded quickly to the availability of more capacity in the same space occupied by 5.25 inch, one side drives. As usual, it is the systems oriented to business applications that are using the lion's share of two sided drives. Small business system applications consumed 41.6% of 1979 shipments. The same applications are destined to consume the major portion of 96 TPI drives, now becoming widely available.

Although Shugart Associates announced the first 5.25 inch, two sided drive in October, 1977, the firm elected to concentrate its efforts in solving two sided recording problems on 8 inch drives. As a result, quantity shipments by Shugart did not start until early 1980 -- and the industry leader provided an opportunity for others to seize major market share positions.

Tandon Magnetics had gambled on 5.25 inch, two sided drives in investing in tooling and facilities for its initial venture into flexible disk drive manufacturing, and the firm quickly moved to supply the latent demand left unsatisfied by Shugart's lack of deliveries. Tandon shipped 48,000 drives in 1979, to secure a 68.0% market share. YE Data and Micro Peripherals also achieved volume shipments in 1979, earning

early market penetration which will be difficult for competitors to lure away. The same firms appear to be holding their leading positions in 1980.

Marketing trends

The expected dynamic growth for this product group will be driven by small business systems and word processing applications. By 1983, small business systems will be using an estimated 47.8% of 5.25 inch, two sided drives, responding to the availability of 1 MB in the 5.25 inch form factor, made possible by the combination of 96 TPI and two sided recording. Word processing OEMs are expected to move to this product group more slowly, due to the existence of large customer diskette libraries in other formats, but by 1983 31.9% of the group's shipments are expected to be used in this application area.

Captive manufacturing programs will be underway in 1981 by both U.S. and non-U.S. firms, and worldwide captive shipments are projected at 199,200 drives in 1983. Like the DISK/TREND estimates for one sided 5.25 inch drives, the projections for this product group are regarded as conservative, with the possibility of substantially higher captive production levels dependent on strategy decisions not yet made by several major system manufacturers.

Worldwide OEM shipments are expected to grow at an average annual rate of 82.5% from 1981 through 1983, with 5.25 inch, two sided drives becoming the largest selling of all floppy drive groups in 1983, with 1,381,900 units worldwide. U.S. manufacturers held 84.3% of worldwide OEM shipments in 1979, but their share is expected to fall to 58.8%

by 1983. Underlying this drop is the anticipated heavy activity by Japanese OEMs in desktop business systems, plus the effect of non-U.S. firms introducing products in this group early in the product life cycle.

Manufacturers of OEM drives will lead the way into widespread use of 96 TPI, and the major usage of 96 TPI is expected to be with two sided 5.25 inch drives, rather than with the more price sensitive one side product group. Here is the DISK/TREND projection of 96 TPI OEM drive shipments for both one side and two sided 5.25 inch drives:

	1979	1980	1981	1982	1983
1 Side drives					
Percent 96 TPI	6.4%	7.2%	12.0%	18.0%	25.0%
Units (000)	27.0	39.4	89.2	169.1	277.2
2 Sided drives					
Percent 96 TPI	--	17.3%	32.0%	54.0%	82.0%
Units (000)	--	39.6	146.5	428.0	1,133.2

Technical trends

The appetite for more capacity in a small space is the key reason for existence of 5.25 inch, two sided flexible disk drives. The ability of 5.25 inch drives to successfully use 96 TPI, while open loop head postioning systems used with 8 inch drives fail to achieve adequate interchangability, is a capacity bonus unplanned by the original designers of the 5.25 inch format. But 96 TPI is the end of the line in track density improvements for 5.25 inch drives, if low cost open loop systems are used. Future capacity improvements will have to come from higher linear density, and it does not appear likely that existing oxide

coatings will be able to provide the qualities required for a doubling of linear density. It is considered possible that IBM may introduce an 8 inch floppy drive using a higher resolution magnetic particle, such as chromium dioxide -- but it is likely that at least two years would be required from IBM's announcement until OEM drives using new media in the 5.25 inch format could be available. Thus it now appears that drives in this group will be limited to the 1 MB capacity of two sided 96 TPI drives through 1982.

Forecasting assumptions

1. 5.25 inch, two sided drives will tend to be favored by system OEMs for applications sensitive to cost considerations and physical size requirements, but for which more than minimum capacity levels are required.

2. Several new OEM and captive 5.25 inch, two sided drives will be introduced during 1980 and 1981.

TABLE 20

FLEXIBLE DISK DRIVES, 5.25 INCH, TWO SIDES

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	--	--	--	--	8.6	9.5	29.6	34.8	78.3	97.8
TOTAL U.S. CAPTIVE	--	--	--	--	8.6	9.5	29.6	34.8	78.3	97.8
PCM	--	--	--	--	--	--	--	--	--	--
OEM	13.3	14.1	29.7	39.1	53.0	71.6	79.2	110.1	117.8	168.2
TOTAL U.S. NON-CAPTIVE	13.3	14.1	29.7	39.1	53.0	71.6	79.2	110.1	117.8	168.2
TOTAL U.S. SHIPMENTS	13.3	14.1	29.7	39.1	61.6	81.1	108.8	144.9	196.1	266.0
Non-U.S. Manufacturers										
Captive	--	--	--	--	.2	7.8	1.5	29.8	6.5	80.6
PCM	--	--	--	--	--	--	--	--	--	--
OEM	.6	3.3	3.7	18.5	7.7	38.5	13.2	69.5	23.0	127.5
TOTAL NON-U.S. SHIPMENTS	.6	3.3	3.7	18.5	7.9	46.3	14.7	99.3	29.5	208.1
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	13.9	17.4	33.4	57.6	69.5	127.4	123.5	244.2	225.6	474.1
OEM Average Price ($000)	.238	.246	.248	.252	.236	.240	.222	.227	.210	.214

TABLE 21

FLEXIBLE DISK DRIVES, 5.25 INCH, TWO SIDES

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	--	--	--	--	9.0	10.0	32.9	38.7	94.9	118.6
TOTAL U.S. CAPTIVE	--	--	--	--	9.0	10.0	32.9	38.7	94.9	118.6
PCM	--	--	--	--	--	--	--	--	--	--
OEM	56.3	59.5	120.8	159.1	226.4	305.9	360.2	500.3	568.9	812.7
TOTAL U.S. NON-CAPTIVE	56.3	59.5	120.8	159.1	226.4	305.9	360.2	500.3	568.9	812.7
TOTAL U.S. SHIPMENTS	56.3	59.5	120.8	159.1	235.4	315.9	393.1	539.0	663.8	931.3
Non-U.S. Manufacturers										
Captive	--	--	--	--	.2	7.1	1.4	28.4	6.5	80.6
PCM	--	--	--	--	--	--	--	--	--	--
OEM	2.0	11.1	14.0	69.8	30.4	152.0	55.5	292.2	102.5	569.2
TOTAL NON-U.S. SHIPMENTS	2.0	11.1	14.0	69.8	30.6	159.1	56.9	320.6	109.0	649.8
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	58.3	70.6	134.8	228.9	266.0	475.0	450.0	859.6	772.8	1,581.1
Installed at Year End										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	58.4	70.9	193.2	299.8	459.2	774.8	909.2	1,634.4	1,682.0	3,215.5
WORLDWIDE TOTAL	58.4	70.9	193.2	299.8	459.2	774.8	909.2	1,634.4	1,682.0	3,215.5

TABLE 22

FLEXIBLE DISK DRIVES, 5.25 INCH, TWO SIDES

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	4.8	8.2	6.1	5.2	5.0	5.4
Mini/micro computer manufacturers	13.1	22.5	17.8	15.1	13.5	13.8
System OEMs/systems houses	24.3	41.7	61.8	65.5	68.0	67.6
Independent peripherals suppliers	16.1	27.6	12.5	11.6	10.7	10.2
Distributors, dealers, end users	--	--	1.8	2.6	2.8	3.0
TOTAL	58.3					

TABLE 23

FLEXIBLE DISK DRIVES, 5.25 INCH, TWO SIDES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1979 Net Shipments To United States Destinations Units (000)	%	Worldwide Units (000)	%
Tandon Magnetics	48.0	82.3	48.0	68.0
YE Data	1.0	1.7	10.0	14.2
Micro Peripherals	7.2	12.4	8.0	11.3
Other U.S.	1.1	1.9	3.5	5.0
Other Non-U.S.	1.0	1.7	1.1	1.5
	58.3	100.0	70.6	100.0

FLEXIBLE DISK DRIVE SPECIFICATIONS

DISK DRIVE SPECIFICATIONS

Coverage

This listing includes most flexible disk drives now in new production or announced. Also included for reference are several IBM systems in which flexible disk drives are used, even though the drives are not sold as separate products.

Generally, no attempt has been made to include drives 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. Disk subsystems complete with power supply, controller and interface are listed for some manufacturers, for clarity.

OEM Prices

New this year is the addition of pricing information for OEM drives sold in the U.S. market. The U.S. OEM price for 500 units is shown for most OEM drives, using pricing information accurate at the time this report was in preparation. A few exceptions involve prices for other quantities or for dual drives, which are appropriately noted.

DISK/TREND Categories

In most cases category assignments noted for individual drives are clear, but a few arbitrary decisions have been made. The IBM magazine drive has been included in the 8 inch, two sided group, since the magazine mechanism feeds diskettes to a single drive.

Generic Type

Because they are generally understood throughout the industry, IBM media designations are used to define types of 8 inch media, and Shugart Associate's media designations are used to define 5.25 inch media types. However, usage of these model numbers is not intended to imply interchangeability. Individual drives may require media with a variety of special characteristics, such as non-standard recording disks, sectors, initialization, etc.

Capacities

Capacities are listed as "U" for unformatted or "F" for formatted. All capacities are per spindle. For DISK/TREND purposes, one spindle consists of the disk drive mechanism required to utilize a single disk. Dual drives which use a single head positioning mechanism with two diskettes are considered to be two spindles.

