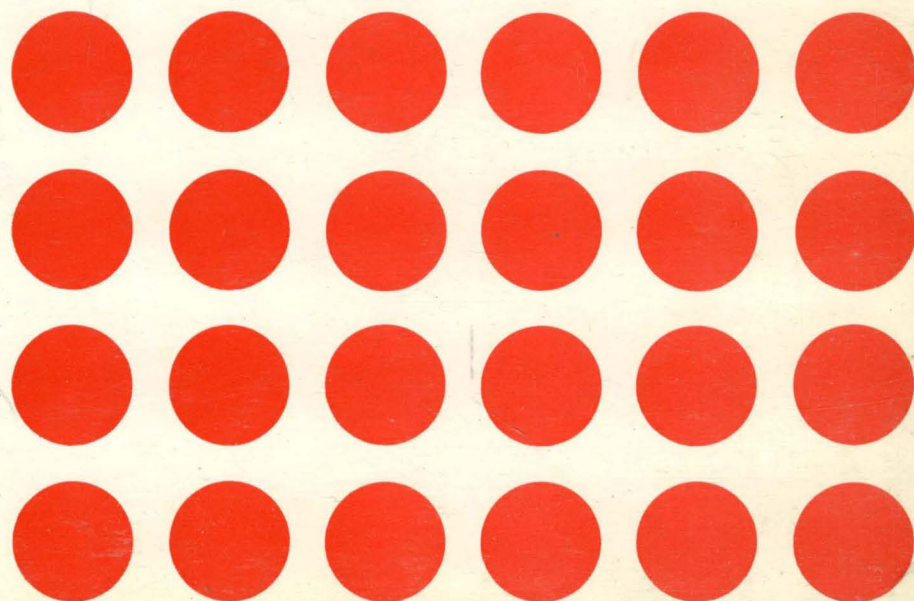


1977 DISK/TREND REPORT

**FLEXIBLE
DISK
DRIVES**



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FLEXIBLE DISK DRIVES

August, 1977

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

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FORWARD

The 1977 DISK/TREND Report is being published in two sections. This volume covers flexible disk drives, and a separate report published in June covered rigid disk drives.

Subscribers are invited to contact me if additional information or backup data is needed. I will be happy to provide any non-proprietary information from my files which can be extracted without extensive research. More elaborate projects requiring extended research and analysis can be addressed on a normal consulting basis if desired.

In any event, your comments and suggestions regarding the DISK/TREND Report are sincerely requested. It is intended that the DISK/TREND Report will be a practical working tool for subscribers, and your thoughts on content and format will be most helpful in increasing the usefulness of future editions.

James N. Porter

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INTRODUCTION

How to use this DISK/TREND Report

The disk drive industry enjoys great diversity in products, distribution channels, applications and companies. DISK/TREND data is grouped by products, and the other key variables are analysed within each product group. With that organization of information in mind, here are a few suggestions for using this report:

- * When looking for information on specific segments of the industry, check the appropriate product sections first.
- * Look for industry-wide data and consolidated statistics in the summary section.
- * You will find specifications on individual disk drives and background on each manufacturer in separate sections on these subjects.

Please note these key points

- * All DISK/TREND projections are based on current or announced products, plus the effect of evolutionary improvements. Completely new configurations or technologies, when introduced, will create additional sales not included in this report.
- * Specific definitions for several terms which could have varying meanings to DISK/TREND users have been prepared for use in this report. The definitions section should not be overlooked.
- * All unit totals are given in spindles. A dual drive configuration, for example, is counted as two spindles.

SUMMARY

Industry size

Sales of floppy disk drives by drive manufacturers totaled an estimated \$166,100,000 in 1976, representing worldwide shipments. U.S. manufacturers were responsible for 79% of this sales volume, amounting to \$130,700,000.

Although DISK/TREND forecasts envision significant shifts in product mix, worldwide sales are expected to increase dramatically, reaching a total for all floppy drives of \$635,300,000 in 1980, an average annual growth rate (AAGR) of 41.4%. Reflecting the expected continuation of the decline in average selling price, the growth rate in unit shipments will exceed that for revenues. Aggregate worldwide shipments of all types of floppy drives will grow from 199,400 units in 1976 to 886,000 units in 1980, an AAGR of 47.8%.

U.S. manufacturers held 79% of worldwide 1976 floppy drive revenues, but are expected to be down to the 76% level in 1980. U.S. manufacturers' share during the intervening years will be somewhat higher, however, due to the momentum in OEM shipments they currently enjoy. Non-U.S. OEM and captive manufacturing programs should achieve their own momentum by the end of the decade, and prevent U.S. domination of international OEM markets.

As with DISK/TREND estimates for rigid disk drives, these projections assume maintenance of a healthy world economy, since data processing equipment sales follow economic conditions closely. 3-5% annual growth in U.S. GNP is assumed.

TABLE 1
CONSOLIDATED WORLDWIDE SHIPMENTS
ALL FLEXIBLE DISK DRIVE GROUPS
REVENUE SUMMARY

Disk Drive Revenues, by Shipment Destination (\$M)										
	1976		Forecast							
	Shipments		1977		1978		1979		1980	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<u>U.S. manufacturers</u>										
IBM	62.2	78.2	73.2	96.8	100.3	135.3	121.4	173.8	135.0	205.3
Other U.S. captive	8.2	10.6	29.7	43.2	68.2	100.0	95.3	139.4	95.4	138.5
TOTAL U.S. CAPTIVE	70.4	88.8	102.9	140.0	168.5	235.3	216.7	313.2	230.4	343.8
OEM	33.4	41.9	65.8	82.0	86.0	108.9	99.2	127.3	107.6	142.1
TOTAL U.S. NON-CAPTIVE	33.4	41.9	65.8	82.0	86.0	108.9	99.2	127.3	107.6	142.1
TOTAL U.S. PRODUCTION	103.8	130.7	168.7	222.0	254.5	344.2	315.9	440.5	338.0	485.9
<u>Non-U.S. manufacturers</u>										
Captive	1.8	30.4	3.9	44.3	8.4	61.6	9.8	81.9	11.6	107.6
OEM	-	5.0	-	11.5	1.2	21.7	2.6	32.3	3.9	41.8
TOTAL NON-U.S. PRODUCTION	1.8	35.4	3.9	55.8	9.6	83.3	12.4	114.2	15.5	149.4
<u>Worldwide recap</u>										
TOTAL WORLDWIDE PRODUCTION	166.1		277.8		427.5		554.7		635.3	
TOTAL WORLDWIDE CAPTIVE	119.2		184.3		296.9		395.1		451.4	
TOTAL WORLDWIDE NON-CAPTIVE	46.9		93.5		130.6		159.6		183.9	

Industry structure

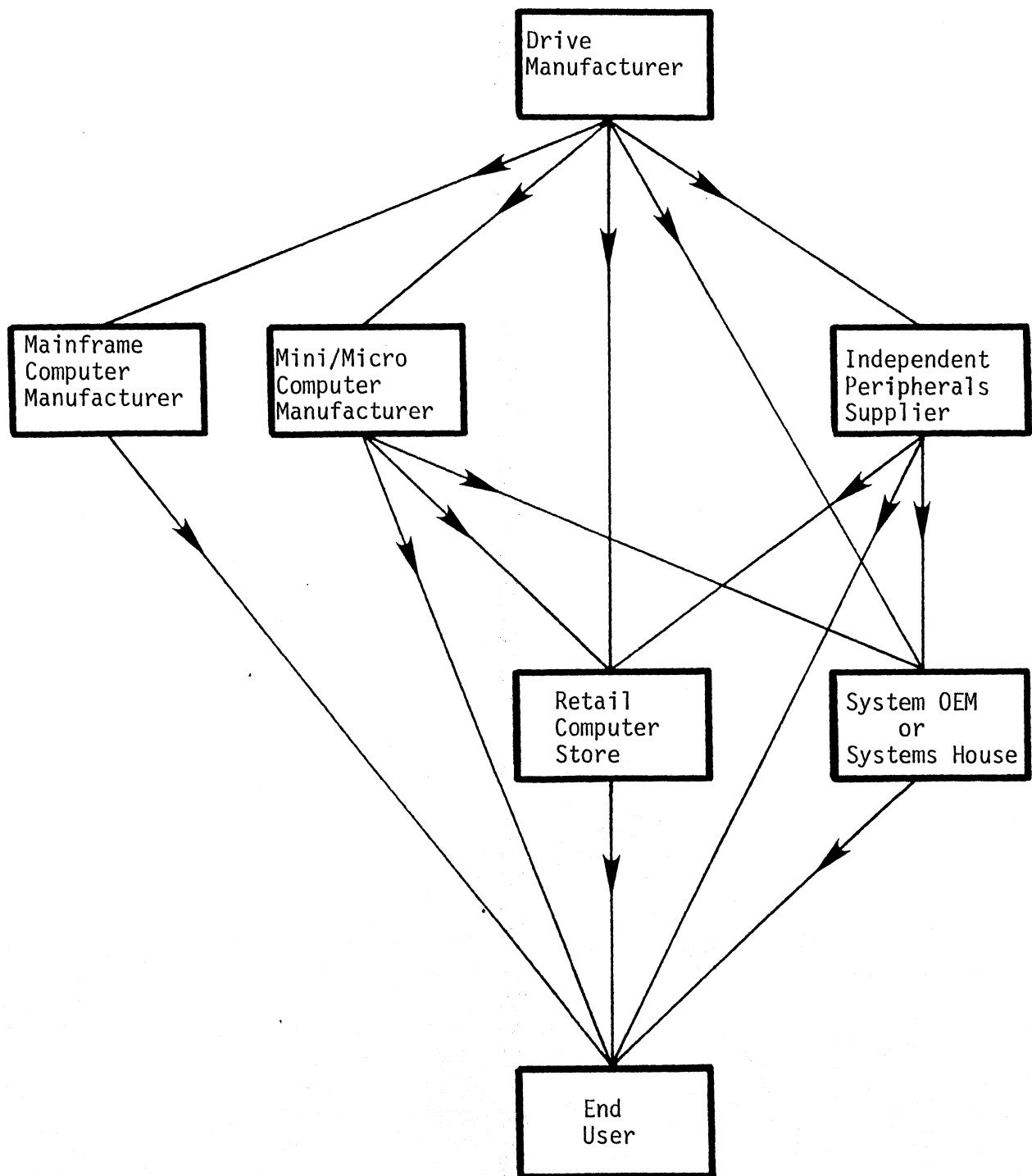
19 U.S. manufacturers now produce floppy disk drives, as do 12 manufacturers in Japan and Europe. At least three U.S. manufacturers produce drives in non-U.S. locations.

Captive production of floppy drives by IBM provided the start for the industry, and still represents an important portion of total production. In addition, other captive manufacturing programs are now in existence, the largest at Burroughs, DEC and Olivetti -- with several other major system OEMs expected to also initiate internal floppy drive production. Captive production now represents an estimated 71.8% of worldwide floppy drive revenues, but only 33.7% of the unit shipments.

OEM drive shipments constitute the balance of the industry -- only 28.2% of worldwide revenues in 1976, but 66.3% of total units shipped. Despite rapid initiation of captive manufacturing programs by the largest potential customers for OEM floppy drives, manufacturers of OEM drives are expected to retain about the same share of total industry unit shipments in 1980 due to the industry's overall rapid growth and the normal delays in introducing new product configurations into captive programs.

Extensive vertical integration has not occurred among manufacturers of floppy drives, with the principal exception of Shugart, which manufactures most of its own heads, and IBM, of course. The majority of other drive manufacturers, both captive and OEM, buy heads and electro-mechanical components such as stepping motors and drive motors externally.

FIGURE 1
NON-CAPTIVE MARKETING STRUCTURE
Flexible Disk Drives



Marketing channels

Distribution channels employed by IBM and other manufacturers of captive floppy drives are relatively straightforward. Their floppy drives are either an integral part of a system sold by the firm, or are sold separately as a subsystem intended for use with one of the firm's systems. Sales may be made directly to the user, or, alternately, to a system OEM or systems house which sells a complete, usually specialized, system to the end user.

However, when channels for non-captive floppy drives are examined (Figure 1), the situation becomes complicated. Manufacturers of OEM floppy drives sell drives and related hardware directly to every type of industry participant. And the actual product sold may vary from a basic drive without electronics to a complete subsystem ready to plug in. The majority of OEM drives are originally sold without power supply, enclosure or interface electronics, but complete subsystems are available from many U.S. drive manufacturers, even some of the largest. A few smaller floppy drive manufacturers have found the subsystem market their key to survival.

An additional complexity has been added by the computer hobbyist and his local retail computer store. It is believed that most floppy drives now reaching hobbyists are moving through computer stores, but this pattern is still evolving.

At present, few drives are sold by drive manufacturers directly to end users, including hobbyists -- so that PCM market class significant in rigid disk distribution has not developed to date.

TABLE 2
 CONSOLIDATED WORLDWIDE SHIPMENTS
 ALL FLEXIBLE DISK DRIVE GROUPS
 MARKET CLASS SUMMARY

Worldwide Revenues By Manufacturer Type	1976		FORECAST							
	Shipments		1977		1978		1979		1980	
	\$M	%	\$M	%	\$M	%	\$M	%	\$M	%
<u>U.S. Manufacturers</u>										
IBM	78.2	47	96.8	35	135.3	32	173.8	31	205.3	32
Other U.S. Captive	10.6	7	43.2	15	100.0	23	139.4	25	138.5	22
OEM	41.9	25	82.0	30	108.9	26	127.3	23	142.1	22
Total U.S. Mfg.	130.7	79	222.0	80	344.2	81	440.5	79	485.9	76
<u>Non-U.S. Manufacturers</u>										
Captive	30.4	18	44.3	16	61.6	14	81.9	15	107.6	17
OEM	5.0	3	11.5	4	21.7	5	32.3	6	41.8	7
Total Non-U.S. Mfg.	35.4	21	55.8	20	83.3	19	114.2	21	149.4	24
WORLDWIDE TOTAL	166.1	100	277.8	100	427.5	100	554.7	100	635.3	100

Product mix

8 inch, one side floppy drives provided 99.7% of all floppy drive worldwide revenues in 1976, but will generate only 31.2% of the total in 1980, according to DISK/TREND projections. Nevertheless, the anticipated growth of the floppy drive market as a whole will be so great that revenues from 8 inch, one side drives are actually expected to be 19.6% higher in 1980 than 1976's total. This drive group is expected to reach its peak production in 1978.

8 inch, two side drives will generate the largest increases in floppy shipments after 1978, responding to the demand for improved cost per megabyte and greater capacity per drive. Revenues for this group are projected at 59.4% of the total in 1980, with unit shipments at 46.2% of the total.

5.25 inch drives, already in volume production in 1977, should account for 24.7% of all floppy drive unit shipments in 1980, but only 9.4% of total revenues, due to much lower average unit prices.

OEM market

The OEM product mix will parallel that of the entire industry in most aspects. Manufacturers of OEM drives are expected to receive 52.8% of drive revenues in 1980 from 8 inch, two side drives. Unit shipments of both 8 inch, two side drives and 5.25 inch drives should exceed shipments of 8 inch, one side drives for the first time in 1980.

Shugart held a commanding 34.4% lead in 1976 OEM revenues, with Calcomp in second place. In 1977, Shugart will stay solidly in first place, but Control Data will take over the second position, benefiting from a strong marketing program and Calcomp's loss of substantial sales to DEC's internal manufacturing program.

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

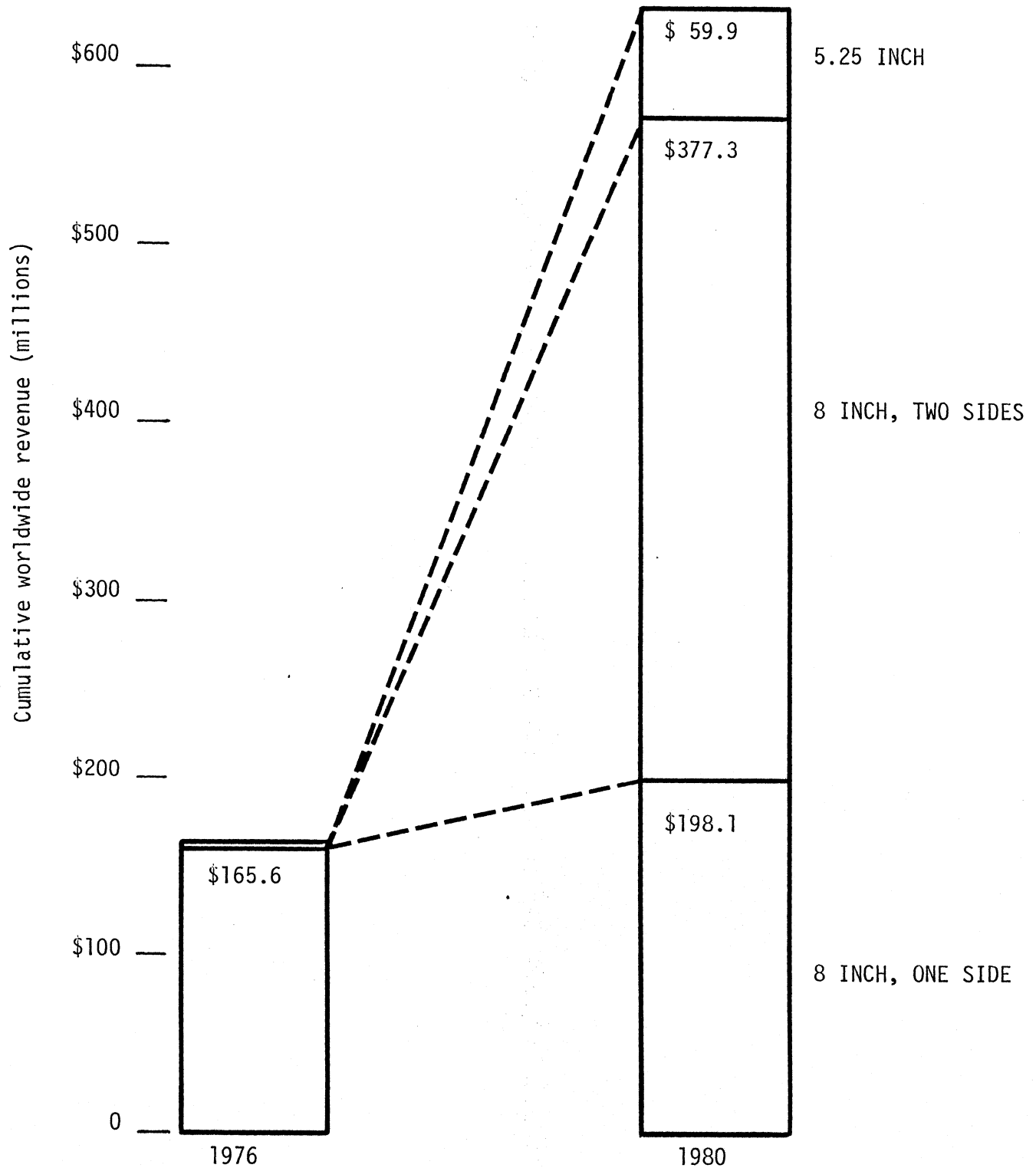
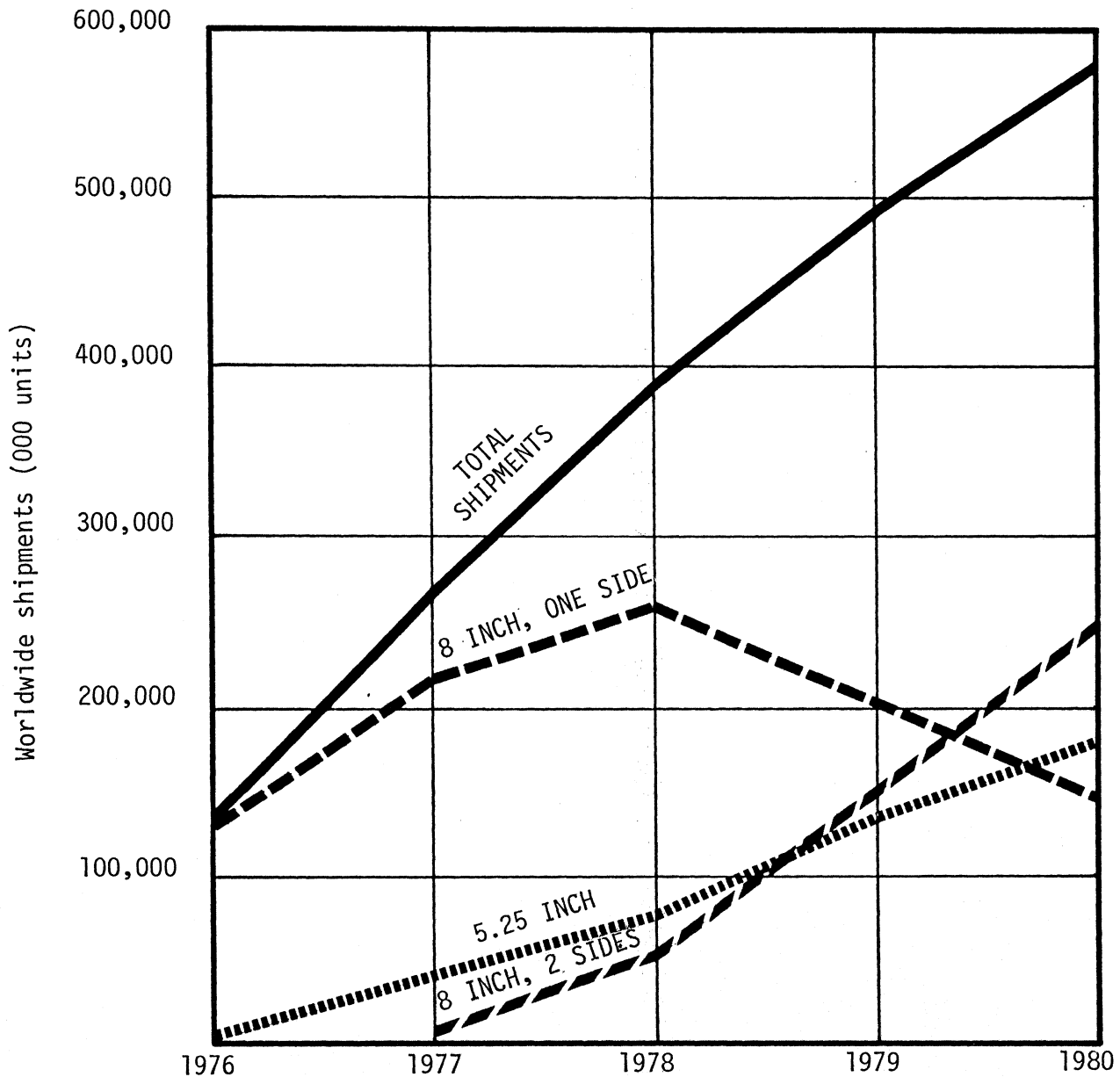