Accuracy

All information has been cross-checked for accuracy. However, it is anticipated that some errors may be included, due primarily to the problem that 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

Flexible disk drives

10. 8 inch, one side
11. 8 inch, two sides
12. 5.25 inch, one side
13. 5.25 inch, two sides

MANUFACTURER	BASF	BASF	BASF	BASF	BASF	BURROUGHS	BURROUGHS
DRIVE	6101	6102	6104	6106	6108	9489-17 9489-18	9489-11 9489-12
DISK/TREND GROUP	10	10	11	12	13	10	11
MEDIA COMPATIBILITY	BASF 601 Diskette 1	BASF 601 Diskette 1	Diskette 1 Diskette 2, 2D	BASF 606 SA 104/SA 105	BASF 606 SA 154/SA 155	Diskette 1	Special
SECTORING	Soft/Hard	Soft/Hard	Soft/Hard	Soft/Hard	Soft/Hard	Soft	Hard
NOMINAL DISK DIAMETER	8"	8"	8"	5.25"	5.25"	8"	8"
PERFORMANCE							
Total capacity (MBytes)	U: .401	U: .401/.802	U: .8/1.6	U: .125/.250	U: .250/.5	F: .243	F: 1.014
Capacity per track (Bytes)	U: 5,208	U: 5,208/10,416	U: 5,208/10,416	U: 3,125/6,250	U: 3,125/6,250	F: 3,328	F: 5,760
Data surfaces per spindle	1	1	2	1	2	1	2
Tracks per surface	77	77	77	40	40	77	88
TPI	48	48	48	48	48	48	64
BPI	3268	3268/6536	3408/6816	2768/5536	2768/5536	3268	4775
RPM	360	360	360	300	300	360	365
Actuator type	Lead Screw	Lead Screw	Lead Screw	Cam	Cam	Lead Screw	Lead Screw
POSITIONING: Track to track(msec)	6	6	3	12	12	10	5
Settling time (msec)	12	14	14	45	45	10	50
Head load time(msec)	40	40	40	35	35	60	85
Average rotational delay (msec)	83.3	83.3	83.3	100	100	83.3	82
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	31.25/62.5	15.63/31.25	15.63/31.25	31.25	50
FIRST CUSTOMER SHIPMENT	1976	1976	1978	3Q78	4Q78	--	4Q76
U.S. OEM PRICE FOR 500 UNITS	--	--	--	$200	$270	--	--
COMMENTS						9489-18 is Dual Version	9489-12 is Dual Version

BASF

BURROUGHS

MANUFACTURER	BURROUGHS	BURROUGHS	CALDISK	CALDISK	CALDISK	CALDISK	CALDISK
DRIVE	9489-21 9489-23	MD 122	142M	143M1	143M	145M	14M1
DISK/TREND GROUP	11	11	10	10	11	11	12
MEDIA COMPATIBILITY	Special	Special	Diskette 1	Diskette 1	Diskette 1 Diskette 2, 2D	Diskette 1 Diskette 2, 2D	SA 104/SA 105
SECTORING	Soft	Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft
NOMINAL DISK DIAMETER	8"	8"	8"	8"	8"	8"	5.25"
PERFORMANCE							
Total capacity (MBytes)	F: 3.016	F: 3.131	U: .4/.8	U: .4/.8	U: .8/1.6	U: .8/1.6	U: .2188/.4375
Capacity per track (Bytes)	F: 10,620	F: 11,264	U: 5,208/10,416	U: 5,208/10,416	U: 5,208/10,416	U: 5,208/10,416	U: 3,125/6,250
Data surfaces per spindle	2	2	1	1	2	2	1
Tracks per surface	142	139	77	77	77	77	35
TPI	150	150	48	48	48	48	48
BPI	7040	7100	3268/6536	3268/6536	3408/6816	3408/6816	2581/5162
RPM	524	524	360	360	360	360	300
Actuator type	Voice Coil	Voice Coil	Lead Screw	Lead Screw	Lead Screw	Lead Screw	Band
POSITIONING: Track to track(msec)	38 (including settling)	38 (including settling)	6	6	6	6	3
Settling time (msec)			10	10	10	10	15
Head load time(msec)			30	30	30	30	30
Average rotational delay (msec)	57.25	57.25	83.3	83.3	83.3	83.3	100
Data transfer rate (KBytes/sec)	125	125	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	15.63/31.25
FIRST CUSTOMER SHIPMENT	3Q80	3Q80	1/77	1/77	8/77	4Q80	1/79
U.S. OEM PRICE FOR 500 UNITS	--	$1750 (Dual)	$410	$450	$520	$550	$252
COMMENTS	Dual Drive, Single Head Positioning Mechanism	OEM Dual Drive, Single Head Positioning Mechanism					

BURROUGHS CALDISK

MANUFACTURER	CALDISK	CANON ELECTRONICS	CANON ELECTRONICS	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
DRIVE	14M	MDD 6106	MDD 6108	9404	9404B	9406-1	9406-2
DISK/TREND GROUP	13	12	12	10	10	11	11
MEDIA COMPATIBILITY	SA 154/SA 155	SA 104/SA 105	SA 154/SA 155	CDC 9821/3 Diskette 1	CDC 9821/3 Diskette 1	CDC 9821/3/5 Diskette 1,2,2D	CDC 9821/3/5 Diskette 1,2,2D
SECTORING	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft
NOMINAL DISK DIAMETER	5.25"	5.25"	5.25"	8"	8"	8"	8"
PERFORMANCE							
Total capacity (MBytes)	U: .4375/.875	U: .125/.250	U: .250/.5	U: .401/.802	U: .401/.802	U: .8/1.6	U: .8/1.6
Capacity per track (Bytes)	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250	U: 5,208/10,416	U: 5,208/10,416	U: 5,208/10,416	U: 5,208/10,416
Data surfaces per spindle	2	1	2	1	1	2	2
Tracks per surface	35	40	40	77	77	77	77
TPI	48	48	48	48	48	48	48
BPI	2581/5162	2768/5536	2768/5536	3268/6536	3268/6536	3408/6816	3408/6816
RPM	300	300	300	360	360	360	360
Actuator type	Band	Cam	Cam	Lead Screw	Lead Screw	Band	Band
POSITIONING: Track to track(msec)	3	12	12	10	10	3	3
Settling time (msec)	15	45	45	10	15	20	20
Head load time(msec)	30	35	35	60	60	40	40
Average rotational delay (msec)	100	100	100	83.3	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	15.63/31.25	15.63/31.25	15.63/31.25	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
FIRST CUSTOMER SHIPMENT	1/79	1980	1980	11/75	2Q79	4Q78	4Q78
U.S. OEM PRICE FOR 500 UNITS	$295	--	--	$425	$340	$515	$555
COMMENTS						CDC Interface	Shugart Interface Compatibility

CALDISK CANON CONTROL DATA

MANUFACTURER	CONTROL DATA	CONTROL DATA	CONTROL DATA	DATA MASTER	DATA MASTER	DATAPOINT	DATA RECORDING EQUIPMENT, LTD.
DRIVE	9406-3	210-10	9408	Megamaster 2	Megamaster 4	9381 Series	7100
DISK/TREND GROUP	11	11	12	12	13	10	10
MEDIA COMPATIBILITY	CDC 9821/3/5 Diskette 1,2,2D	CDC 9821/3/5 Diskette 1,2,2D	SA 104/SA 105			Diskette 1	Diskette 1 Diskette 2
SECTORING	Hard/Soft	Soft	Hard/Soft	Soft	Soft	Soft	Hard/Soft
NOMINAL DISK DIAMETER	8"	8"	5.25"	5.25"	5.25"	8"	8"
PERFORMANCE							
Total capacity (MBytes)	U: .8/1.6	F: .606208	U: .109/.218	F: .544	F: 1.088	F: .256	U: .401/.802
Capacity per track (Bytes)	U: 5,208/10,416	F: 4,096	U: 3,125/6,250	F: 6,400	F: 6,400	F: 3,328	U: 5,208/10,416
Data surfaces per spindle	2	2	1	1	2	1	1
Tracks per surface	77	74/3	35	85	85	77	77
TPI	48	48	48	96	96	48	48
BPI	3408/6816	3408/6816	2581/5162	6500	6500	3268	3268/6536
RPM	360	360	300	300	300	360	360
Actuator type	Band	Band	Band	Lead Screw	Lead Screw	Lead Screw	Lead Screw
POSITIONING: Track to track(msec)	3	3	20	6	6	10	6
Settling time (msec)	20	20	15	12	12	20	14
Head load time(msec)	40	40	50	15	15	36	30
Average rotational delay (msec)	83.3	83.3	100	100	100	83.3	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	15.63/31.25	36.88	36.88	31.25	31.25/62.5
FIRST CUSTOMER SHIPMENT	4Q78	1/79	3/80	1Q81	3Q81	1976	1977
U.S. OEM PRICE FOR 500 UNITS	$565	--	$210 (1000)	$500 (Dual)	$600 (Dual)	--	--
COMMENTS	Shugart Interface and Physical Compatibility	Series/1 Interface		Dual Drive, Single Head Positioning Mechanism	Dual Drive, Single Head Positioning Mechanism		

MANUFACTURER	DATA RECORDING EQUIPMENT, LTD.	DECITEK	DECITEK	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	HITACHI, LTD.	HITACHI, LTD.
DRIVE	7200	DF-8000/S	DF-8002/S	RX01	RX02	FDD 101A	FDD 201
DISK/TREND GROUP	11	10	11	10	10	10	11
MEDIA COMPATIBILITY	Diskette 1 Diskette 2, 2D	Diskette 1	Diskette 1 Diskette 2, 2D	RX01K Diskette 1	RX01K Diskette 1	Diskette 1	Diskette 1 Diskette 2
SECTORING	Hard/Soft	Hard/Soft	Hard/Soft	Soft	Soft	Soft	Soft
NOMINAL DISK DIAMETER	8"	8"	8"	8"	8"	8"	8"
PERFORMANCE							
Total capacity (MBytes)	U: .8/1.6	U: .401/.802	U: .8/1.6	F: .256	F: .256/.512	F: .36	F: .718
Capacity per track (Bytes)	U: 5,208/10,416	U: 5,208/10,416	U: 5,208/10,416	F: 3,328	F: 3,328/6,656	F: 4,800	F: 4,800
Data surfaces per spindle	2	1	2	1	1	1	2
Tracks per surface	77	77	77	77	77	77	77
TPI	48	48	48	48	48	48	48
BPI	3408/6816	3268/6536	3408/6816	3268	3268/6536	3268	3408
RPM	360	360	360	360	360	360	360
Actuator type	Lead Screw	Linear Stepper	Linear Stepper	Lead Screw	Lead Screw	Lead Screw	Band
POSITIONING: Track to track(msec)	6	5	5	6	6	8	3
Settling time (msec)	14	12	12	20	20	14	35
Head load time(msec)	30	35	35	16	16	25	50
Average rotational delay (msec)	83.3	83.3	83.3	83.3	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25	31.25/62.5	31.25	31.25
FIRST CUSTOMER SHIPMENT	1977	2Q80	2Q80	1976	4Q78		1978
U.S. OEM PRICE FOR 500 UNITS	--	$365	$520	--	--	--	--
COMMENTS							