TABLE 3
WORLDWIDE SHIPMENTS
ALL FLEXIBLE DISK DRIVE GROUPS
PRODUCT CATEGORY SUMMARY

		F O R E C A S T									
		1976 Shipments		1977		1978		1979		1980	
		Ship	%	Ship	%	Ship	%	Ship	%	Ship	%
<u>Consolidated Shipments</u> <u>All Flexible Disk Drives</u>											
8 Inch, One Side:	Units (000)	198.3	99.5	322.2	83.7	400.0	69.0	336.0	45.1	258.0	29.1
	\$M	165.6	99.7	237.4	85.5	294.1	68.8	253.6	45.7	198.1	31.2
8 Inch, Two Sides:	Units (000)	.1	-	22.0	5.7	101.0	17.4	263.0	35.3	409.0	46.2
	\$M	.2	.1	31.1	11.2	115.0	26.9	264.1	47.6	377.3	59.4
5.25 Inch:	Units (000)	1.0	.5	40.6	10.6	79.0	13.6	146.0	19.6	219.0	24.7
	\$M	.3	.2	9.3	3.3	18.4	4.3	37.0	6.7	59.9	9.4
Total All FD Drives:	Units (000)	199.4	100.0	384.8	100.0	580.0	100.0	745.0	100.0	886.0	100.0
	\$M	166.1	100.0	277.8	100.0	427.5	100.0	554.7	100.0	635.3	100.0
Annual Growth Rate: Units		-		+93.0%		+50.7		+28.5		+18.9%	
\$		-		+67.3%		+53.9		+29.8		+14.5%	
<u>Worldwide Shipments</u> <u>OEM Drives</u>											
8 Inch, One Side:	Units (000)	131.0	99.2	221.6	82.1	262.2	67.1	203.3	41.7	144.7	24.9
	\$M	46.6	99.4	80.7	86.3	91.7	70.2	69.3	43.4	48.0	26.1
8 Inch, Two Sides:	Units (000)	-	-	7.7	2.9	52.3	13.4	150.7	30.9	248.1	42.7
	\$M	-	-	3.5	3.7	22.5	17.2	62.0	38.9	97.0	52.8
5.25 Inch:	Units (000)	1.0	.8	40.6	15.0	76.0	19.5	134.0	27.4	188.0	32.4
	\$M	.3	.6	9.3	10.0	16.4	12.6	28.3	17.7	38.9	21.1
Total All OEM Drives:	Units (000)	132.1	100.0	269.9	100.0	390.5	100.0	488.0	100.0	580.8	100.0
	\$M	46.9	100.0	93.5	100.0	130.6	100.0	159.6	100.0	183.9	100.0
Annual Growth Rate: Units		-		+104.3		+44.7%		+25.0%		+19.0%	
\$		-		+ 99.4%		+39.7%		+22.2%		+15.2%	

FIGURE 3
CHANGING PRODUCT MIX
WORLDWIDE FLEXIBLE DISK DRIVE SHIPMENTS
OEM UNIT SHIPMENTS



Application mix

Today's biggest non-IBM floppy drive application is with small business systems, which used an estimated 35% of all independent 8 inch, one side drives in 1976. The 8 inch, two side drive is expected to change that picture, with most newly designed small business systems using the two sided drive after 1977. However, because of the tendency of all old peripherals to not die (but merely fade away), one side drives should still account for about 25% of the shipments for this application as late as 1980.

Other heavy users of 8 inch, two side drives will be the capacity-hungry applications -- intelligent terminals and a variety of mini-computer based systems.

5.25 inch drives are expected to dominate applications such as word processing, hobby computers and "portable" computers. However, they will also find adoptions before 1980 with many other systems requiring cheap random access storage, including some data entry applications.

TABLE 4
NON-IBM WORLDWIDE SHIPMENTS
APPLICATION PROJECTION

<u>F.D. Drive Category</u>	<u>1976 Estimated</u>	<u>1980 Projection</u>
<u>8 Inch, One Side</u>		
Small business systems	35%	25%
Mini/Micro computer systems	22%	28%
Terminals, inc. data entry, intelligent	21%	26%
Word processing	15%	11%
Hobby computers	2%	1%
Other	5%	9%
<u>8 Inch, Two Sides</u>		
Small business systems	-	36%
Mini/Micro computer systems	-	27%
Terminals, inc. data entry, intelligent	-	32%
Word processing	-	-
Hobby computers	-	1%
Other	-	4%
<u>5.25 Inch</u>		
Small business systems	-	10%
Mini/Micro computer systems	-	22%
Terminals, inc. data entry, intelligent	-	15%
Word processing	-	28%
Hobby computers	-	14%
Other	-	11%

TABLE 5

1976 MARKET SHARES

U.S. FLEXIBLE DISK DRIVE MANUFACTURERS

Based on revenue generated by worldwide shipments
of flexible disk drives by U.S. manufacturers

	Captive		OEM		Total Industry	
	\$M	%	\$M	%	\$M	%
CALCOMP	.5	.6	7.6	18.1	8.1	6.2
CONTROL DATA	2.4	2.7	6.0	14.3	8.4	6.5
DATAPoint	2.4	2.7	-	-	2.4	1.8
GSI	-	-	2.1	5.0	2.1	1.6
IBM	78.2	88.0	-	-	78.2	59.8
INNOVEX	-	-	1.6	3.8	1.6	1.2
MEMOREX	.5	.6	4.5	10.7	5.0	3.8
PER SCI	-	-	.5	1.2	.5	.4
PERTEC	.7	.8	2.0	4.8	2.7	2.1
REMEX	-	-	.4	1.0	.4	.3
SHUGART	-	-	14.4	34.4	14.4	11.0
SYCOR	4.1	4.6	.2	.5	4.3	3.3
SYKES	-	-	1.2	2.9	1.2	.9
WANGCO	-	-	1.4	3.3	1.4	1.1
TOTAL	88.8	100.0	41.9	100.0	130.7	100.0

TABLE 6
CURRENT PRODUCT LINES
U.S. MANUFACTURERS OF FLEXIBLE DISK DRIVES

<u>Company</u>	<u>Type</u>	<u>10 8 Inch One Side</u>	<u>11 8 Inch Two Side</u>	<u>12 5.25 Inch</u>
BURROUGHS	C		X	
CALCOMP	C,0	X	X	
CONTROL DATA	C,0	X	X	
DATA POINT	C	X		
DEC	C	X		
GSI	0	X	X	X
IBM	C	X	X	
INNOVEX	0	X	X	
MEMOREX	C,0	X	X	
MICRO PERIPHERALS	0		X	X
MICROPOLIS	0			X
MFE	0		X	
PER SCI	0	X	X	
PERTEC	C,0	X	X	X
REMEX	0	X	X	
SHUGART	0	X	X	X
SYCOR	C,0	X		
SYKES	0	X		
WANGCO	C,0	X	X	X

Code: C = Captive
0 = OEM

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. All terms defined below are used throughout the DISK/TREND Report with the meanings given.

Market class: Used here, arbitrarily, to differentiate captive and OEM floppy 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 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 Wangco are non-captive, except for drives sold 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.

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

Independent: Any disk drive manufacturer other than IBM.

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

- * An OEM shipment by a U.S. drive manufacturer to a European system manufacturer is included in worldwide totals.
- * An OEM shipment by a Japanese drive manufacturer to a U.S. system manufacturer is included in U.S. totals.
- * A Burroughs shipment of a drive manufactured in Europe to a European end user is included in worldwide totals.

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, or OEM levels. All projected prices are in 1977 constant dollars.

Forecasts: Expected performance of 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 would probably require establishment of new DISK/TREND product categories.

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

Mainframe computer manufacturers: The major 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 Incoterm, Vydec or Tektronix. (2) Systems houses, of any size, which combine finished components and custom software to offer users complete systems.

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, Advanced Electronic Design and North Star.

Retail computer stores: Outlets performing the function of local trading area dealers, usually with a store suitable for walk-in trade, offering low cost computer systems, peripherals, other components and advice to individual buyers. Includes independent dealers, franchises such as Byte Shops, chains operated nationally in the manner of Tandy's Radio Shacks and the Heathkit organization, mixing retail outlets with mail order.

TECHNICAL REVIEW

Competing technologies

It is unlikely that any competing technology will seriously impact the high growth rates forecasted in this report for floppy disk drives through 1980. However, it should be noted that the newer memory technologies will develop specialized applications in the data processing market during this time frame, despite prices which are currently very high. These market niches will result in the start of volume production programs, and the inevitable initiation of the manufacturing experience curve leading to more competitive prices. Nevertheless, floppys' ace in the hole will be removability, an advantage that will protect many of its markets indefinitely. Here is the current status of the leading technology alternatives to floppy drives:

- * Charge coupled devices: CCDs offer access times and transfer rates well matched to mainframe memories, but their volatility is the major constraint in system design. Examples of probable early applications are in fast auxiliary memories associated with virtual memory operating systems, and as small memories with limited capabilities used with I/O devices and displays. Head per track disk drives are an early target, but moving head disk drives, both rigid and floppy, are not probable victims this decade. 64 K-bit devices are now available with 256 K-bit before 1980, with continual price reduction.
- * Magnetic bubbles: It is clear that bubbles will have a major segment of the future memory market -- but their impact on floppy disk drives through 1980 should be hardly noticeable. Bubbles cannot hope to provide removability in the foreseeable future, so floppy's key advantage of a cheap removable medium for input, back up, interchange and archival storage is unassailable. But even without that problem, bubbles will not match floppy's cost before the end of the decade -- since the floppy is a moving target, as noted in Table 7.

Rather than be regarded as a direct attack on floppies, bubbles probably should be appreciated for the product areas they will help to develop (some of which will even require floppy drives). The earliest major applications will be those with very limited physical space available for storage and which do not require larger capacities. Memory typewriters, point of sale devices, home computers, small programmable calculators, portable terminals, measurement/test equipment and certain military and aerospace systems are all likely candidates during this decade.

Texas Instruments introduced a 92 K-bit single chip device this year, and have already made use of it in a 17 pound portable terminal intended for field usage in newspaper reporting, real estate, insurance and order entry. 256 K-bit devices will probably be available in sample quantities from TI this year, with production before 1980. Bubble development programs are highly advanced in many U.S., Japanese and European companies, including the original inventor, Bell Labs -- plus IBM. An early IBM application could well be in connection with its very large typewriter business, as an improvement over the existing memory typewriter configuration.

Floppy drive enhancements

The technical innovations offered on commercially available floppy drives through 1980 will probably be strictly evolutionary, with no big surprises -- unless IBM decides to introduce one of its back-room projects now underway. Here is a review of the probable, and possible:

- * Double bit density: It is safe to expect continually expanding usage of double bit density recording in all three floppy formats. An important milestone will be IBM's delivery in January, 1978, of a two sided, double bit density drive with System/34, thus establishing, presumably, IBM's choice for a recording scheme. Independents will inevitably offer the chosen recording technique, and OEM system designers will probably fall in line. The net result should be a lot more double density systems.
- * Double track density: At least one drive manufacturer has been brave enough to offer double track density -- Micropolis is shipping 100 TPI 5.25 inch drives. It is probable that the combination of more accurate head positioning mechanisms and improved media dimensional stability will also lead to 8 inch drives with double track density during this decade. The thermal and hygroscopic stability problems are greater with the larger media size, but probably manageable. Increasing capacity appetites will stimulate action.

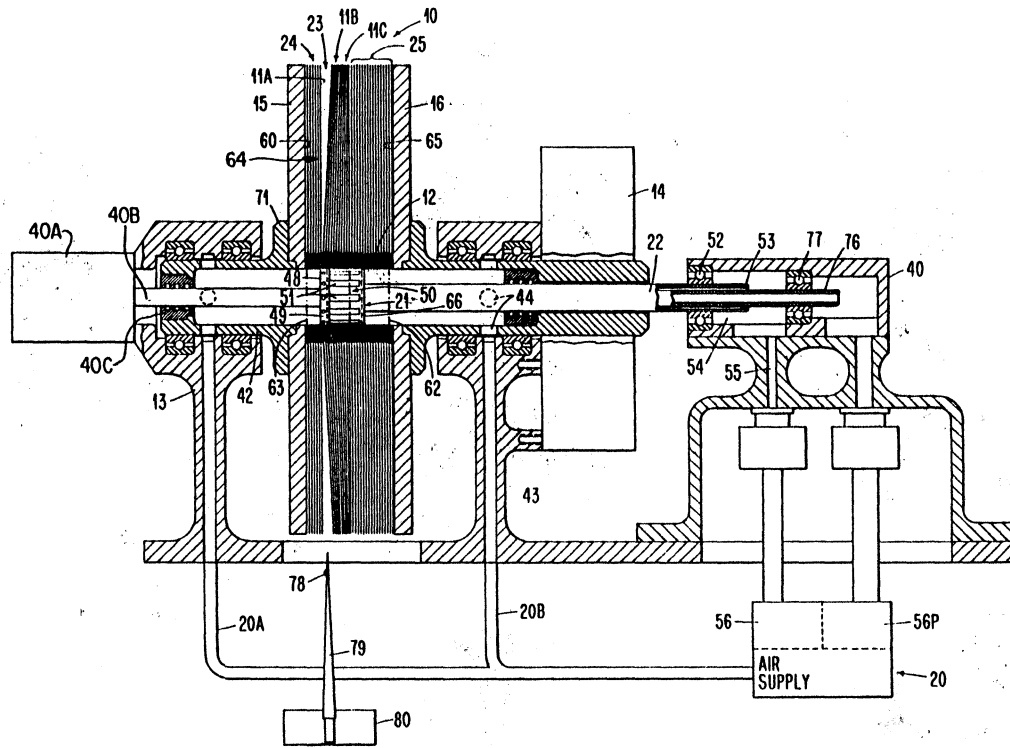
TABLE 7
PERFORMANCE PROJECTION
MAGNETIC BUBBLES VS. FLEXIBLE DISKS

	1 9 7 7			1 9 8 0		
	<u>Bubbles</u>	<u>5.25" Floppies</u>	<u>8" 2 Side Floppies</u>	<u>Bubbles</u>	<u>5.25" Floppies</u>	<u>8" 2 Side Floppies</u>
Capacity Per Device (MBytes)	.011	.250	1.6	.032	.300	3.2
Price Per Device (OEM)	\$ 75	\$ 230	\$ 455	\$ 25	\$ 200	\$ 390
Cost Per MByte	\$6500	\$ 920	\$ 284	\$ 800	\$ 667	\$ 122
Average Access (msec)	8	450	175	2	250	175
Transfer Rate (KB/Sec)	5.5	31.25	62.5	125	31.25	62.5
System Size (Cubic inches)	38	150	560	20	150	450
Reliability (MTBF-Hours)	10,000+	5,000	5,000	10,000+	8,000	8,000
Removability	No	Yes	Yes	No	Yes	Yes