MANUFACTURER	HITACHI, LTD.	HITACHI, LTD.	IBM	IBM	IBM	IBM	IBM
DRIVE	FDD 401	FDD 403	3740 Series 3770 Series 3790 Series 3601/3602 (33FD Drive)	System/32 (33FD Drive)	System/34 (33FD Drive)	System/34 (43FD Drive)	System/34 System/38 (Magazine Drive)
DISK/TREND GROUP	11	13	10	10	10	11	11
MEDIA COMPATIBILITY	Diskette 1 Diskette 2, 2D	Diskette 1 Diskette 2, 2D	Diskette 1	Diskette 1	Diskette 1	Diskette 1 Diskette 2, 2D	Diskette 1 Diskette 2, 2D
SECTORING	Soft	Soft	Soft	Soft	Soft	Soft	Soft
NOMINAL DISK DIAMETER	8"	8"	8"	8"	8"	8"	8"
PERFORMANCE							
Total capacity (MBytes)	F: .720/1.44	U: .8/1.6	F: .242944	F: .246272 or F: .303104	F: .246272 or F: .303104	F: .985088 or F: 1.212416	F: .985088 or F: 1.212416
Capacity per track (Bytes)	F: 4,800/9,600	U: 5,208/10,416	F: 3,328	F: 3,328/4,096	F: 3,328/4,096	F: 6,656/8,192	F: 6,656/8,192
Data surfaces per spindle	2	2	1	1	1	2	2
Tracks per surface	77	77	74/3	74/3	74/3	74/3	74/3
TPI	48	48	48	48	48	48	48
BPI	3408/6816	3408/6816	3268	3268	3268	3408/6816	3408/6816
RPM	360	360	360	360	360	360	720
Actuator type	Band	Band	Lead Screw	Lead Screw	Lead Screw	Band	Band
POSITIONING: Track to track(msec)	3	3	50	50	50	5	5
Settling time (msec)	35	35	20	20	20	35	35
Head load time(msec)	50	50	80	80	80		
Average rotational delay (msec)	83.3	83.3	83.3	83.3	83.3	83.3	41.7
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25	31.25	31.25	31.25/62.5	125
FIRST CUSTOMER SHIPMENT	1978	7/80	6/73	1/75	12/77	12/77	1/79 (S/34)
U.S. OEM PRICE FOR 500 UNITS	--	$450	--	--	--	--	--
COMMENTS			3540 - Input to S/370 3747 - Tape Converter				Capacity is 2 10-diskette magazines and 3 diskettes

HITACHI IBM

MANUFACTURER	IBM	IBM	IBM	IBM	IBM	IBM	IBM
DRIVE	3601-2B, 3B 3602-1A, 1B 3631/3632 (43FD Drive)	4964 (43FD Drive)	4966 (Magazine Drive)	5114 (1st Drive) 3240 (Add-on) (43FD Drive)	8130-A11 8140-A11	8101-A10 8101-A11 8101-A13	5120
DISK/TREND GROUP	11	11	11	11	11	11	11
MEDIA COMPATIBILITY	Diskette 1 Diskette 2	Diskette 1 Diskette 2	Diskette 1 Diskette 2, 2D	Diskette 1 Diskette 2, 2D	Diskette 2D	Diskette 2D	Diskette 2D
SECTORING	Soft	Soft	Soft	Soft	Soft	Soft	Soft
NOMINAL DISK DIAMETER	8"	8"	8"	8"	8"	8"	8"
PERFORMANCE							
Total capacity (MBytes)	F: .246272 or F: .284160	F: .492544 or F: .568320 or F: .606208	F: .985088 or F: 1.136640 or F: 1.212416	F: 1.212416	F: .985088	F: .985088	F: 1.212416
Capacity per track (Bytes)	F: 3,328/3,840	F: 3,328/3,840/ 4,096	F: 6,656/7,680/ 8,192	F: 8,192	F: 6,656	F: 6,656	F: 8,192
Data surfaces per spindle	2	2	2	2	2	2	2
Tracks per surface	74/3	74/3	74/3	74/3	74/3	74/3	77/3
TPI	48	48	48	48	48	48	48
BPI	3408	3408	3408/6816	3408/6816	3408/6816	3408/6816	6816
RPM	360	360	720	360	360	360	360
Actuator type	Band	Band	Band	Band	Band	Band	Band
POSITIONING: Track to track(msec)	5	5	5	5	5	5	5
Settling time (msec)	35	35	35	35	35	35	35
Head load time(msec)							
Average rotational delay (msec)	83.3	83.3	41.7	83.3	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25	125	31.25/62.5	62.5	62.5	62.5
FIRST CUSTOMER SHIPMENT	1976 (3601/2)	11/76	2/79	2/78	Mid-1980	Mid-1980	2/80
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--	--	--
COMMENTS	3600	Similar drive included with some 4962 models Series/1	Series 1 Capacity is 2 10-diskette magazines and 3 diskettes	Dual Drives for 5110, 5120	8100 System	8100 System	Uses "Trim" Drive, with smaller dimensions

MANUFACTURER	IBM	IBM	IBM	IBM	INNOTRONICS	INNOTRONICS	ISOTIMPEX
DRIVE	5281-Z01/2/6 5282-Z01/2/6 5285-X01/2/6 5286/X02 5288-XXX	5281-Z05/6/10 5282-Z05/6/10 5285-X05/6/10 5286-X10 5288-XXX	5525-020 5525-030 5525-040	5520-050 (Magazine Drive)	410	420	ES 5074
DISK/TREND GROUP	10	11	11	11	10	10	10
MEDIA COMPATIBILITY	Diskette 1	Diskette 1 Diskette 2, 2D	Diskette 2D	Diskette 2D	Diskette 1	Diskette 1	Diskette 1
SECTORING	Soft	Soft	Soft	Soft	Soft	Hard	Soft
NOMINAL DISK DIAMETER	8"	8"	8"	8"	8"	8"	8"
PERFORMANCE							
Total capacity (MBytes)	F: .246272 or F: .284160 or F: .303104	F: .985088 or F: 1.136640 or F: 1.212416	F: 1.212416	F: 1.212416	U: .401/.802	U: .401/.802	F: .4
Capacity per track (Bytes)	F: 3,328/3,840/ 4,096	F: 6,656/7,680/ 8,192	F: 8,192	F: 8,192	U: 5,208/10,416	U: 5,208/10,416	F: 3,328
Data surfaces per spindle	1	2	2	2	1	1	1
Tracks per surface	77/3	77/3	77/3	77/3	77	77	77
TPI	48	48	48	48	48	48	48
BPI	3268	3408/6816	6816	6816	3268/6536	3268/6536	3268
RPM	360	360	360	720	360	360	360
Actuator type	Band	Band	Band	Band	Lead Screw	Lead Screw	Lead Screw
POSITIONING: Track to track(msec)	5	5	5	5	8	8	10
Settling time (msec)	35	35	35	35	8	8	10
Head load time(msec)					30	30	
Average rotational delay (msec)	83.3	83.3	83.3	83.3	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	62.5	125	31.25/62.5	31.25/62.5	31.25
FIRST CUSTOMER SHIPMENT	10/80	10/80	2/80	11/80	2/77	2/77	1979
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--	--	--
COMMENTS	5280 Terminal System	5280 Terminal System	5520 Administrative System	5520 Administrative System			

MANUFACTURER	ISOTIMPEX	LOGABAX	MATSUSHITA COMMUNICATION INDUSTRIAL CO., LTD.	MATSUSHITA COMMUNICATION INDUSTRIAL CO., LTD.	MATSUSHITA COMMUNICATION INDUSTRIAL CO., LTD.	MATSUSHITA COMMUNICATION INDUSTRIAL CO., LTD.	MATSUSHITA COMMUNICATION INDUSTRIAL CO., LTD.
DRIVE	Mini Floppy	LX45D	JK-890 JK-891	JK-880 JK-881	JK-885 JK-886	JK-874	JK-875
DISK/TREND GROUP	12	10	10	10	11	12	13
MEDIA COMPATIBILITY		Diskette 1	Diskette 1	Diskette 1	Diskette 1 Diskette 2, 2D	SA 104 (S) SA 105/107 (H)	SA 154 (S) SA 155/157 (H)
SECTORING	Soft/Hard	Hard/Soft	Soft/Hard	Soft/Hard	Soft/Hard	Soft/Hard	Soft/Hard
NOMINAL DISK DIAMETER	5.25"	8"	8"	8"	8"	5.25"	5.25"
PERFORMANCE							
Total capacity (MBytes)	U: .1094	U: .401	U: .401	U: .401/.802	U: .8/1.6	U: .1094/.2188	U: .2188/.4375
Capacity per track (Bytes)	U: 3,125	U: 5,208	U: 5,208	U: 5,208/10,416	U: 5,208/10,416	U: 3,125/6,250	U: 3,125/6,250
Data surfaces per spindle	1	1	1	1	2	1	2
Tracks per surface	35	77	77	77	77	35	35
TPI	48	48	48	48	48	48	48
BPI	2581	3268	3268	3268/6536	3408/6816	2581/5162	2728/5456
RPM	300	360	360	360	360	300	300
Actuator type	Cam	Lead Screw	Lead Screw	Lead Screw	Band	Cam	Cam
POSITIONING: Track to track(msec)	40	2.5	10	8	3	40	25
Settling time (msec)	10	27	8	8	15	10	15
Head load time(msec)		90	35	35	35	75	50
Average rotational delay (msec)	100	83.3	83.3	83.3	83.3	100	100
Data transfer rate (KBytes/sec)	15.63	31.25	31.25	31.25/62.5	31.25/62.5	15.63/31.25	15.63/31.25
FIRST CUSTOMER SHIPMENT	1980	1976	3/76	9/76	12/77	2/79	3Q79
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--	--	--
COMMENTS			Shugart License: SA 900 SA 901	Shugart License: SA 800 SA 801	Shugart License: SA 850 SA 851	Shugart License: SA 400	Shugart License: SA 450

MANUFACTURER	MEMOREX	MEMOREX	MERA METRONEX	MFE CORPORATION	MFE CORPORATION	MICRO PERIPHERALS	MICRO PERIPHERALS
DRIVE	651	550	PLX45D	500	700	51	91
DISK/TREND GROUP	10	10	10	10	11	12	12
MEDIA COMPATIBILITY	FD/IV	Diskette 1	Diskette 1	Diskette 1	Diskette 1 Diskette 2, 2D	SA 104/SA 105	
SECTORING	Hard	Hard/Soft	Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft
NOMINAL DISK DIAMETER	8"	8"	8"	8"	8"	5.25"	5.25"
PERFORMANCE							
Total capacity (MBytes)	U: .312	U: .401/.802	U: .401	U: .401/.802	U: .8/1.6	U: .125/.250	U: .250/.5
Capacity per track (Bytes)	U: 4,875	U: 5,208/10,416	U: 5,208	U: 5,208/10,416	U: 5,208/10,416	U: 3,125/6,250	U: 3,125/6,250
Data surfaces per spindle	1	1	1	1	2	1	1
Tracks per surface	64	77	77	77	77	40	80
TPI	48	48	48	48	48	48	96
BPI	3100	3268/6536	3268	3268/6536	3408/6816	2768/5536	2788/5576
RPM	375	360	360	360	360	300	300
Actuator type	Lead Screw	Lead Screw	Lead Screw	Band	Band	Band	Band
POSITIONING: Track to track(msec)	10	6	2.5	3	3	5	5
Settling time (msec)	10	10	27.5	15	15	15	15
Head load time(msec)	40	35	90	35	35	35	35
Average rotational delay (msec)	80	83.3	83.3	83.3	83.3	100	100
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	31.25	31.25/62.5	31.25/62.5	15.63/31.25	15.63/31.25
FIRST CUSTOMER SHIPMENT	12/72	1/77	1977	8/77	8/77	10/77	4/80
U.S. OEM PRICE FOR 500 UNITS	$600	$450	--	$330	$490	$220	$300
COMMENTS							

MANUFACTURER	MICRO PERIPHERALS	MICRO PERIPHERALS	MICRO PERIPHERALS	MICRO PERIPHERALS	MICROPOLIS	MICROPOLIS	MICROPOLIS
DRIVE	52	92	41	42	1015-II	1015-IV	1015-V
DISK/TREND GROUP	13	13	10	11	12	13	12
MEDIA COMPATIBILITY	SA 154/SA 155		Diskette 1	Diskette 1 Diskette 2, 2D	Micropolis 1081	Micropolis 1081	Micropolis 1081
SECTORING	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft
NOMINAL DISK DIAMETER	5.25"	5.25"	8"	8"	5.25"	5.25"	5.25"
PERFORMANCE							
Total capacity (MBytes)	U: .250/.5	U: .5/1.0	U: .4/.8	U: .8/1.6	U: .480	U: .960	U: .5
Capacity per track (Bytes)	U: 3,125/6,250	U: 3,125/6,250	U: 5,208/10,416	U: 5,208/10,416	U: 6,250	U: 6,250	U: 6,250
Data surfaces per spindle	2	2	1	2	1	2	1
Tracks per surface	40	80	77	77	77	77	80
TPI	48	96	48	48	100	100	96
BPI	2938/5876	2961/5922	3268/6536	3408/6816	5248	5248	5248
RPM	300	300	360	360	300	300	300
Actuator type	Band	Band	Band	Band	Lead Screw	Lead Screw	Lead Screw
POSITIONING: Track to track(msec)	5	5	3	3	10	10	10
Settling time (msec)	15	15	15	15	15	15	15
Head load time(msec)	35	35	35	35	75	75	75
Average rotational delay (msec)	100	100	83.3	83.3	100	100	100
Data transfer rate (KBytes/sec)	15.63/31.25	15.63/31.25	31.25/62.5	31.25/62.5	31.25	31.25	31.25
FIRST CUSTOMER SHIPMENT	3/79	4/80	1Q81	1Q81	3/77	8/78	2Q80
U.S. OEM PRICE FOR 500 UNITS	$300	$400	$395	$530	$265	$315	$265
COMMENTS			½ height of standard 8" OEM drives	½ height of standard 8" OEM drives	OEM Drive	OEM Drive	OEM Drive

MICRO PERIPHERALS

MICROPOLIS

MANUFACTURER	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
DRIVE	1015-VI	1016-II	1016-IV	1041-I 1042-I	1021-I 1022-I	1041-II 1043-II 1053-II 1054-II	1021-II 1023-II 1033-II
DISK/TREND GROUP	13	12	13	12	12	12	12
MEDIA COMPATIBILITY	Micropolis 1081	Micropolis 1081	Micropolis 1081	SA 105	SA 105	Micropolis 1081	Micropolis 1081
SECTORING	Hard/Soft	Soft	Soft	Hard	Hard	Hard	Hard
NOMINAL DISK DIAMETER	5.25"	5.25"	5.25"	5.25"	5.25"	5.25"	5.25"
PERFORMANCE							
Total capacity (MBytes)	U: 1.0	U: .585	U: 1.170	F: .143	F: .143	F: .315	F: .315
Capacity per track (Bytes)	U: 6,250	U: 7,600	U: 7,600	F: 4,096	F: 4,096	F: 4,096	F: 4,096
Data surfaces per spindle	2	1	2	1	1	1	1
Tracks per surface	80	77	77	35	35	77	77
TPI	96	100	100	48	48	100	100
BPI	5248	6380	6380	5162	5162	5162	5162
RPM	300	300	300	300	300	300	300
Actuator type	Lead Screw	Lead Screw	Lead Screw	Lead Screw	Lead Screw	Lead Screw	Lead Screw
POSITIONING: Track to track(msec)	10	10	10	10	10	10	10
Settling time (msec)	15	15	15	15	15	15	15
Head load time(msec)	75	75	75	75	75	75	75
Average rotational delay (msec)	100	100	100	100	100	100	100
Data transfer rate (KBytes/sec)	31.25	38.0	38.0	31.25	31.25	31.25	31.25
FIRST CUSTOMER SHIPMENT	2Q80	6/78	9/78	1/78	1/78	3/77	3/77
U.S. OEM PRICE FOR 500 UNITS	$315	$275	$325	--	--	--	--
COMMENTS		OEM Drive GCR	OEM Drive GCR	S-100 Subsystems	S-100 Subsystem Add-on Drives	S-100 Subsystems	S-100 Subsystem Add-on Drives

MICROPOLIS

MANUFACTURER	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION
DRIVE	1055-II 1035-II	1055-IV 1035-IV	SBC-55-II SBC-16-II	SBC-55-IV SBC-16-IV	M892	M2893	M2894
DISK/TREND GROUP	12	13	12	13	10	11	11
MEDIA COMPATIBILITY	Micropolis 1081	Micropolis 1081	Micropolis 1081	Micropolis 1081	Diskette 1	Diskette 2	Diskette 2D
SECTORING	Soft	Soft	Soft	Soft	Soft	Soft	Soft
NOMINAL DISK DIAMETER	5.25"	5.25"	5.25"	5.25"	8"	8"	8"
PERFORMANCE							
Total capacity (MBytes)	F: .473	F: .946	F: .394	F: .788	U: .401	U: .802	U: 1.6
Capacity per track (Bytes)	F: 6,144	F: 6,144	F: 5,360	F: 5,360	U: 5,208	U: 5,208	U: 10,416
Data surfaces per spindle	1	2	1	2	1	2	2
Tracks per surface	77	77	77	77	77	77	77
TPI	100	100	100	100	48	48	48
BPI	6380	6380	6380	6380	3268	3408	6816
RPM	300	300	300	300	360	360	360
Actuator type	Lead Screw	Lead Screw	Lead Screw	Lead Screw	Lead Screw	Band	Band
POSITIONING: Track to track(msec)	10	10	10	10	7	3	3
Settling time (msec)	15	15	15	15	23	15	15
Head load time(msec)	75	75	75	75	50	50	50
Average rotational delay (msec)	100	100	100	100	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	38.0	38.0	38.0	38.0	31.25	31.25	62.5
FIRST CUSTOMER SHIPMENT	6/78	9/78			1974	1978	4Q78
U.S. OEM PRICE FOR 500 UNITS	$1150 (Dual)	$1250 (Dual)	--	--	--	--	--
COMMENTS	OEM Subsystem 1035 Add-on GCR	OEM Subsystem 1035 Add-on GCR	Intel Subsystems GCR	Intel Subsystems GCR			

MICROPOLIS

MITSUBISHI

MANUFACTURER	NIPPON ELECTRIC COMPANY	NIPPON ELECTRIC COMPANY	NORTHERN TELECOM SYSTEMS	OLIVETTI	OLIVETTI	OLIVETTI	OLIVETTI
DRIVE	N7707	FD 1160	4505	FDU 5600	FDU 6102	AFD 6102	MDU 8008
DISK/TREND GROUP	11	11	10	10	10	10	Special
MEDIA COMPATIBILITY	Diskette 2D	Diskette 1 Diskette 2, 2D	Diskette 1	Diskette 1	Diskette 1	Diskette 1	Olivetti 2.5" Disk
SECTORING	Soft	Soft	Soft	Soft	Soft	Soft	N/A
NOMINAL DISK DIAMETER	8"	8"	8"	8"	8"	8"	2.5"
PERFORMANCE							
Total capacity (MBytes)	F: 1.0	U: .8/1.6	F: .243	F: .242 (26sec) F: .280 (15sec)	F: .246 (26sec) F: .284 (15sec)	F: .246 (26sec) F: .284 (15sec)	F: .008
Capacity per track (Bytes)	F: 6,656	U: 5,208/10,416	F: 3,328	F: 3,840	F: 3,840	F: 3,840	F: 8,000
Data surfaces per spindle	2	2	1	1	1	1	1
Tracks per surface	77	77	77	77	77	77	1
TPI	48	48	48	48	48	48	N/A
BPI	6816	3408/6816	3268	3268	3268	3268	980
RPM	360	360	360	360	360	360	Variable
Actuator type	Band	Band	Lead Screw	Lead Screw	Lead Screw	Lead Screw	N/A
POSITIONING: Track to track(msec)	5	5	2.5	10	10	10	N/A
Settling time (msec)	15	15	25	30	30	30	N/A
Head load time(msec)	50	50	30	40	40	40	N/A
Average rotational delay (msec)	83.3	83.3	83.3	83.3	83.3	83.3	N/A
Data transfer rate (KBytes/sec)	62.5	31.25/62.5	31.25	31.25	31.25	31.25	2.5
FIRST CUSTOMER SHIPMENT	12/78	1980	1975				
U.S. OEM PRICE FOR 500 UNITS	--	$565	--	--	--	--	--
COMMENTS	Astra 2 NEAC	OEM		A6 System	Dual Drive with Single Actuator	Dual Drive w/ Single Actuator. Automatically loads 20 diskettes.	8 K Bytes in Single Spiral Track of 78". Max. Read Time 4.4 sec.