- * Access time: High access times will always be acceptable in many price sensitive applications. But there are market segments responsive to access time improvements, and Per Sci has the 1977 sales increases to prove it. More voice coil head positioning is a good possibility, and wider use of the new 3 msec. track to track stepping motor systems introduced with two sided drives is predictable.
- * Two side drives: Now that 8 inch, two side drives are a reality, the introduction of 5.25 inch two side drives is an obvious step, and it's only a question of who does it first. The extra capacity in a small space could develop a large market.
- * Revolutionary improvements: Flying heads, high rotational speeds, new media substrates, smaller disks, larger disks, multiple-disk packs -- are all possible in commercial products this decade, and all have been tried, either in commercial products or in the lab. But don't bet on any to be successful commercial products before 1980 unless the computer industry's largest company introduces them. IBM certainly has carried out development programs in some of these areas -- for an interesting example, note the patent illustrations in Figure 4.

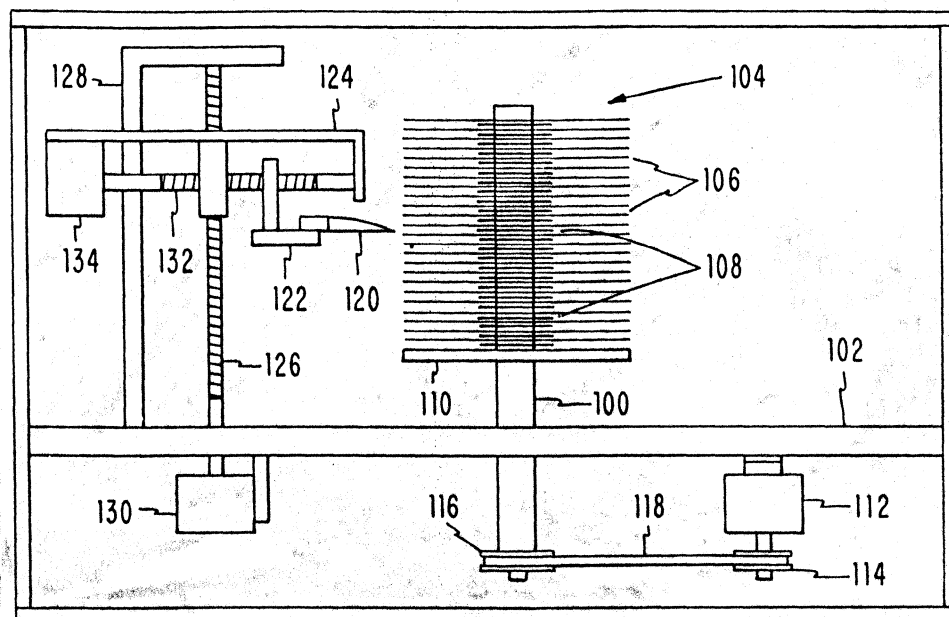
FIGURE 4

ILLUSTRATIONS FROM SELECTED IBM PATENTS
FLEXIBLE DISK STACK CONFIGURATIONS



U.S. Patent 4,019,204

April 19, 1977



U.S. Patent 3,975,769

August 17, 1976

FLEXIBLE DISK DRIVES, 8 INCH, ONE SIDE

Coverage

Examples of flexible disk drives included in this group include:

IBM	33FD (3740 series, System/32)
BASF	6101, 6102
Calcomp	140, 142, 142M
Control Data	9400, 9404
Datapoint	9381 series
DEC	RX01
GSI	FDD 110
Innovex	210, 220, 410, 420
Logabax	LX45D
Memorex	651, 550
Olivetti	FDU 2010, FDU 2020
Per Sci	70, 270, 277
Pertec	FD 511, FD 5X0, FD 400
Remex	RFD1000
SAGEM	DS3
Shugart	SA 800, SA 801
Sycor	FD 145
Sykes Datatronics	7150, 9150
Wangco	76, 87

This category includes drives designed for media interchangeability with IBM (frequently known as "3740 compatible"), as well as the hard sectorized drives available from most OEM suppliers, using holes around the inner diameter, to identify sectors. In addition, the Memorex 651 is included, despite its non-standard specifications. This pioneering drive, designed before IBM introduced the 3740 standard, utilizes essentially the same technology and is sold for similar applications to the rest of the drives in the group. However, the Dynastor drive has been excluded, in that the technology utilized is drastically different (flying head, 3600 RPM), and the drive is not commercially significant.

Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
U.S. manufacturers	130.2	182.1	223.8	194.9	152.4
All manufacturers	165.6	237.4	294.1	253.6	198.1

IBM created basic equipment/media standards for the 8 inch, one side floppy with the introduction of the 3740 data entry system in 1973 -- only four years ago. During that period, IBM has broadened its usage of the basic one side floppy to include several terminals, word processing systems, and the System/32 small business system, with an installed population estimated at 84,000 by the end of 1976.

The dramatic growth in shipments of floppy disk drives in the last few years, however, is attributable to the OEM market, sparked by rapidly increasing requirements for inexpensive, removable random access storage for applications such as small business computer systems, terminals of many types and word processing. Worldwide OEM shipments in 1976 are estimated at 131.1 drives, more than three times the number shipped by IBM.

Shugart Associates has established clear leadership among OEM drive suppliers, with an estimated 32.9% of worldwide 1976 OEM shipments by U.S. manufacturers. Shugart's market position is solidly based, with little reliance on individual major customers -- rather, with a large number of customers, serving all floppy applications. Calcomp was second in 1976, with an estimated 23.6% share, built largely on major purchases from DEC, which had not yet started its internal manufacturing program in 1976. Control Data completed transfer of floppy drive manufacturing from Hawthorne, California, to the MPI Oklahoma City plant

early in 1976, and secured a respectable 14.3% share. The balance of OEM sales were split among nine other U.S. manufacturers and eight non-U.S. manufacturers.

In 1976, captive production other than IBM's included only one major manufacturing program -- that of Olivetti, to support a diverse product line of small business systems, terminals and word processing equipment. Other captive manufacturing programs existed during 1976 in the U.S., Europe and Japan, but total captive floppy drive production, including Olivetti, totaled an estimated 28,200 units, only 14.2% of the total.

Marketing trends

Drives in this category are expected to reach their production peak in 1978, with growth beyond that point displaced by growing demand for 8 inch, two side drives and 5.25 inch drives. DISK/TREND projections of worldwide unit shipments of 8 inch, one side drives represent the following annual growth rates:

1977	+62.5%
1978	+24.2%
1979	-16.0%
1980	-23.2%

IBM shipments of drives in this category are expected to increase only slightly through 1978, then decline -- due to reduced demand for 3740 compatible drives for data entry, and a shift to two side drives for volume applications such as System/34 and Series/1. Other captive production is expected to increase at least 300% between 1976 and 1978,

as several internal manufacturing programs by major system OEMs get underway, including DEC, and probably Data General and Hewlett Packard. After 1978, however, growth in captive production will be diverted to two sided drives.

Starting in 1978, the shift in demand to two sided drives will also affect OEM markets in several data processing applications. The growth of 5.25 inch drive shipments will also displace 8 inch, one side sales for word processing applications and the emerging hobby computer market. Following the 1978 production peak, 8 inch, one side drive OEM shipments will fall off sharply, and 1980 worldwide shipments will have declined almost to 1976's level.

OEM average unit prices actually increased in 1977, according to DISK/TREND estimates. The largest cause of this temporary trend was the slowdown of floppy drive purchases from Calcomp by DEC -- at the industry's lowest price by far. Also contributing to higher average prices were increased shipments of higher priced drives by Memorex (the non-standard 651) and by Per Sci (voice coil head positioning). Much of this phenomenon is temporary, however, since DEC's withdrawal as an OEM buyer can only happen once, and time is catching up with the 651, which is expected to decline rapidly after 1977. Longterm, the OEM price trend continues down through 1980, eroded by learning curve improvements in manufacturing costs, larger volume purchases by individual OEMs (drive manufacturers will probably amalgamate purchases of all three drive types for quantity discount purposes), and the obvious effects of free-market competition.

Shugart is expected to retain its pre-eminent position as leading OEM supplier, but changes will occur in the second tier. Calcomp's

lost DEC sales will drop the firm from second place, and the replacement will be Control Data, now enjoying the growth of the systems offered by their several major customers.

Technical trends

The incentive for investment of the resources required to achieve significant improvements in the 8 inch, one side floppy drive format is not great. The 5.25 inch drive will satisfy the nearterm demand for lower cost. And the 8 inch, two sided drive will appeal to most system designers looking for capacity, especially in the double density versions.

Capacity increases in the 8 inch, one side format have centered on the double bit density drives available from almost all manufacturers of OEM drives. So far, double bit density is used by relatively few OEMs -- probably for several reasons, including lack of an industry standard for recording method, a tendency to use two standard density drives for redundancy instead of one double density drive, the frequent desire to maintain IBM compatibility, and the belief that a mere doubling of capacity is not significant enough to justify major system changes to utilize it.

Other developments, however, will probably stimulate growth of usage for higher capacity 8 inch, one side drives. IBM is scheduled to deliver its first floppy drive with double bit density in January, 1978 -- the two sided drive used with System/34. The recording system IBM uses with this drive, so far not revealed, may well establish another industry standard which will find wide usage in all floppy drive formats. In addition, there is the possibility that double track density may finally be offered -- it's already available on a 5.25 inch drive by Micropolis.

The biggest stimulus to higher capacity, however, will probably be the usual appetite for increased storage capacity on existing systems. Many systems relying completely on floppy drives for random access storage have been in the market for two to three years -- adequate time for existing capacity constraints to become a nuisance to users -- and system designers are going to be ready soon for more floppy capacity.

Access time is another performance area which could develop additional competitive activity. To date, Per Sci is the only manufacturer offering a linear motor actuator, apparently the only feasible method of greatly improving upon the access times available from the stepping motors used with all other floppy drives. Per Sci is achieving some success in 1977 in developing the market segment more interested in performance than price, and it would not be surprising to see competitive improvements in access time, using the same or other methods.

Forecasting assumptions

1. 8 inch, one side floppy drives will remain the dominant magnetic medium used for computer data entry through 1980, except for clustered terminal systems, which will tend toward usage of 8 inch, two sided drives.
2. 8 inch, one side floppy drives will be superseded by two sided drives for auxiliary storage required for a majority of new systems oriented to data processing applications introduced after 1977, including small business systems, intelligent terminals and miscellaneous mini/micro computer systems.
3. Existing applications for 8 inch, one side drives in word processing systems will be almost entirely replaced by 5.25 inch drives by 1980.
4. The trend to internal production of floppy drives by main-frame and major minicomputer manufacturers will continue.