NEC

NORTHERN TELECOM

OLIVETTI

MANUFACTURER	PER SCI, INC.	PER SCI, INC.	PERTEC	PERTEC	PERTEC	PERTEC	PERTEC
DRIVE	277	299	FD 511 A FD 514 FD 510	FD 410	FD 650	FD 200	FD 250
DISK/TREND GROUP	10	11	10	10	11	12	13
MEDIA COMPATIBILITY	Diskette 1	Diskette 1 Dsikette 2, 2D	Diskette 1	Diskette 1	Diskette 1 Diskette 2, 2D	SA 104/SA 105	SA 154/SA 155
SECTORING	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft
NOMINAL DISK DIAMETER	8"	8"	8"	8"	8"	5.25"	5.25"
PERFORMANCE							
Total capacity (MBytes)	U: .401/.802	U: .8/1.6	U: .401/.802	U: .401/.802	U: .8/1.6	U: .125/.250	U: .219/.438
Capacity per track (Bytes)	U: 5,208/10,416	U: 5,208/10,416	U: 5,208/10,416	U: 5,208/10,416	U: 5,208/10,416	U: 3,125/6,250	U: 3,125/6,250
Data surfaces per spindle	1	2	1	1	2	1	2
Tracks per surface	77	77	77	77	77	40	35
TPI	48	48	48	48	48	48	48
BPI	3268/6536	3408/6816	3268/6536	3268/6536	3408/6816	2768/5536	2768/5536
RPM	360	360	360	360	360	300	300
Actuator type	Linear Motor	Linear Motor	Lead Screw	Lead Screw	Lead Screw	Cam	Cam
POSITIONING: Track to track(msec)	10	10	10	10	3	25	25
Settling time (msec)	0	0	20	20	15	10	10
Head load time(msec)	40	40	40	40	35	35	35
Average rotational delay (msec)	83.3	83.3	83.3	83.3	83.3	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	15.63/31.25	15.63/31.25
FIRST CUSTOMER SHIPMENT	3Q77	6/78			1/79	12/77	1/79
U.S. OEM PRICE FOR 500 UNITS	$1050 (Dual)	$1600 (Dual)	$470	$490	$560	$215	$305
COMMENTS	Average Positioning Time 33 msec Dual Drive	Average Positioning Time 33 msec Dual Drive		DC Power			

PER SCI

PERTEC

MANUFACTURER	QUME	QUME	REMEX	REMEX	REMEX	REMEX	REMEX
DRIVE	Datatrak 8	Datatrak 5	RFD 2000 RFD 2001	RFS 2400	20	24	RFD 4000 RFD 4001
DISK/TREND GROUP	11	13	10	10	10	10	11
MEDIA COMPATIBILITY	Diskette 1 Diskette 2, 2D	SA 154	Diskette 1	Diskette 1	Diskette 1	Diskette 1	Diskette 1 Diskette 2, 2D
SECTORING	Soft	Soft	Hard/Soft	Soft	Soft	Soft	Hard/Soft
NOMINAL DISK DIAMETER	8"	5.25"	8"	8"	8"	8"	8"
PERFORMANCE							
Total capacity (MBytes)	U: .8/1.6	U: .250/.5	U: .401/.802	26 Sectors: F: .256/.512	26 Sectors: F: .256/.512	26 Sectors: F: .256/.512	U: .8/1.6
Capacity per track (Bytes)	U: 5,208/10,416	U: 3,125/6,250	U: 5,208/10,416	F: 3,328/6,656	F: 3,328/6,656	F: 3,328/6,656	U: 5,208/10,416
Data surfaces per spindle	2	2	1	1	1	1	2
Tracks per surface	77	40	77	77	77	77	77
TPI	48	48	48	48	48	48	48
BPI	3408/6816	2768/5536	3268/6536	3268/6536	3268/6536	3268/6536	3408/6816
RPM	360	300	360	360	360	360	360
Actuator type	Band	Lead Screw	Band	Band	Band	Band	Band
POSITIONING: Track to track(msec)	3	12	3	3	3	3	3
Settling time (msec)	15	15	15	15	15	15	15
Head load time(msec)	35	50	35	35	35	35	35
Average rotational delay (msec)	83.3	100	83.3	83.3	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	15.63/31.25	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
FIRST CUSTOMER SHIPMENT	1Q79	4Q79	1Q79	1979	1979	1980	1Q79
U.S. OEM PRICE FOR 500 UNITS	$560 (250)	$350 (250)	$380	2410: $650 2420: $350	$1125 (Dual)	$1595 (Dual)	$499
COMMENTS				Subsystem Master: 2410 Add-on: 2420	Subsystem with two drives	Subsystem with two drives	

QUME REMEX

MANUFACTURER	REMEX	REMEX	REMEX	RICOH	RICOH	SANKYO SEIKI MFG. CO., LTD.	SHUGART ASSOCIATES
DRIVE	RFS 4800	40	48	RD-2	RD-2D	FMC-100	SA 800 SA 801
DISK/TREND GROUP	11	11	11	10	11	Special	10
MEDIA COMPATIBILITY	Diskette 1 Diskette 2, 2D	Diskette 1 Diskette 2, 2D	Diskette 1 Diskette 2, 2D	Diskette 1	Diskette 1 Diskette 2, 2D	Sankyo Seiki Special Disk	SA 100/1/2/3 Diskette 1
SECTORING	Soft	Soft	Soft	Soft	Soft	N/A	Hard/Soft
NOMINAL DISK DIAMETER	8"	8"	8"	8"	8"	2.598"	8"
PERFORMANCE							
Total capacity (MBytes)	26 Sectors: F: .512/1.025	26 Sectors: F: .512/1.025	26 Sectors: F: .512/1.025	F: .225	F: .568 or F: .985	F: .008	U: .401/.802
Capacity per track (Bytes)	F: 3,328/6,656	F: 3,328/6,656	F: 3,328/6,656	F: 3,040	F: 3,840/6,656	F: 8,000	U: 5,208/10,416
Data surfaces per spindle	2	2	2	1	2	1	1
Tracks per surface	77	77	77	74/3	74/3	1	77
TPI	48	48	48	48	48	N/A	48
BPI	3408/6816	3408/6816	3408/6816	3268	3408/6816	1069	3268/6536
RPM	360	360	360	360	360	405	360
Actuator type	Band	Band	Band	Lead Screw	Lead Screw	N/A	Lead Screw
POSITIONING: Track to track(msec)	3	3	3	6	6	N/A	8
Settling time (msec)	15	15	15	10	10	N/A	8
Head load time(msec)	35	35	35	30	30	N/A	35
Average rotational delay (msec)	83.3	83.3	83.3	83.3	83.3	N/A	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25	31.25/62.5	2	31.25/62.5
FIRST CUSTOMER SHIPMENT	1979	1979	1980	12/79	12/79	8/80	9/75
U.S. OEM PRICE FOR 500 UNITS	4810: $750 4820: $450	$1255 (Dual)	$1710 (Dual)	--	--	$212	$345
COMMENTS	Subsystem Master: 4810 Add-on: 4820	Subsystem with two drives		TX330 Word Process-ing System	TC 2200 TC 2400 Small Business Systems	8 K Bytes in single spiral	

MANUFACTURER	SHUGART ASSOCIATES	SHUGART ASSOCIATES	SHUGART ASSOCIATES	SHUGART ASSOCIATES	SHUGART ASSOCIATES	SIEMENS	SIEMENS
DRIVE	SA 850 SA 851	SA 400	SA 450	SA 410	SA 460	FDD 100-8D, E	FDD 200-8P, R
DISK/TREND GROUP	11	12	13	12	13	10	11
MEDIA COMPATIBILITY	SA 150/SA 151 Diskette 1,2,2D	SA 104 (S) SA 105/107 (H)	SA 154 (S) SA 155/157 (H)	SA 104 (S) SA 105/107 (H)	SA 154 (S) SA 155/157 (H)	Diskette 1	Diskette 1 Diskette 2, 2D
SECTORING	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft
NOMINAL DISK DIAMETER	8"	5.25"	5.25"	5.25"	5.25"	8"	8"
PERFORMANCE							
Total capacity (MBytes)	U: .8/1.6	U: .125/.250	U: .250/.5	U: .250/.5	U: .5/1.0	U: .401/.802	U: .8/1.6
Capacity per track (Bytes)	U: 5,208/10,416	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250	U: 5,208/10,416	U: 5,208/10,416
Data surfaces per spindle	2	1	2	1	2	1	2
Tracks per surface	77	40	40	80	80	77	77
TPI	48	48	48	96	96	48	48
BPI	3408/6816	2938/5876	2938/5876	2938/5876	2938/5876	3268/6536	3408/6816
RPM	360	300	300	300	300	360	360
Actuator type	Band	Cam	Cam	Lead Screw	Lead Screw	Lead Screw	Lead Screw
POSITIONING: Track to track(msec)	3	20	20	6	6	6	3
Settling time (msec)	15	15	15	10	10	14	14
Head load time(msec)	45	75		*	*	25	25
Average rotational delay (msec)	83.3	100	100	100	100	83.3	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	15.63/31.25	15.63/31.25	15.63/31.25	15.63/31.25	31.25/62.5	31.25/62.5
FIRST CUSTOMER SHIPMENT	6/77	9/76	1/80	1Q81	1Q81	1975	4/78
U.S. OEM PRICE FOR 500 UNITS	$520	$200	$300	$300	$375	$355	$480
COMMENTS				*Heads in continuous contact	*Heads in continuous contact		

SHUGART ASSOCIATES

SIEMENS

MANUFACTURER	SIEMENS	SIEMENS	SYKES DATATRONICS	SYKES DATATRONICS	TANDON MAGNETICS	TANDON MAGNETICS	TANDON MAGNETICS
DRIVE	FDD 100-5B	FDD 200-5N	7150 (Single) 7250 (Dual)	9150 (Single) 9250 (Dual)	TM-100-1	TM-100-3	TM-100-3M
DISK/TREND GROUP	12	13	10	10	12	12	12
MEDIA COMPATIBILITY	SA 104/SA 105	SA 154/SA 155	Diskette 1	Diskette 1	SA 104 (S) SA 105/107 (H)		
SECTORING	Hard/Soft	Hard/Soft	Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft
NOMINAL DISK DIAMETER	5.25"	5.25"	8"	8"	5.25"	5.25"	5.25"
PERFORMANCE							
Total capacity (MBytes)	U: .125/.250	U: .250/.5	F: .256	F: .631	U: .125/.250	U: .250/.5	U: .240/.480
Capacity per track (Bytes)	U: 3,125/6,250	U: 3,125/6,250	F: 3,328	F: 8,192	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250
Data surfaces per spindle	1	2	1	1	1	1	1
Tracks per surface	40	40	77	77	40	80	
TPI	48	48	48	48	48	96	100
BPI	2768/5536	2938/5876	3268	6536	5535	5535	5305
RPM	300	300	360	360	300	300	300
Actuator type	Lead Screw	Lead Screw	Lead Screw	Lead Screw	Band	Band	Band
POSITIONING: Track to track(msec)	25	25	6	6	5	3	3
Settling time (msec)	15	15	30	30	15	15	15
Head load time(msec)	50	50	30	30	*	*	*
Average rotational delay (msec)	100	100	83.3	83.3	100	100	100
Data transfer rate (KBytes/sec)	15.63/31.25	15.63/31.25	31.25	62.5	15.63/31.25	15.63/31.25	15.63/31.25
FIRST CUSTOMER SHIPMENT	3/77	5/78	9/74	10/76	11/78	2/80	2/80
U.S. OEM PRICE FOR 500 UNITS	$210	$260	--	--	$200	$300	$300
COMMENTS					*Heads in continuous contact	*Heads in continuous contact	*Heads in continuous contact