TABLE 8
FLEXIBLE DISK DRIVES, 8 INCH, ONE SIDE
REVENUE SUMMARY

Disk Drive Revenues, by Shipment Destination (\$M)										
	1976		Forecast							
	Shipments		1977		1978		1979		1980	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<u>U.S. manufacturers</u>										
IBM	62.0	78.0	62.7	83.6	64.6	91.2	59.4	91.8	47.6	79.9
Other U.S. captive	8.2	10.6	21.1	28.8	39.9	57.0	34.1	48.7	26.0	37.2
TOTAL U.S. CAPTIVE	70.2	88.6	83.8	112.4	104.5	148.2	93.5	140.5	73.6	117.1
OEM	33.2	41.6	55.4	69.7	59.0	75.6	41.9	54.4	26.8	35.3
TOTAL U.S. NON-CAPTIVE	33.2	41.6	55.4	69.7	59.0	75.6	41.9	54.4	26.8	35.3
TOTAL U.S. PRODUCTION	103.4	130.2	139.2	182.1	163.5	223.8	135.4	194.9	100.4	152.4
<u>Non-U.S. manufacturers</u>										
Captive	1.8	30.4	3.9	44.3	7.7	54.2	6.0	43.8	3.6	33.0
OEM	--	5.0	--	11.0	.7	16.1	1.0	14.9	1.0	12.7
TOTAL NON-U.S. PRODUCTION	1.8	35.4	3.9	55.3	8.4	70.3	7.0	58.7	4.6	45.7
<u>Worldwide recap</u>										
TOTAL WORLDWIDE PRODUCTION	165.6		237.4		294.1		253.6		198.1	
TOTAL WORLDWIDE CAPTIVE	119.0		156.7		202.4		184.3		150.1	
TOTAL WORLDWIDE NON-CAPTIVE	46.6		80.7		91.7		69.3		48.0	

TABLE 9
FLEXIBLE DISK DRIVES, 8 INCH, ONE SIDE
UNIT SHIPMENT SUMMARY

	Installed YE 1975	1976 Shipments			Installed YE 1976	Forecast							
		Captive	Non-capt.	Total		1977		1978		1979		1980	
						Ship	Inst	Ship	Inst	Ship	Inst	Ship	Inst
<u>U.S. net shipments</u>													
IBM -- Units (000)	53.0	31.0	-	31.0	84.0	33.0	117.0	34.0	151.0	33.0	184.0	28.0	212.0
Non-IBM -- Units (000)	58.5	8.3	94.9	103.2	161.7	176.5	338.2	216.3	554.5	168.1	722.6	118.5	841.1
Total -- Units (000)	111.5	39.3	94.9	134.2	245.7	209.5	445.2	250.3	705.5	201.1	906.6	146.5	1053.1
<u>Worldwide net shipments</u>													
IBM -- Units (000)	66.0	39.0	-	39.0	105.0	44.0	149.0	48.0	197.0	51.0	248.0	47.0	295.0
Non-IBM -- Units (000)	81.5	28.2	131.1	159.3	240.8	278.2	519.0	352.0	871.0	285.0	1156.0	211.0	1367.0
Total -- Units (000)	147.5	67.2	131.1	198.3	345.8	322.2	668.0	400.0	1068.0	336.0	1404.0	258.0	1662.0

FLEXIBLE DISK DRIVES, 8 INCH, TWO SIDES

Coverage

Examples of flexible disk drives included in this group include:

IBM	43FD (3601, 3602, System/34), 4964
Burroughs	9489-1, 9489-2
Calcomp	143M
Control Data	9406
DRI	7200
GSI	FDD 200
Memorex	552
MFE	MFE 700
Micro Peripherals	B 82
Per Sci	288, 299
Shugart	SA 850, SA 851
Wangco	276

With the exception of the Burroughs drive, all independent drives above are intended to provide media interchangeability with IBM drives operated at "single" density. Most of the independent drives can also be operated in a double density mode, using one of the three recording systems provided by individual manufacturers. It is a reasonable assumption that most independent manufacturers will quickly offer the same double density recording system as IBM provides on the System/34's floppy drive, when delivered in January, 1978.

Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
U.S. manufacturers	.2	30.6	103.8	217.0	289.4
All manufacturers	.2	31.1	115.0	264.1	377.3

IBM established the industry's standards for two sided floppy drives, with the 1976 introductions of the 3601 and 3602 (3600 financial terminal

TABLE 10
 FLEXIBLE DISK DRIVES, 8 INCH, ONE SIDE
 PRICE SUMMARY
 Non-Captive Disk Drives

	1976 net shipments		Forecast							
			1977		1978		1979		1980	
	<u>U.S.</u>	<u>Worldwide</u>	<u>U.S.</u>	<u>WW</u>	<u>U.S.</u>	<u>WW</u>	<u>U.S.</u>	<u>WW</u>	<u>U.S.</u>	<u>WW</u>
<u>Non-captive shipments</u>										
OEM -- Units (000)	94.9	131.1	153.8	221.6	173.0	262.2	128.0	203.3	85.6	144.7
<u>Average unit price</u>										
To OEMs (\$)	350	360	360	364	345	350	335	341	325	332
<u>Value of shipments</u>										
To OEMs (\$M)	33.2	47.2	55.4	80.7	59.7	91.7	42.9	69.3	27.8	480

TABLE 11
FLEXIBLE DISK DRIVES, 8 INCH, ONE SIDE
DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

<u>Distribution channel</u>	1976 U.S. Net Shipments		FORECAST			
	<u>Units (000)</u>	<u>%</u>	<u>1977 %</u>	<u>1978 %</u>	<u>1979 %</u>	<u>1980 %</u>
Mainframe computer manufacturers	9.7	10.2	10.0	9.4	8.9	8.6
Mini/micro computer manufacturers	28.1	29.6	29.1	28.7	28.4	28.1
System OEMs/system houses	43.8	46.1	47.0	48.7	49.5	50.2
Independent peripherals suppliers	10.4	11.0	11.7	12.2	12.4	12.5
Direct to end user/retail dealers	2.9	3.1	2.2	1.0	.8	.6
TOTAL	94.9					

TABLE 12
FLEXIBLE DISK DRIVES, 8 INCH, ONE SIDE
MARKET SHARE SUMMARY
Non-Captive Disk Drives

<u>Drive manufacturers</u>	1976 Net Shipments			
	To United States Destinations		Worldwide	
	<u>Units (000)</u>	<u>%</u>	<u>Units (000)</u>	<u>%</u>
SHUGART	31.2	32.9	39.0	32.9
CALCOMP	24.0	25.3	28.0	23.6
CONTROL DATA	12.8	13.5	17.0	14.3
MEMOREX	8.1	8.5	9.0	7.6
GSI	3.0	3.2	6.0	5.0
PERTEC	4.3	4.5	5.4	4.6
INNOVEX	4.5	4.7	4.5	3.8
WANGCO	2.0	2.1	4.0	3.4
SYKES	2.4	2.5	3.0	2.5
PER SCI	1.1	1.2	1.2	1.0
REMEX	1.0	1.1	1.0	.8
SYCOR	.5	.5	.6	.5
	94.9	100.0	118.7	100.0

FLEXIBLE DISK DRIVES, 8 INCH, TWO SIDES

Coverage

Examples of flexible disk drives included in this group include:

IBM	43FD (3601, 3602, System/34), 4964
Burroughs	9489-1, 9489-2
Calcomp	143M
Control Data	9406
DRI	7200
GSI	FDD 200
Memorex	552
MFE	MFE 700
Micro Peripherals	B 82
Per Sci	288, 299
Shugart	SA 850, SA 851
Wangco	276

With the exception of the Burroughs drive, all independent drives above are intended to provide media interchangeability with IBM drives operated at "single" density. Most of the independent drives can also be operated in a double density mode, using one of the three recording systems provided by individual manufacturers. It is a reasonable assumption that most independent manufacturers will quickly offer the same double density recording system as IBM provides on the System/34's floppy drive, when delivered in January, 1978.

Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
U.S. manufacturers	.2	30.6	103.8	217.0	289.4
All manufacturers	.2	31.1	115.0	264.1	377.3

IBM established the industry's standards for two sided floppy drives, with the 1976 introductions of the 3601 and 3602 (3600 financial terminal

system) and the 4964 (Series/1 minicomputer system). IBM shipments were minimal in 1976, and are estimated at only 5,000 drives for 1977.

The only other captive manufacturing program to date involves the Burroughs unique design, announced in 1976, with production shipments starting in late 1976 and early 1977.

Shugart is leading in early OEM shipments, having made initial deliveries as early as May, 1977 -- and is expected to ship several thousand drives in 1977. Other manufacturers of OEM drives will make first shipments during fourth quarter of 1977, for the most part, and total worldwide 1977 shipments of OEM drives are expected to be below 8,000 units.

Marketing trends

IBM will rapidly increase shipment levels of two sided drives through the remainder of this decade, as installations of System/34 and Series/1 accelerate. DISK/TREND estimates show an IBM average annual growth rate of 123.6% through 1980.

Other captive manufacturing programs are expected to increase even faster than IBM's, realizing a 145.6% average annual growth rate through 1980. Most of this increase is traceable to the expected growth in small business systems and intelligent terminal systems offered by the existing and future producers of two sided floppy drives.

Initial shipments of OEM drives are expected to be heavily oriented to system OEMs and systems houses, due to the relative speed with which these customers are prepared to integrate the new drives into their systems. By the end of 1978, however, distribution patterns are expected to more closely resemble those of one sided drives -- with

system OEMs and systems houses still taking half the total OEM output, but minicomputer manufacturers and other OEMs starting to buy in volume.

For most OEMs the motivation to switch to two sided drives will involve both the desire for increased on-line storage capacity and the attractive reduction in cost per megabyte. Capacity of drives now offered is up to 1.6 MB unformatted. And the cost per megabyte is expected to be 38.6% less than for one sided drives in 1978, based on DISK/TREND projections of average unit price.

In general, most current systems using one sided drives can be adapted to two sided drives much faster than if other completely new peripherals were involved. All independent two sided drives are designed to be plug compatible and mounting hole compatible with one sided drives from the same manufacturer, with only minor software modifications required to utilize both sides of the disk. As a result, manufacturers of OEM drives are expected to realize a rather startling 277.5% average annual increase through 1980 in worldwide shipments. Of course, a large portion of this growth represents displacement of one sided drive sales which would have occurred without the presence of the two sided drive.

OEM two sided drives will command a 25% premium over one sided drives in 1977, but this differential will gradually decrease, so that in 1980 the spread will be about 18%.

Technical trends

As noted above, it is expected that most OEM drives will match the double density recording system (2X linear density) offered by IBM as soon as it becomes clear what this system is. This step will

be necessary in order to provide complete media compatibility with IBM double density drives. But the broader industry benefit will be the existence of a de facto standard for double bit density, which will inevitably result in wider usage of the double density capability of these drives in commercial systems.

The next step will probably be double track density. All of the independent two sided drives utilize either the IBM-type band head positioner or improved stepping motor-lead screw mechanisms. In addition to faster track to track positioning times (down to 3 msec.), these devices are capable of more accurate head positioning. Thus the introduction of double track density is a good bet in the two sided drive category. Of course, this is all based on the assumption that media thermal and hygroscopic stability prove adequate for reliable double track density recording under the normal range of environmental conditions. If not, some kind of track following system will probably be required, boosting drive cost significantly, and delaying introduction of the feature for some time.

It should be noted that a double bit density, double track density, two sided, 8 inch floppy drive would have an unformatted capacity of 3.2 MB. Such a drive would probably sell in OEM quantities for about 25% of the single disk cartridge drive it could replace. Obviously, this area represents an attractive future growth direction for this category of floppy drives.

Forecasting assumptions

1. 8 inch, two sided floppy drives will be chosen as the auxiliary storage medium for the majority of new systems

oriented to data processing applications after 1977, including small business systems, intelligent terminals and miscellaneous mini/micro computer systems.

2. Unformatted capacities of drives in this category will reach 3.2 MB before 1980, expanding floppy drive market penetration to the areas now covered by smaller capacity rigid disk cartridge drives.