MANUFACTURER	TANDON MAGNETICS	TANDON MAGNETICS	TANDON MAGNETICS	TEAC CORPORATION	TEAC CORPORATION	TEAC CORPORATION	TEAC CORPORATION
DRIVE	TM-100-2	TM-100-4	TM-100-4M	FD-100	FD-50A	FD-50C	FD-50E
DISK/TREND GROUP	13	13	13	11	12	12	12
MEDIA COMPATIBILITY	SA 154 (S) SA 155/157 (H)			Diskette 1 Diskette 2, 2D	SA 104/SA 105	Micropolis 1081	
SECTORING	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft	Hard/Soft
NOMINAL DISK DIAMETER	5.25"	5.25"	5.25"	8"	5.25"	5.25"	5.25"
PERFORMANCE							
Total capacity (MBytes)	U: .250/.5	U: .5/1.0	U: .480/.960	U: .8/1.6	U: .125/.250	U: .2406/.4812	U: .250/.5
Capacity per track (Bytes)	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250	U: 5,208/10,416	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250
Data surfaces per spindle	2	2	2	2	1	1	1
Tracks per surface	40	80		77	40	77	80
TPI	48	96	100	48	48	100	96
BPI	5877	5877	5450	3408/6816	2768/5536	2623/5246	2788/5576
RPM	300	300	300	360	300	300	300
Actuator type	Band	Band	Band	Lead Screw	Lead Screw	Lead Screw	Lead Screw
POSITIONING: Track to track(msec)	5	3	3	25	25	25	25
Settling time (msec)	15	15	15	10	10	10	10
Head load time(msec)	*	*	*	35	35	35	35
Average rotational delay (msec)	100	100	100	83.3	100	100	100
Data transfer rate (KBytes/sec)	15.63/31.25	15.63/31.25	15.63/31.25	31.25/62.5	15.63/31.25	15.63/31.25	15.63/31.25
FIRST CUSTOMER SHIPMENT	11/78	2/80	2/80	4Q79	4Q78	4Q79	2Q80
U.S. OEM PRICE FOR 500 UNITS	$300	$375	$375	--	$200	$260	$260
COMMENTS	*Heads in continuous contact	*Heads in continuous contact	*Heads in continuous contact				

TANDON

TEAC

MANUFACTURER	T&E ENGINEERING	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA	VIDEOTON INDUSTRIE - AUSSENHALDELS	VIDEOTON INDUSTRIE - AUSSENHALDELS
DRIVE	A-40	ND-10S	ND-20D ND-20DL	ND-01	ND-02D	MFM-2 MFM-4	Momflex 3200
DISK/TREND GROUP	12	10	11	12	13	10	10
MEDIA COMPATIBILITY		Diskette 1	Diskette 1 Diskette 2, 2D			Diskette 1	Diskette 1
SECTORING	Hard/Soft	Soft	Soft	Soft	Soft	Soft	Soft/Hard
NOMINAL DISK DIAMETER	5.25"	8"	8"	5.25"	5.25"	8"	8"
PERFORMANCE							
Total capacity (MBytes)	U: .256/.512	U: .4	U: .8/1.6	U: .1094	U: .1094/.4375	F: .256	U: .401
Capacity per track (Bytes)	U: 3,125/6,250	U: 5,208	U: 5,208	U: 3,125	U: 3,125/6,250	F: 3,328	U: 5,208
Data surfaces per spindle	1	1	2	1	2	1	1
Tracks per surface	40	77	77	35	35	77	77
TPI	48	48	48	48	48	48	48
BPI	2768/5536	3268	3408/6816	2581	2581/5162	3268	3268
RPM	300	360	360	300	300	360	360
Actuator type	Lead Screw	Band	Band	Lead Screw	Lead Screw	Lead Screw	Lead Screw
POSITIONING: Track to track(msec)	12	3	3	40	25	10	10
Settling time (msec)	12	18	18	10	15	40	40
Head load time(msec)	15	50	50	75	50	40	40
Average rotational delay (msec)	100	83.3	83.3	100	100	83.3	83.3
Data transfer rate (KBytes/sec)	15.63/31.25	31.25	31.25	15.62	15.62/	31.25	31.25
FIRST CUSTOMER SHIPMENT	4Q79	1977	1977	1Q80	1Q80	1977	1978
U.S. OEM PRICE FOR 500 UNITS	$436 (Dual)	--	--	--	--	--	--
COMMENTS	Dual Drive, Single Head Positioning Mechanism						

T & E TOSHIBA VIDEOTON

MANUFACTURER	YE DATA, INC.	YE DATA, INC.	YE DATA, INC.				
DRIVE	YD-74C	YD-174	YD-274				
DISK/TREND GROUP	10	11	13				
MEDIA COMPATIBILITY	Diskette 1	Diskette 1 Diskette 2,2D	SA 104/SA 105				
SECTORING	Hard/Soft	Hard/Soft	Hard/Soft				
NOMINAL DISK DIAMETER	8"	8"	5.25"				
PERFORMANCE							
Total capacity (MBytes)	U: .401	U: .8/1.6	U: .125/.250				
Capacity per track (Bytes)	U: 5,208	U: 5,208/10,416	U: 3,125/6,250				
Data surfaces per spindle	1	2	2				
Tracks per surface	77	77	35				
TPI	48	48	48				
BPI	3268	3408/6816	2728/5456				
RPM	360	360	300				
Actuator type	Lead Screw	Band	Lead Screw				
POSITIONING: Track to track(msec)	9	3	20				
Settling time (msec)	20	15	15				
Head load time(msec)	35	35	50				
Average rotational delay (msec)	83.3	83.3	100				
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	15.63/31.25				
FIRST CUSTOMER SHIPMENT	1974	1977	1/79				
U.S. OEM PRICE FOR 500 UNITS	--	--	--				
COMMENTS							

MANUFACTURER PROFILES

1980 DISK/TREND REPORT

MANUFACTURER PROFILES

Every known manufacturer of flexible disk drives is listed in this section, with a brief description of the firm's role in the industry. The heading "FDD sales" refers only to the DISK/TREND estimate of sales of flexible disk drives -- no sales of other drive types are included, nor are sales of parts or other related products. "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

APPLE COMPUTER, INC.
10260 Bandley Drive
Cupertino, CA 95014 408/996-1010

1979 FDD sales: None

Because of its emergence as a leading manufacturer of desktop computers, Apple has become one of the largest OEM buyers of 5.25 inch floppy drives. For the last few years, the firm has been purchasing the "SA 390", a mechanism-only drive, from Shugart Associates. Apple manufactures the electronics and performs final drive alignment and testing to its own standards. After many rumors of vertical integration plans for floppies, the company's management has recently confirmed plans to manufacture 5.25 inch, two sided drives. Apparently, production will start next year and will include an internal head manufacturing facility in Southern California.

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

1979 FDD sales: $21,600,000
1979 total net sales: $2,785,429,000 Net income: $305,636,000

Since 1976, Burroughs has been manufacturing an 8 inch, two sided drive with its own unique design, which uses a pressure pad opposite each recording head, instead of the IBM approach in which heads on each side of the diskette directly oppose each other. This one megabyte drive did not suffer from the media wear problems which plagued drives designed to use

IBM standard media formats. During the last year Burroughs announced its long-anticipated 8 inch, two sided high capacity drive, which uses a single voice coil actuator to position heads on two diskettes. The new drive has a capacity of 3 MB per diskette, using 150 TPI. The actuator is a closed loop system, which adjusts head position to compensate for media dimensional changes caused by temperature or humidity variations, through use of two prerecorded servo tracks. This drive has been announced on new Burroughs small business systems and is also being offered as an OEM drive.

CALDISK
Subsidiary of Billings Energy Corporation
2921 East La Palma Avenue
Anaheim, CA 92806 714/630-8160

1979 FDD sales: $7,300,000
1979 total net sales: $8,662,000 Net income: $599,000

Following acquisition of the Calcomp flexible disk drive product line in early 1979 by Billings Computer Corporation, a subsidiary of Billings Energy Corporation, operations have been established in new facilities in Anaheim, California, and 5.25 inch drives have been added. Although a portion of Caldisk floppy production is used with Billings Computer systems, the main thrust remains the OEM market.

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

1979 FDD sales: $34,800,000
1979 total net sales: $2,248,600,000 Net income: $89,464,000

Control Data continues to hold second place in worldwide OEM flexible disk drive revenues, on the strength of its 8 inch drive programs. During 1980, the firm has added 48 TPI 5.25 inch one and two sided drives, and seems committed to further development of that market. Floppy drives credited to CDC in DISK/TREND statistics are manufactured by Magnetic Peripherals, Inc., a firm jointly owned by CDC and Honeywell, with management by CDC. Drives sold by either parent company with their own systems are considered captive drives, and are included in the CDC total, as the manager of the joint venture company.

DATA MASTER, INC.
389 North Carmen Drive
Camarillo, CA 93010 805/498-8466

1979 FDD sales: None

Data Master is a start-up company which has announced 96 TPI 5.25 inch one and two sided versions of a dual drive. The drive uses a single

stepping motor to control movement of heads on two diskettes. This organization was founded in 1980 by Ko Ko Gyi, a veteran of advanced rigid and flexible disk drive development programs at Burroughs.

DATAPOINT CORPORATION
9725 Datapoint Drive
San Antonio, TX 78285 512/699-7000

1979 FDD sales: $8,000,000
1979 total net sales: $232,101,000 Net income: $25,246,000

Datapoint has manufactured 8 inch, one side drives for several years under a license from Shugart Associates, for use with the company's terminals and system products. The firm recently formed a joint venture with Tandy Corporation, to be called Texas Peripherals, which will manufacture flexible disk drives for both parent companies. It is expected that manufacturing responsibility for Datapoint's 8 inch, one side drive will be transferred to Texas Peripherals during 1981, and a two sided drive will be added.

DECITEK
A Division of Jamesbury Corporation
129 Flanders Road
Westboro, MA 01581 617/366-8334

1979 FDD sales: None
1979 total net sales: $77,735,000 Net income: $5,307,000

Decitek, a major supplier of paper tape equipment for the computer industry, started deliveries in mid-1980 of its first flexible disk drive, a unique design using a linear stepping motor. The firm is oriented to the OEM drive market. A previously announced version of the company's basic 8 inch drive using a voice coil actuator has been dropped.

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

1979 FDD sales: $51,600,000
1979 total net sales: $1,804,092,000 Net income: $178,434,000

DEC's leadership position in the minicomputer industry has resulted in huge requirements for captive floppy drives to support its many system programs. The firm has manufactured 8 inch, one side drives internally since 1976, originally under a Calcomp license. So far, the DEC floppy product line is confined to standard and double density versions of the 8 inch, one side drive, but it seems inevitable that the firm will make other floppy configurations eventually.