TABLE 13
FLEXIBLE DISK DRIVES, 8 INCH, TWO SIDES
REVENUE SUMMARY

Disk Drive Revenues, by Shipment Destination (\$M)										
	1976		Forecast							
	Shipments		1977		1978		1979		1980	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<u>U.S. manufacturers</u>										
IBM	.2	.2	10.5	13.2	35.7	44.1	62.0	82.0	87.4	125.4
Other U.S. captive	-	-	8.6	14.4	26.7	41.0	58.2	86.9	59.6	89.0
TOTAL U.S. CAPTIVE	.2	.2	19.1	27.6	62.4	85.1	120.2	168.9	147.0	214.4
OEM	-	-	2.6	3.0	14.9	18.7	37.5	48.1	57.0	75.0
TOTAL U.S. NON-CAPTIVE	-	-	2.6	3.0	14.9	18.7	37.5	48.1	57.0	75.0
TOTAL U.S. PRODUCTION	.2	.2	21.7	30.6	77.3	103.8	157.7	217.0	204.0	289.4
<u>Non-U.S. manufacturers</u>										
Captive	-	-	-	-	.7	7.4	3.2	33.2	6.8	65.9
OEM	-	-	-	.5	.1	3.8	.8	13.9	1.7	22.0
TOTAL NON-U.S. PRODUCTION	-	-	-	.5	.8	11.2	4.0	47.1	8.5	87.9
<u>Worldwide recap</u>										
TOTAL WORLDWIDE PRODUCTION	.2		31.1		115.0		264.1		377.3	
TOTAL WORLDWIDE CAPTIVE	.2		27.6		92.5		202.1		280.3	
TOTAL WORLDWIDE NON-CAPTIVE	-		3.5		22.5		62.0		97.0	

TABLE 14
FLEXIBLE DISK DRIVES, 8 INCH, TWO SIDE
UNIT SHIPMENT SUMMARY

	Installed YE 1975	1976 Shipments			Installed YE 1976	Forecast							
		Captive	Non-capt.	Total		1977		1978		1979		1980	
						Ship	Inst	Ship	Inst	Ship	Inst	Ship	Inst
<u>U.S. net shipments</u>													
IBM -- Units (000)	-	.1	-	.1	.1	5.0	5.1	17.0	22.1	31.0	53.1	46.0	99.1
Non-IBM -- Units (000)	-	-	-	-	-	10.6	10.6	51.5	62.1	133.0	195.1	196.6	391.7
Total -- Units (000)	-	.1	-	.1	.1	15.6	15.7	68.5	84.2	164.0	248.2	242.6	490.8
<u>Worldwide net shipments</u>													
IBM -- Units (000)	-	.1	-	.1	.1	6.3	6.4	21.0	27.4	41.0	68.4	66.0	134.4
Non-IBM -- Units (000)	-	-	-	-	-	15.7	15.7	80.0	95.7	222.0	317.7	343.0	660.7
Total -- Units (000)	-	.1	-	.1	.1	22.0	22.1	101.0	123.1	263.0	386.1	409.0	795.1

TABLE 15
 FLEXIBLE DISK DRIVES, 8 INCH, TWO SIDE
 PRICE SUMMARY
 Non-Captive Disk Drives

	1976 net shipments		Forecast							
			1977		1978		1979		1980	
	<u>U.S.</u>	<u>Worldwide</u>	<u>U.S.</u>	<u>WW</u>	<u>U.S.</u>	<u>WW</u>	<u>U.S.</u>	<u>WW</u>	<u>U.S.</u>	<u>WW</u>
<u>Non-captive shipments</u>										
OEM -- Units (000)	--	--	5.8	7.7	35.4	52.3	94.6	150.7	152.4	248.1
<u>Average unit price</u>										
To OEMs (\$)	--	--	440	455	425	430	405	411	385	391
<u>Value of shipments</u>										
To OEMs (\$M)	--	--	2.6	3.5	15.0	22.5	38.3	62.0	58.7	97.0

TABLE 16
FLEXIBLE DISK DRIVES, 8 INCH, TWO SIDES

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

<u>Distribution channel</u>	Shipments to U.S. Destinations Forecast			
	<u>1977</u> %	<u>1978</u> %	<u>1979</u> %	<u>1980</u> %
Mainframe computer manufacturers	-	5.2	7.4	8.1
Mini/micro computer manufacturers	18.9	22.1	26.8	29.2
System OEMs/system houses	73.0	61.3	51.9	48.4
Independent peripherals suppliers	8.1	10.8	13.0	13.2
Direct to end user/retail dealers	-	.6	.9	1.1

FLEXIBLE DISK DRIVES, 5.25 INCH

Coverage

Examples of flexible disk drives included in this group include:

BASF	6106
Micro Peripherals	B 52
Micropolis	1015-II, 1043-II, 1053-II
Pertec	FD 200
Shugart	SA 400
Wangco	82

All of the drives in this group are designed to use the 5.25 inch diskette introduced by Shugart in 1976. There is wide divergence in recording systems, however, with interchangeability between drives of different manufacturers not possible in most cases.

Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
U.S. manufacturers	.3	9.3	16.6	28.6	44.1
All manufacturers	.3	9.3	18.4	37.0	59.9

Shugart Associates, not IBM, created the standards for this product category. Actually, Shugart's leadership in OEM floppy drive sales did enable them to define the media standard, but their competitors have attempted to supply their own improvements for every other parameter -- including recording method, track placement and track density. In general, it is fair to say that Shugart attempted to design a reliable drive, producible at minimum cost. Competition, understandably, designed drives with a variety of additional features -- but many of which add cost. As in most markets, it is likely that some customers will be responsive to

individual advanced features, but to date the main stream of latent demand for drives in this category seems to be that segment of the market sensitive to low price.

Shugart initiated shipments in 1976, with heavy early deliveries to Wang Labs. Shugart will also deliver the lion's share of 1977 shipments, about 84% of the worldwide total according to DISK/TREND estimates.

Most manufacturers are finding a very fast response to the availability of these drives from computer hobbyists, who are in a position to select and buy a floppy drive without the evaluation and systems design delays inherent in most OEM sales. About a third of 1977 unit shipments are expected to go to hobbyists, most through the network of retail computer stores which have appeared in metropolitan areas throughout the U.S.

Other significant early applications are expected to be in word processing systems and in "portable" computers. Volume shipments for these applications will be dependent upon the design and introduction of next-generation systems by most OEMs, however, since existing systems are rarely re-designed to utilize a newly available peripheral.

Marketing trends

The 5.25 inch drive category seems destined to remain primarily an OEM arena through 1980, since existing floppy drive captive programs are mostly intended to support system OEM's small business system and intelligent terminal programs, areas hungry for additional capacity, not less. Worldwide unit shipments are expected to grow at a very respectable average annual rate of 67.9% through 1980, based on DISK/TREND projections.

As traditional OEMs find applications for extremely low-cost floppy drives, shipments to a wide variety of system OEMs, minicomputer manufacturers, and even mainframers can be expected, with the result that the distribution channel mix for 5.25 inch drives will be transformed by 1980 to a pattern resembling that for today's industry. By 1980, the hobbyist sales through computer retail stores will account for only about 10% of total shipments, it is estimated.

An interesting aberration in the early marketing pattern for 5.25 inch drives will probably be caused by the acquisition of Shugart Associates by Xerox, if the deal now pending is finally consummated. Xerox ownership of the firm shouldn't affect its ability to sell to most types of OEMs, but may prove fatal with Xerox' word processing competitors. Shugart's competitors now offering 5.25 inch drives are renewing their efforts in this market segment, and several floppy drive manufacturers which have passed up the 5.25 inch area so far are re-examining the area.

Shugart's price reduction in mid-1977 has made this market a harsh environment for competitors unable to generate significant production volume early in their programs. DISK/TREND estimates place 1977's world-wide OEM average unit price below \$230, with the level approaching \$200 in 1980, as the increasing size of customer purchases and the forces of competition have their effect.

Technical trends

All of the innovations which currently are available with 8 inch floppy drives, as well as future enhancements, will probably be offered in this category. Double track density (actually 100 TPI) is available

from Micropolis, and double bit density is available on several drives. Two-sided drives will probably be offered before too long, and faster access times are probably not far behind. There is undoubtedly a market for all these capabilities, especially in view of the drive's basic advantage of diminutive size and weight -- but, as noted, the volume markets will be most responsive to low price.

It should be noted that the grapevine has reported an IBM development program involving a 3 inch floppy disk, for an unknown application. If such a drive were announced by IBM during the period covered by this report, it could obviously impact the projections included, with the degree of impact dependent on the nature of the drive and its application.

Forecasting assumptions

1. 5.25 inch floppy drives will become dominant for computer hobbyist applications and will be selected for a majority of newly designed systems of various types after 1977, including word processing, "portable" computers, programmable calculators, and certain small business system data entry requirements not requiring IBM media interchangeability.
2. Numerous performance enhancements will continue to be offered by floppy drive manufacturers, and the 5.25 inch format will not settle down to industry-wide standard specifications for 2-3 years, facilitating the successful market entry by new floppy drive manufacturers in 1977.

TABLE 17
FLEXIBLE DISK DRIVES, 5.25 INCH
REVENUE SUMMARY

Disk Drive Revenues, by Shipment Destination (\$M)										
	1976		Forecast							
	Shipments		1977				1978		1979	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<u>U.S. manufacturers</u>										
IBM	-	-	-	-	-	-	-	-	-	-
Other U.S. captive	-	-	-	-	1.6	2.0	3.0	3.8	9.8	12.3
TOTAL U.S. CAPTIVE	-	-	-	-	1.6	2.0	3.0	3.8	9.8	12.3
OEM	.2	.3	7.8	9.3	12.1	14.6	19.8	24.8	23.8	31.8
TOTAL U.S. NON-CAPTIVE	.2	.3	7.8	9.3	12.1	14.6	19.8	24.8	23.8	31.8
TOTAL U.S. PRODUCTION	.2	.3	7.8	9.3	13.7	16.6	22.8	28.6	33.6	44.1
<u>Non-U.S. manufacturers</u>										
Captive	-	-	-	-	-	-	.6	4.9	1.2	8.7
OEM	-	-	-	-	.4	1.8	.8	3.5	1.2	7.1
TOTAL NON-U.S. PRODUCTION	-	-	-	-	.4	1.8	1.4	8.4	2.4	15.8
<u>Worldwide recap</u>										
TOTAL WORLDWIDE PRODUCTION	.3		9.3		18.4		37.0		59.9	
TOTAL WORLDWIDE NON-CAPTIVE	-		-		2.0		8.7		21.0	
TOTAL WORLDWIDE NON-CAPTIVE	.3		9.3		16.4		28.3		38.9	

TABLE 18
FLEXIBLE DISK DRIVES, 5.25 INCH
UNIT SHIPMENT SUMMARY

	Installed YE 1975	1976 Shipments			Installed YE 1976	Forecast							
		Captive	Non-capt.	Total		1977		1978		1979		1980	
						Ship	Inst	Ship	Inst	Ship	Inst	Ship	Inst
<u>U.S. net shipments</u>													
IBM -- Units (000)	--	--	--	--	--	--	--	--	--	--	--	--	--
Non-IBM -- Units (000)	--	--	.9	.9	.9	34.5	35.4	60.8	96.2	104.2	200.4	140.3	340.7
Total -- Units (000)	--	--	.9	.9	.9	34.5	35.4	60.8	96.2	104.2	200.4	140.3	340.7
<u>Worldwide net shipments</u>													
IBM -- Units (000)	--	--	--	--	--	--	--	--	--	--	--	--	--
Non-IBM -- Units (000)	--	--	1.0	1.0	1.0	40.6	41.6	79.0	120.6	146.0	266.6	219.0	485.6
Total -- Units (000)	--	--	1.0	1.0	1.0	40.6	41.6	79.0	120.6	146.0	266.6	219.0	485.6

TABLE 19
 FLEXIBLE DISK DRIVES, 5.25 INCH
 PRICE SUMMARY
 Non-Captive Disk Drives

	1976 net shipments		Forecast							
			1977		1978		1979		1980	
	<u>U.S.</u>	<u>Worldwide</u>	<u>U.S.</u>	<u>WW</u>	<u>U.S.</u>	<u>WW</u>	<u>U.S.</u>	<u>WW</u>	<u>U.S.</u>	<u>WW</u>
<u>Non-captive shipments</u>										
OEM -- Units (000)	.9	1.0	34.5	40.6	58.4	76.0	98.4	134.0	122.3	188.0
<u>Average unit price</u>										
To OEMs (\$)	270	275	226	229	214	216	209	211	204	207
<u>Value of shipments</u>										
To OEMs (\$M)	.2	.3	7.8	9.3	12.5	16.4	20.6	28.3	25.0	38.9

TABLE 20
FLEXIBLE DISK DRIVES, 5.25 INCH
DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

<u>Distribution channel</u>	1976 U. S. net shipments		Forecast			
	<u>Units (000)</u>	<u>%</u>	<u>1977 %</u>	<u>1978 %</u>	<u>1979 %</u>	<u>1980 %</u>
Mainframe computer manufacturers	--	--	--	3.8	5.5	6.2
Mini/micro computer manufacturers	--	--	23.7	19.0	17.1	16.0
System OEMs/system houses	1.0	100.0	31.4	44.6	51.0	54.2
Independent peripherals suppliers	--	--	7.9	11.1	12.7	13.5
Direct to end user/retail dealers	--	--	37.0	21.5	13.7	10.1
TOTAL	1.0					

DISK DRIVE SPECIFICATIONS

Coverage

Although this listing is probably not complete, it includes most drives now in new production or announced.