HEWLETT-PACKARD COMPANY
Greeley Division
3400 East Harmony Road
Fort Collins, CO 80525 303/226-3800

1979 FDD sales: None
1979 total net sales: $2,361,000,000 Net income: $203,000,000

Hewlett-Packard has been a major OEM customer of Shugart Associates 8 inch floppy drives, for use with its various minicomputer based systems and other requirements. The firm recently announced establishment of the new Greeley Division, with a 580-acre site at Greeley, Colorado, which will have responsibility to develop and manufacture tape and flexible disk drives. The new division is already starting to do some assembly of two sided 5.25 inch floppy drives at Fort Collins, in support of the HP-85 desktop computer requirements. HP negotiated a manufacturing license with Tandon Magnetics under which HP will gradually build up its manufacturing capability, while buying drives from Tandon.

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

1979 FDD sales: $254,100,000
1979 total net sales: $22,862,776,000 Net income: $3,011,259,000

The DISK/TREND estimates of IBM flexible disk drive shipments have been revised upward this year, for both one side and two sided 8 inch drives, the only formats in which IBM is currently involved. Based on a detailed review of IBM system requirements for floppy drives, the new estimates indicate that IBM held 32.2% of worldwide flexible disk drive revenues in 1979. Because all of the company's shipments are sold at relatively high end user price levels, IBM's share of worldwide unit shipments of all types of floppy drives were only 8.8% in 1979, with a decline to 5.9% in 1983 forecasted. The IBM floppy product line hasn't changed much in the last year, with the exception that it is used on more systems than ever, and the addition of the "Trim" version of the 8 inch, two sided drive. The Trim drive uses standard Diskette 2D media, but is repackaged for the smaller size needed for desktop computers such as the 5120, and employs a simplified latch mechanism for diskette loading. As discussed elsewhere in this report, it remains likely that IBM will provide the key product introductions of both smaller drives and higher capacity drives, creating new industry standards for floppy drive configurations. The only real question in when.

INNOTRONICS
Brooks Road
Lincoln, MA 01773 617/259-0600

1979 FDD sales: $1,000,000

Following the liquidation of Innovex, an early flexible disk drive manufacturer in late 1977, the firm's assets were purchased by key employees. They immediately continued production of the same 8 inch, one side drives under the new company name of Innotronics. The firms's manufacturing is now in a facility at Fall River, Massachusetts, and sales are increasing, with an emphasis on hardware reliability.

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

1979 FDD sales: $9,500,000
1979 total net sales: $737,761,000 Net income: $31,544,000

Despite being the first manufacturer of OEM flexible disk drives, Memorex seems to be at a growth plateau in this product. The original drive, the 651, preceded the introduction of the IBM 3740, which established industry standards for 8 inch, one side drives. The product life cycle for the 651 is now in decline, and Memorex has never participated in the sharp growth other firms realized in IBM compatible drives, because of late introduction of IBM compatible drives and quality problems in recent years. The firm has discontinued production of two sided drives, and moved the manufacturing facility to a Southern California plant. The firm indicates it plans to revitalize the entire program, but the actions to be taken apparently aren't ready yet.

MFE
Keewaydin Drive
Salem, NH 03079 603/893-1921

1979 FDD sales: $3,600,000

MFE entered the OEM flexible disk drive market in 1977 with an 8 inch, two sided drive, as an addition to its established line of digital cassette drives and instrumentation recorders. After a slow start while the firm and the rest of the industry wrestled with two sided drive problems, the MFE floppy shipment rate has been steadily building, and the firm now manufactures the drive in both Massachusetts and Scotland.

MICRO PERIPHERALS, INC.
9754 Deering Avenue
Chatsworth, CA 91311 213/709-4202

1979 FDD sales: $7,300,000

So far, Micro Peripherals looks like one of the success stories in the 5.25 inch floppy drive market. The firm has been shipping both one and two sided 5.25 inch drives in quantity, and is one of the early entrants in the emerging market for 96 TPI drives. An innovative 8 inch drive, only one half the height of industry standard OEM drives, was announced at the 1980 NCC. Micro Peripherals is well positioned to take advantage of its current momentum, and has added several experienced managers this year in an attempt to keep things organized.

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

1979 FDD sales: $8,500,000

Micropolis apparently surprised the rest of the industry when it introduced the first 100 TPI 5.25 inch floppy in 1977 -- to the extent that it had all of 1978 and 1979 to develop the segment of the OEM floppy market that was ready for higher capacity in the 5.25 inch floppy form. The company was successful in building its special place in the market, but it has suddenly attracted a swarm of competitors, which are now offering 96 TPI 5.25 inch drives (essentially the same density as 100 TPI). In view of a slow start on two sided drives, and the sudden widespread availability of 96 TPI drives, Micropolis is now entering a period of extremely tough competition.

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

1979 FDD sales: $8,000,000
1979 total net sales: $1,634,000,000 Net income: $97,474,000

Sycor, which manufactured floppy drives since 1974, was acquired by Northern Telecom in 1978, and was combined with the operations of Data 100, also acquired in 1978. Sycor's OEM marketing program for floppy drives had been deemphasized prior to the acquisition and has not been restarted. At this time the floppy program is still limited to 8 inch, one side captive drives.

PER SCI, INC.
12210 Nebraska Avenue
West Los Angeles, CA 90025 213/820-3764

1977 FDD sales: $5,300,000

Per Sci had a flat growth year in 1979, with one result the installation of a new management. The firm continues as the only source for 8 inch floppy drives using industry standard media with access times in the rigid disk class. The firm's voice coil actuator delivers performance, and has proven fully compatible with two sided drive usage -- but creates an intrinsically higher cost. Per Sci's new management has the task of identifying segments of the OEM floppy drive market which are willing to pay more for performance and reestablishing the previous growth rate.

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

1979 FDD sales: $11,500,000

Pertec was an early manufacturer of OEM floppy drives, and currently participates in all current floppy drive standard configurations. The company uses captive floppy drives in systems and in add-on systems, and as part of its line of tape and disk OEM products. The floppy manufacturing facilities are relatively new, with plenty of room available for expansion -- and the organization is now trying to establish a higher growth rate.

QUME CORPORATION
Subsidiary of International Telephone & Telegraph
2323 Industrial Parkway West
Hayward, CA 94545 415/783-6100

1979 FDD sales: $4,300,000
1979 total net sales: $17,197,423,000 Net income: $380,685,000

Qume has achieved fast growth for the two sided 8 inch and 5.25 inch drives it is currently manufacturing in Hayward, under license from YE Data. Qume's management secured a large share of the daisywheel printer market, and it is safe to assume they expect to obtain a major share of the OEM markets for two sided floppy drives, also. Qume has already done well, with a drive well regarded for reliability, and may be expected to be one of the industry's more aggressive competitors.

QYX
Division of Exxon Enterprises, Inc.
329 Gordon Drive
Lionville, PA 19353 215/363-3000

1979 FDD sales: $3,200,000
1979 total net sales: $84,809,048,000 Net income: $4,295,243,000

Qyx developed its own 5.25 inch, one side floppy drive for use as part of the intelligent typewriter system announced in early 1978. The drive is designed for minimum possible height, to facilitate integration into the typewriter-like enclosure for its system. Production is now ramping up, as the Exxon Enterprises office equipment marketing program gets into gear. The firm has not acted on hints made by its management last year about a possible OEM marketing program for floppy drives.

REMEX DIVISION
EX-CELL-O CORPORATION
1733 Alton Street
Irvine, CA 92713 714/557-6860

1979 FDD sales: $5,300,000
1979 total net sales: $983,204,000 Net income: $54,212,000

Remex started manufacturing floppy drives in 1975, to expand its line of data processing equipment, consisting primarily of paper tape equipment. For several years the firm achieved only limited success in the OEM market for 8 inch, one side floppy drives. However, after a change in management, Remex is now enjoying rapid growth, based mostly on sales of two sided 8 inch drives. The firm recently dropped its "Data Warehouse", a subsystem consisting of a 14 inch Winchester drive with built-in floppy backup, and is concentrating its floppy activities in the OEM drive market.

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

1979 FDD sales: $122,600,000
1979 total net sales: $7,027,000,000 Net income: $563,100,000

Shugart Associates accomplished the monumental task of shipping 528,000 OEM flexible disk drives of all types in 1979. Depending on the way you think about market shares, on a unit shipment basis this quantity was 39.0% of total worldwide floppy drive shipments, 49.9% of total shipments by U.S. manufacturers to all destinations, or 63.5% of all OEM drive shipments by U.S. manufacturers to all destinations. Shugart remains the leader in all four current DISK/TREND floppy drive categories except 5.25 inch, two sided drives, where its extended delay in production startup gave Tandon Magnetics a clear lead. The fond hopes of Shugart's competi-

tors that Xerox' big company methods would stifle the Shugart momentum are still just hopes. The company is apparently getting results with its programs aimed at two sided drive problems, there are numerous new product programs coming along, including the newly announced 96 TPI 5.25 inch drives, and the small fixed Winchester drive programs are quickly moving into high production levels. In order to make room for all the new products at the firm's Sunnyvale manufacturing complex, 8 inch and 5.25 inch one sided drive manufacturing operations are being transferred to a new facility at Roseville, near Sacramento, California.

SYKES DATATRONICS, INC.
375 Orchard Street
Rochester, NY 14606 716/458-8000

1979 FDD sales: $4,800,000
1979 total net sales: $12,298,000 Net income: $1,492,000

Sykes manufactures 8 inch, one side floppy drives to use in its own subsystems, sold primarily for attachment to terminals and minicomputers. In 1979 AT&T agreed to market the Sykes floppy subsystem as a tariffed product, and the tedious task of securing tariff authorizations for the myriad of Bell operating companies has been underway. The effects on Sykes sales are already pronounced, and the firm can expect rapid growth.

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

1979 FDD sales: $14,800,000

After establishing a position as leading independent floppy head manufacturer, Tandon entered the 5.25 inch floppy drive business in early 1979. The firm became the fastest growing floppy drive manufacturer overnight by providing key OEM customers with quantity deliveries of two sided drives and competitive pricing. Tandon is now adding extensive additional production capacity, and is aggressively adding new products, including a 5.25 inch Winchester drive.

TEXAS PERIPHERALS
Joint Venture of Datapoint Corporation and Tandy Corporation
1010 East 8th
Odessa, TX 79761 915/332-0277

1979 FDD sales: None

Texas Peripherals will manufacture flexible disk drives for both Tandy and Datapoint, at a new facility now being readied for large quantity production at Odessa, Texas. Datapoint, which has been producing 8 inch, one side drives for several years under a Shugart Associates license,

will transfer production to Texas Peripherals, and will add an 8 inch, two sided drive in 1981. Tandy has probably been the largest OEM buyer of floppy drives for the last few years, in support of its hugely successful small computer product line. Apparently, Texas Peripherals will produce floppy drives only for the two parent companies.

T & E ENGINEERING, INC.
1015 West 190th Street
Gardena, CA 90248 213/327-7657

1979 FDD sales: None

T & E introduced a dual 5.25 inch, one side drive late in 1979. The drive uses a single stepping motor actuator to control movement of heads for two diskettes. The firm has had typical startup problems, with shipments interrupted during 1980 by financing and procurement problems.

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

ALPS ELECTRIC CO., LTD.
1-7, Yukigawa Ohtsuka-cho
Ohta-ku, Tokyo 145 (03)726-1211

1979 FDD sales: None
1979 total net sales: $459,013,000 Net income: $5,529,000

Alps is a diversified manufacturer of electronic products and subassemblies, including television tuners, audio equipment and small business computer systems. The firm has resold Micro Peripherals 5.25 inch floppy drives in the Japanese market, but the company management has indicated it will produce one and two sided 5.25 inch floppy drives in the near future, including products intended for the U.S. market.

CANON ELECTRONICS CO., INC.
Subsidiary of Canon, Inc.
1248, Shimokagemori, Chichibu-city
Saitama 369-18 (04942)3-3111

1979 FDD sales: None
1979 total net sales: $1,399,973,000 Net income: $38,520,000

Canon Electronics produces electronic subassemblies for Canon cameras, plus audio and digital magnetic heads, small printers, card readers and other electronic products. The firm is now producing 5.25 inch one and two sided floppy drives under a BASF license, for use with Canon small business systems and for sale in the Japanese OEM market.

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

1979 FDD sales: $15,900,000
1979 total net sales: $11,442,302,000 Net income: $431,253,000

Hitachi manufactures one and two sided 8 inch floppy drives for the OEM market and for the company's own system requirements and terminal product lines. The firm is a diversified electrical and electronics manufacturer, with less than a fifth of total sales derived from the computer industry.

MATSUSHITA COMMUNICATION INDUSTRIAL CO., LTD.
4-3-1 Tsunashima-Higashi
Kohoku-ku, Yokohama 223 (045)531-1231

1979 FDD sales: $7,400,000
1979 total net sales: $569,760,000 Net income: $23,151,000

Matsushita Communication Industrial is part of the Matsushita Electric Industrial group of companies, and is a diversified manufacturer of

communications, audio-visual, automotive and other electronic equipment. This firm is the Shugart licensee for Japan, and produces all of the Shugart floppy drive configurations, as well as floppy and rigid disk heads. Shugart Associates and Matsushita have cooperated in a joint program to produce an extremely low cost 5.25 inch floppy drive for the personal computer market, and if this product is successfully introduced, it is expected to be produced by Matsushita for distribution by both firms.

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

1979 FDD sales: $19,700,000
1979 total net sales: $4,527,609,000 Net income: $97,604,000

Mitsubishi is a leader in small business computer systems in the Japanese market, with a broad product line. Both one and two sided floppy drives are produced for captive use with Mitsubishi systems, and the firm is also a major factor in the Japanese OEM market.

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

1979 FDD sales: $27,900,000
1979 total net sales: $3,511,644,000 Net income: $35,089,000

NEC's only floppy drive so far is an 8 inch, two sided drive produced in large quantities entirely for the firm's captive requirements. 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.

OKI ELECTRIC INDUSTRY CO., LTD.
1-17-12, Toranomon
Minato-ku, Tokyo 105 (03)501-3111

1979 FDD sales: $1,400,000
1979 total net sales: $673,627,000 Net income: ($10,071,000)

Oki is primarily a manufacturer of telecommunications equipment, but other products include small computer systems and peripheral equipment. The firm manufactures 8 inch, one side drives for captive use with Oki systems.

RICOH CO., LTD.
1-3-6 Naka-Magome
Ota-ku, Tokyo 143 (03)543-5111

1979 FDD sales: $900,000
1979 total net sales: $877,550,000 Net income: $77,360,000

Ricoh began production of one side and two sided 8 inch floppy drives in 1979, and is involved only in production for the firm's own system requirements. In addition to being a major producer of cameras and office equipment, Ricoh is emphasizing the development of its small business systems and word processing systems.

SANKYO SEIKI MFG. CO., LTD.
17-2, 1-chome, Shinbashi
Minato-ku, Tokyo 105 (03)508-1154

1979 FDD sales: None
1979 total net sales: $208,996,000 Net income: ($7,378,000)

Sankyo Seiki is a diversified electronics manufacturer, with products ranging from tape recorders, motors and timers, to magnetic heads. The firm has announced an 8 kilobyte spiral track floppy drive using a special 2.598 inch disk, with the intention of developing the potential OEM market for the device in word processing, program loading and special industrial applications.

TEAC CORPORATION
3-7-3, Naka-cho
Musashino, Tokyo 180 (0422)53-1111

1979 FDD sales: $2,200,000
1979 total net sales: $141,440,000 Net income: ($4,510,000)

Teac is well known for quality audio tape decks, but generates about a quarter of its revenues from digital electronic products. The firm entered the worldwide OEM flexible disk drive market in late 1978 with a 5.25 inch, one side drive, and has since added a two sided 8 inch drive. The 5.25 inch drive is offered in 48, 96 and 100 TPI versions.

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

1979 FDD sales: $17,700,000
1979 total net sales: $7,569,640,000 Net income: $102,916,000

Toshiba is a major Japanese manufacturer of minicomputers and small business systems, but is an even larger manufacturer of home electric appliances, heavy electric machinery and communications equipment. One

and two sided 8 inch floppy drives have been produced since 1977, and one and two sided 5.25 inch drives were added in early 1980. Toshiba is an active participant in OEM floppy drive markets, in addition to captive drive production.

YE DATA, INC.
Subsidiary of Yaskawa Electric Mfg. Co., Ltd.
1-20-7 Suehiro Building, Kita-Otsuka
Toshima-ku, Tokyo 170 (03)949-2033

1979 FDD sales: $15,200,000
1979 total net sales: $285,849,000 Net income: ($1,276,000)

Yaskawa Electric is a major manufacturer of motors, numerical control systems, and other industrial automation equipment. The YE Data subsidiary is Japan's leading producer of flexible disk drives for the OEM market. 8 inch, one side drives have been manufactured since 1974, under an Orbis license. Two sided 8 inch and 5.25 inch drives are now the company's growth products, and both are manufactured in the U.S. under YE Data license by Qume.

European Manufacturers (Exchange basis: Indicated for each firm)

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

1979 FDD sales: $17,100,000
1979 total net sales: $14,138,872,000 Net income: $338,040,000
(Basis: DM 1.86 = US $1)

A leading chemical industry conglomerate with worldwide operations, BASF is one of the world's largest manufacturers of magnetic tape and disk media products, including flexible disks. The firm started production of 8 inch, one side drives in Germany in 1976, and in 1978 added 8 inch, two sided drives, plus both one side and two sided 5.25 inch drives. The 5.25 inch drives are also manufactured in Massachusetts for the U.S. market. BASF's total flexible disk drive revenues for 1979 make the firm the largest non-U.S. manufacturer of OEM floppy drives.

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

1979 FDD sales: $1,100,000
(Basis: 1 Pound = US $2.35)

Flexible disk drive manufacturing for DRE is now the responsibility of United Peripherals, Ltd., a joint venture company formed by Magnetic Peripherals, Inc. (in turn, a joint venture owned primarily by Control Data and Honeywell) and Data Recording Instruments (controlled by the British government's National Enterprise Board). MPI holds 24% of UPL and DRI has 76%, with both parents contributing products and management. DRE will continue to sell the one and two sided 8 inch floppy drives previously in production, now made by UPL, and will receive the benefit of additional products from MPI.

ISOTIMPEX
51, Chapaev St.
Sofia, Bulgaria

1979 FDD sales: None

Isotimpex is the official foreign trade organization specializing in electronic products manufactured by Isot, the Bulgarian state computer organization. Several rigid disk configurations have been sold throughout the Eastern Bloc countries for several years by Isotimpex, and one sided 8 inch and 5.25 inch floppy drives are now being added.

LOGABAX
146, avenue des Champs-Elysees
75008 Paris
France (1)350-61-24

1979 FDD sales: $2,800,000

Logabax has been manufacturing 8 inch, one side floppy drives for several years, under a Sycor license, entirely for captive use with Logabax systems. Logabax small business systems, terminals and printers are marketed throughout Europe, with more limited distribution in the United States and Brazil.

MERA/METRONEX
Al. Jerozolimskie 44
00-950 Warszawa
Poland 26-22-21

1979 FDD sales: $2,700,000

MERA is the acronym for the Polish Union of Automation and Measuring Instruments Industry, a state organization manufacturing computer systems and peripherals now used thoughout Eastern Europe and the USSR. Flexible disk drives are manufactured under a 1975 license from Logabax, with production at the MERA Krakowska Fabryka Aparatow Pomiarowych facility at Krakow, with export responsibilities held by Metronex. Production is limited to 8 inch, one side drives.

ING. C. OLIVETTI & C., S.P.A.
77 via Jervis
10015 Ivrea
Italy

1979 FDD sales: $60,400,000
1979 total net sales: $2,223,240,000

Olivetti manufactures and markets office equipment and data processing systems in numerous countries around the world. For several years the company has been one of the largest producers of captive 8 inch, one side drives, and added two sided drives in 1979. The firm manufactures a unique 2.5 inch flexible disk drive using a spiral track configuration; the drive is not included in DISK/TREND statistics, since it is essentially a serial recording device. Olivetti is expected to start shipments of 5.25 inch drives this year. Olivetti and Cii-Honeywell Bull are currently discussing the possibility of collaborating in the production of some of their equipment, perhaps including floppy drives, apparently at the prodding of Saint-Gobain-Pont-a-Mousson, which has major investments in both firms.

SIEMENS AG
Wittelsbacherplatz 2
D-8000 Munchen 2
West Germany (089)2341

1979 FDD sales: $9,600,000
1979 total net sales: $15,069,575,000 Net income: $361,938,000
(Basis: DM 1.86 = US $1)

Data processing operations account for only about 5% of the Siemens total revenues, yet the firm is one of Europe's leading computer system manufacturers. Floppy drive manufacturing is confined to North America, with products derived from acquisitions of General Systems International and the Orbis (later Wangco, then Perkin Elmer) operation. Manufacturing is in Orange County, California, and at a Siemens plant near Mexico City. Floppy drive marketing is part of the Siemens U.S. OEM peripherals sales activity. Products include both 8 inch and 5.25 inch, one and two sided products.

VIDEOTON INDUSTRIE-AUSSENHALDELS AG
1068 Budapest VI., Szofiz u. 9
Hungary 228-821

1979 FDD sales: $900,000

Videoton offers 8 inch, one side industry compatible floppy drives, both as OEM drives and as subsystems. The organization is an Hungarian electronics manufacturing operation which produces minicomputers and peripherals for domestic use and for export to Eastern European countries.