Generally, no attempt has been made to include drives sold by computer system manufacturers but purchased on an OEM basis from others. Also not mentioned by specific model number in most cases are captive drives which are similar to OEM models made by the same manufacturer. Listings for most drive manufacturers are confined to OEM drive models, but subsystems complete with power supply, controller and interface are listed for some manufacturers, for clarity.

DISK/TREND categories

In most cases category assignments noted for individual drives are rather straightforward, but a few arbitrary decisions have been made. For example, the Dynastor drive, recently acquired by Cipher Data Products, is not included in the existing categories, due to its completely non-compatible characteristics.

Generic type

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

Capacities

An attempt has been made to give unformatted capacities for all drives, except in instances where information was not available from the manufacturer, in which cases formatted capacities are shown. All capacities are per spindle.

Accuracy

This information has been made as accurate as possible through extensive cross-checking. 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. Please point out any errors -- or omissions -- you may notice; 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

Manufacturer	BASF			BURROUGHS	
DRIVE	6101	6102	6106	9489-1	9489-2
DISK/TREND GROUP	10	10	12	11	11
MEDIA COMPATIBILITY	Diskette 1	Diskette 1	BASF 606	Special	Special
SECTORING	H/S	H/S	H/S	H	H
CAPACITY (MBytes)	.401	.401/.802	.1094	1.25	1.25
PERFORMANCE					
Recording surfaces per spindle	1	1	1	2	2
Tracks per surface	77	77	40	88	88
TPI	48	48	48	64	64
BPI	3268	3268/6536	2767	4775	4775
RPM	360	360	300	365	365
POSITIONING: Track to track (msec)	6	6	12	5	5
Settling time (msec)	12	12	45	50	50
Head load time (msec)	40	40	35	85	85
Average rotational delay (msec)	83.3	83.3	100	82	82
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	15.63	50	50
FIRST CUSTOMER SHIPMENT	1976	1976	1Q78	1976 Single	1976 Dual

Manufacturer	CALCOMP			
DRIVE	140	142	142M	143M
DISK/TREND GROUP	10	10	10	11
MEDIA COMPATIBILITY	Diskette 1	Diskette 1	Diskette 1	Diskette 1 Diskette 2
SECTORING	H/S	H/S	H/S	H/S
CAPACITY (MBytes)	.401	.802	.802	.802/1.6
PERFORMANCE				
Recording surfaces per spindle	1	1	1	2
Tracks per surface	77	77	77	77
TPI	48	48	48	48
BPI	3268	6536	3268/6536	3268/6536
RPM	360	360	360	360
POSITIONING: Track to track (msec)	6	6	6	6
Settling time (msec)	10	10	10	10
Head load time (msec)	16	16	30	30
Average rotational delay (msec)	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
FIRST CUSTOMER SHIPMENT	1/74	8/75	1/77	9/77

Manufacturer	CONTROL DATA			DATAPOINT
DRIVE	9400	9404	9406	9381 Series
DISK/TREND GROUP	10	10	11	10
MEDIA COMPATIBILITY	9878 Diskette 1	9878 Diskette 1	Diskette 1 Diskette 2	Diskette 1
SECTORING	H/S	H/S	H/S	S
CAPACITY (MBytes)	.401	.802	.802/1.6	.256
PERFORMANCE				
Recording surfaces per spindle	1	1	2	1
Tracks per surface	77	77	77	77
TPI	48	48	48	48
BPI	3268	3268/6536	3268/6536	3268
RPM	360	360	360	360
POSITIONING: Track to track (msec)	10	10	6	10
Settling time (msec)	10	10		20
Head load time (msec)	60	60	40	35
Average rotational delay (msec)	83.3	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	31.25/62.5	31.25
FIRST CUSTOMER SHIPMENT	3/74	11/75	4Q77	1976

Manufacturer	DATA RECORDING INSTRUMENTS	DIGITAL EQUIPMENT CORP.
DRIVE	7200	RX01
DISK/TREND GROUP	11	10
MEDIA COMPATIBILITY	Diskette 1 Diskette 2	RX01K Diskette 1
SECTORING	H/S	S
CAPACITY (MBytes)	.8/1.6	.256
PERFORMANCE		
Recording surfaces per spindle	2	1
Tracks per surface	77	77
TPI	48	48
BPI	3268/6536	3268
RPM	360	360
POSITIONING: Track to track (msec)	6	10
Settling time (msec)	14	20
Head load time (msec)	30	16
Average rotational delay (msec)	83.3	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25
FIRST CUSTOMER SHIPMENT	1977	1976

Manufacturer	FACIT AB	GENERAL SYSTEMS INTERNATIONAL	
DRIVE	4231	FDD 110	FDD 200
DISK/TREND GROUP	10	10	11
MEDIA COMPATIBILITY	Diskette 1	Diskette 1	Diskette 1 Diskette 2
SECTORING	H/S	H/S	H/S
CAPACITY (MBytes)	.401/.802	.401	.8/1.6
PERFORMANCE			
Recording surfaces per spindle	1	1	2
Tracks per surface	77	77	77
TPI	48	48	48
BPI	3268/6536	3268/6536	3268/6536
RPM	360	360	360
POSITIONING: Track to track (msec)	4	6	3
Settling time (msec)	20	14	14
Head load time (msec)	25	35	35
Average rotational delay (msec)	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5
FIRST CUSTOMER SHIPMENT	1976	1975	4Q77

Manufacturer	IBM				
DRIVE	3740 Series (33RD Drive)	System/32 (33FD Drive)	System/34 (43FD Drive)	3601 3602 (43FD Drive)	4964
DISK/TREND GROUP	10	10	11	11	11
MEDIA COMPATIBILITY	Diskette 1	Diskette 1	Diskette 1 Diskette 2	Diskette 1 Diskette 2	Diskette 1 Diskette 2
SECTORING	S	S	S	S	S
CAPACITY (MBytes)	.242944	.303104 (Extended format)	.303 or 1.212	.140 or .420	.492, .568 or .606
PERFORMANCE					
Recording surfaces per spindle	1	1	1/2	1/2	2
Tracks per surface	77	77	77	77	77
TPI	48	48	48	48	48
BPI	3200	3200	3200/6400	3200	3200
RPM	360	360	360	360	360
POSITIONING: Track to track (msec)	50	50	5	5	5
Settling time (msec)	20	20	35	35	35
Head load time (msec)	80	80			
Average rotational delay (msec)	83.3	83.3	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	31.25	31.25	31.25/62.5	31.25	31.25
FIRST CUSTOMER SHIPMENT	6/73	1/75	1/78	1976	11/76
	3540 - Input to S/370				
	3747 - Tape Converter				

Manufacturer	INNOVEX			
DRIVE	210	220	410	420
DISK/TREND GROUP	10	10	10	10
MEDIA COMPATIBILITY	Diskette 1	Diskette 1	Diskette 1	Diskette 1
SECTORING	Soft	Hard	Soft	Hard
CAPACITY (MBytes)	.397	.397	.401/.802	.401/.802
PERFORMANCE				
Recording surfaces per spindle	1	1	1	1
Tracks per surface	77	77	77	77
TPI	48	48	48	48
BPI	3200	3200	3200/6400	3200/6400
RPM	360	360	360	360
POSITIONING: Track to track (msec)	8	10	8	8
Settling time (msec)	8	10	8	8
Head load time (msec)	30	30	30	30
Average rotational delay (msec)	83.3	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	31.25	31.25	31.25/62.5	31.25/62.5
FIRST CUSTOMER SHIPMENT	6/74	6/74	2/77	2/77

Manufacturer	LOGABAX	MEMOREX		
DRIVE	LX45D	651	550	552
DISK/TREND GROUP	10	10	10	11
MEDIA COMPATIBILITY	Diskette 1	FD/IV	Diskette 1	Diskette 1 Diskette 2
SECTORING	H/S	H	H/S	H/S
CAPACITY (MBytes)	.401	.312	.401/.802	.8/1.6
PERFORMANCE				
Recording surfaces per spindle	1	1	1	2
Tracks per surface	77	64	77	77
TPI	48	48	48	48
BPI	3268	3100	3268/6536	3268/6536
RPM	360	375	360	360
POSITIONING: Track to track (msec)	2.5	10	8	3
Settling time (msec)	27	10	8	10
Head load time (msec)	90	40	35	35
Average rotational delay (msec)	83.3	80	83.3	83.3
Data transfer rate (KBytes/sec)	31.25	31.25	31.25/62.5	31.25/62.5
FIRST CUSTOMER SHIPMENT	1976	12/72	1/77	4Q77

Manufacturer	MFE CORPORATION	MICRO PERIPHERALS, INC.	
DRIVE	Mayflower MFE 700	882	B51
DISK/TREND GROUP	11	11	12
MEDIA COMPATIBILITY	Diskette 1 Diskette 2	Diskette 1 Diskette 2	SA104/SA105
SECTORING	H/S	H/S	H/S
CAPACITY	.802/1.604	.802/1.6	124.7/249.4
PERFORMANCE			
Recording surfaces per spindle	2	2	1
Tracks per surface	77	77	40
TPI	48	48	48
BPI	3268/6536	3268/6536	2580/5160
RPM	360	360	300
POSITIONING: Track to track (msec)	3	3	5
Settling time (msec)	15	15	15
Head load time (msec)	35	35	35
Average rotational delay (msec)	83.3	83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	15.63/31.25
FIRST CUSTOMER SHIPMENT	8/77	1/78	10/77

Manufacturer	MICROPOLIS			OLIVETTI
DRIVE	1015-II	1043-II 1023-II	1053-II 1033-II	FDU 2010 (Single) FDU 2020 (Dual)
DISK/TREND GROUP	12	12	12	10
MEDIA COMPATABILITY	Micropolis -1081 SA 105	Micropolis -1081 SA 105	Micropolis -1081 SA 105	Diskette 1
SECTORING	H	H	H	S
CAPACITY	.315	.315	.315	.280 (15 sectors) .242 (26 sectors)
PERFORMANCE				
Recording surfaces per spindle	1	1	1	1
Tracks per surface	77	77	77	77
TPI	100	100	100	48
BPI	5162	5162	5162	3268
RPM	300	300	300	360
POSITIONING: Track to track (msec)	30	30	30	10
Settling time (msec)	10	10	10	30
Head load time (msec)	75	75	75	40
Average rotational delay (msec)	100	100	100	83.3
Data transfer rate (KBytes/sec)	31.25	31.25	31.25	31.25
FIRST CUSTOMER SHIPMENT	7/77	7/77	7/77	1975
	OEM Drive	Single Drive Subsystem	Dual Drive Subsystem	

Manufacturer	PER SCI				
DRIVE	70	270	277	288	299
DISK/TREND GROUP	10	10	10	11	11
MEDIA COMPATIBILITY	Diskette 1	Diskette 1	Diskette 1	Diskette 1 Diskette 2	Diskette 1 Diskette 2
SECTORING	H/S	H/S	H/S	H/S	H/S
CAPACITY (MBytes)	.401/802	.401/.802	.401/.802	.8/1/6	.8/1.6
PERFORMANCE					
Recording surfaces per spindle	1	1	1	2	2
Tracks per surface	77	77	77	77	77
TPI	48	48	48	48	48
BPI	3268/6536	3268/6536	3268/6536	3268/6536	3268/6536
RPM	360	360	360	360	360
POSITIONING: Track to track (msec)	10	10	10	10	10
Settling time (msec)	0	0	0	0	0
Head load time (msec)	40	40	40	35	35
Average rotational delay (msec)	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	31.25/62.5	31.25/62.5
FIRST CUSTOMER SHIPMENT	1/76	1/76	3Q77	2Q78	4Q77
	Single	Dual	Dual	Dual Shugart 800 Compatible	Dual Per Sci 277 Compatible
----- Voice Coil Actuator -----					

Manufacturer	PERTEC			
DRIVE	FD511	FD5X0	FD400	FD200
DISK/TREND GROUP	10	10	10	12
MEDIA COMPATIBILITY	Diskette 1	Diskette 1	Diskette 1	SA104/SA105
SECTORING	H/S	H/S	H/S	H/S
CAPACITY	.401/.802	.401/.802	.401	.125/.250
PERFORMANCE				
Recording surfaces per spindle	1	1	1	1
Tracks per surface	77	77	77	40
TPI	48	48	48	48
BPI	3268/6536	3268/6536	3268	2768/5536
RPM	360	360	360	300
POSITIONING: Track to track (msec)	10	10	10	25
Settling time (msec)	20	20	20	10
Head load time (msec)	40	40	40	35
Average rotational delay (msec)	83.3	83.3	83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25	15.63/31.25
FIRST CUSTOMER SHIPMENT				4Q77
			DC Power	DC Power

Manufacturer	REMEX	SAGEM
DRIVE	RFD1000	DS3
DISK/TREND GROUP	10	10
MEDIA COMPATIBILITY	Diskette 1	Diskette 1
SECTORING	H/S	H/S
CAPACITY	.401/.802	.401
PERFORMANCE		
Recording surfaces per spindle	1	1
Tracks per surface	77	77
TPI	48	48
BPI	3268/6536	3268
RPM	360	360
POSITIONING: Track to track (msec)	6	10
Settling time (msec)	24	10
Head load time (msec)	50	50
Average rotational delay (msec)	83.3	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25
FIRST CUSTOMER SHIPMENT	4/76	1976

Manufacturer	SHUGART				
DRIVE	SA800	SA801	SA850	SA851	SA400
DISK/TREND GROUP	10	10	11	11	12
MEDIA COMPATIBILITY	SA100 Diskette 1	SA101	SA150 Diskette 2	SA151	SA104(S) SA105(H)
SECTORING	Soft	Hard	Soft	Hard	S/H
CAPACITY (MBytes)	.401/.802	.401/.802	.8/1.6	.8/1.6	.1094
PERFORMANCE					
Recording surfaces per spindle	1	1	2	2	1
Tracks per surface	77	77	77	77	35
TPI	48	48	48	48	48
BPI	3200/6400	3200/6400	3408/6816	3408/6816	2581
RPM	360	360	360	360	300
POSITIONING: Track to track (msec)	8	8	3	3	40
Settling time (msec)	8	8	15	15	10
Head load time (msec)	35	35	35	35	75
Average rotational delay (msec)	83.3	83.3	83.3	83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	15.63
FIRST CUSTOMER SHIPMENT	1973	1975	5/77	5/77	1976

Manufacturer	SYCOR	SYKES DATATRONICS	
DRIVE	FD145	7150 (Single) 7250 (Dual)	9150 (Single) 9250 (Dual)
DISK/TREND GROUP	10	10	10
MEDIA COMPATIBILITY	Diskette 1	Diskette 1	Diskette 1
SECTORING	H/S	S	H/S
CAPACITY (MBytes)	.242	.256	.630
PERFORMANCE			
Recording surfaces per spindle	1	1	1
Tracks per surface	77	77	77
TPI	48	48	48
BPI	3268	3268	6536
RPM	360	360	360
POSITIONING: Track to track (msec)	2.5	6	6
Settling time (msec)	25	30	30
Head load time (msec)	30	30	30
Average rotational delay (msec)	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	31.25	31.25	62.5
FIRST CUSTOMER SHIPMENT	1975	9/74	4/76

Manufacturer	WANGCO		
DRIVE	76	276	82
DISK/TREND GROUP	10	11	12
MEDIA COMPATIBILITY	Diskette 1	Diskette 1 Diskette 2	WANGCO 820 SA104/SA105
SECTORING	H/S	S	H/S
CAPACITY (MBytes)	.401/.802	.8/1.6	.1247/.2494
PERFORMANCE			
Recording surfaces per spindle	1	2	1
Tracks per surface	77	77	40
TPI	48	48	48
BPI	3268/6536	3268/6536	2768/5536
RPM	360	360	300
POSITIONING: Track to track (msec)	6	3	30
Settling time (msec)	14	15	20
Head load time (msec)	16	35	60
Average rotational delay (msec)	83.3	83.3	100
Data transfer rate (KBytes/sec)	31.25	31.25/6.5	15.63/31.25
FIRST CUSTOMER SHIPMENT	9/75	4Q77	4/77
	Model 87 is Subsystem version		

MANUFACTURER PROFILES

Each known manufacturer of flexible disk drives headquartered in the United States is listed in this section, with a capsule description. Throughout the listings, the heading "FDD sales" refers to the DISK/TREND estimate of internally manufactured flexible disk drive sales only -- no sales of other drive types are included, nor are sales of parts or other related products.

BURROUGHS CORPORATION
Burroughs Place
Detroit, MI 48232

313/972-7000

1976 FDD sales: --

1976 total net sales: \$1,870,845,000

Net income: \$185,904,000

Burroughs initiated an internal manufacturing program in 1976 at Glen Rothie, Scotland, with a unique 1.25 MB two sided drive. The technology employed in this drive is not unusual, but track density, track placement, recording density and rotation speed are all non-standard. Applications include small business systems and intelligent terminals. Parallel with this captive program, Burroughs also offers industry standard floppy drives made by Control Data. It is believed that Burroughs will expand production of its internally manufactured drive to a plant at Guadalajara, Mexico -- and it would not be surprising if the firm eventually phased in production of IBM compatible drives, also. Addition of industry standard versions would probably enhance the attractiveness of a Burroughs program launched this year to sell peripherals to OEM customers.

CALIFORNIA COMPUTER PRODUCTS, INC.
2411 West La Palma
Anaheim, CA 92801

714/821-2011

1976 FDD sales: \$8,100,000

1976 total net sales: \$121,495,000

Net income: (\$3,994,000)

Calcomp's management structure has seen considerable reorganization in 1977. The floppy drive business has been established as a separate profit center. Calcomp's floppy drive problems center on the loss of

the world's largest customer of OEM drives -- DEC, of course -- and the near impossibility of replacing that much business quickly. However, the Calcomp floppy drive group is scrambling, with redesigned products, a new two sided drive, and aggressive marketing. If the company's management has the patience to wait out the inherent delays in securing OEM adoptions, Calcomp could retain its role as a leading floppy drive manufacturer.

CONTROL DATA CORPORATION
8100 34th Avenue South
Minneapolis, MN 55440

612/853-8100

1976 FDD sales: \$8,400,000

1976 total net sales: \$1,331,012,000

Net income: \$48,553,000

CDC is the largest manufacturer of OEM rigid disk drives, and seems destined to increase its share of the floppy drive business, also -- at least, to second place. Most Control Data disk drive manufacturing capability is now embodied in Magnetic Peripherals, Inc., a joint venture in which ownership is shared with Honeywell. CDC, however, manages the MPI disk drive operations, including floppy drive development and manufacturing at Oklahoma City, Oklahoma. Floppy drive manufacturing was moved from Hawthorne, California, early in 1976.

DATAPOINT CORPORATION
9725 Datapoint Drive
San Antonio, TX 78285

512/699-7151

1976 FDD sales: \$2,400,000

1976 total net sales: \$72,050,000

Net income: \$6,431,000

Datapoint manufactures floppy drives under a license from Shugart Associates. All production is captive, supporting the company's leading product line of intelligent terminals and other products.

DIGITAL EQUIPMENT CORPORATION
146 Main Street
Maynard, MA 01754

617/897-5111

1977 FDD sales: --

1976 total net sales: \$736,288,000

Net income: \$73,400,000

DEC was the largest OEM customer for floppy drives, until the firm decided to exercise its manufacturing license from Calcomp. Internal production has apparently been delayed from original targets, but is

expected to be well underway in 1977. It is probable that DEC's program will eventually include additional products, such as two sided drives, and could well evolve into non-standard configurations, a direction the company has taken in some other product areas.

GENERAL SYSTEMS INTERNATIONAL, INC.
1440 Allec Street
Anaheim, CA 92805

714/956-7183

1976 FDD sales: \$2,100,000

GSI is a privately held company founded in 1973 by Willi Jilke, a disk drive industry pioneer, to develop and manufacture floppy drives and subsystems. The company developed initial momentum through a contract with BASF to supply floppy drives for resale in Europe, with deliveries starting in early 1975. BASF gradually assumed production responsibility internally, and GSI is now marketing all of its own production under its own name, primarily to the U.S. OEM market.

INTERNATIONAL BUSINESS MACHINES CORPORATION
Route 22
Armonk, NY 10504

914/765-1900

1976 FDD sales: \$78,200,000

1976 total net sales: \$16,304,333,000

Net income: \$2,398,093,000

IBM developed "Minnow", (the floppy's original code name) for the relatively obscure role of loading microcode into the controller for 3330 disk drives and two early System/370 CPUs. The industry-wide floppy bandwagon didn't get started, however, until a redesigned drive/media combination was introduced in 1973 as the 3740 series -- IBM's successful attempt to hold its crumbling position on the data entry front. In subsequent years, one and two sided versions have shown up in small business systems, several terminal families, word processing systems, and that enigmatic minicomputer, Series/1. It's hard to say what's next, but most horse-players would bet on more floppies -- in all shapes, sizes and applications.

INNOVEX CORPORATION
75 Wiggins Avenue
Bedford, MA 01730

617/275-2110

1976 FDD sales: \$1,600,000

Innovex invested the word "Diskette", if not the product as it's known today. The company's original drive was a technical tour de force, in which the heads revolved while the floppy disk was stationary.

1977 DISK/TREND REPORT

Somehow the world preferred IBM's version, and Innovex had to scramble to produce a compatible drive. The two firms reached an accommodation allowing IBM to use the Diskette name. Unfortunately, during the floppy drive industry's formative years in 1974-75 Innovex was able to land only one major customer, with management changes apparently a contributing factor. However, since 1976 the company's original management is back in place, and prospects look better, if the cash holds out.

MEMOREX CORPORATION

San Tomas and Central Expressways
Santa Clara, CA 95052

408/987-1000

1976 FDD sales: \$5,000,000

1976 total net sales: \$344,633,000

Net income: \$40,130,000

Memorex developed a floppy drive very early in the game, in order to emulate IBM's approach to the controller for the 3330 disk drive. So, it's not surprising that the OEM version of the drive introduced in late 1972, the 651, had unique specifications. Early market entry with a well-designed drive secured several OEM adoptions for Memorex before IBM set de facto specifications with the 3740 in 1973. Production volume generated by these adoptions is only now peaking. The company's first attempt at an IBM compatible drive fizzled a few years later due to high prices and the famous Memorex management mess. Today, however, new management, new one side and two side low cost drives, and a new dedicated OEM marketing activity are likely to regain some of the early Memorex floppy drive momentum. OEM sales programs do not produce overnight results, though, and total Memorex unit shipments of floppies could decline temporarily.

MFE CORPORATION

Keewaydin Drive
Salem, NH 03079

603/893-1921

1976 FDD sales: --

MFE, a privately held firm, known primarily as an OEM supplier of digital cassette drives, announced entry into the floppy drive market in June, 1977, with an 8 inch, two side drive. The drive offered is the smallest 8 inch drive on the market, with relatively early deliveries, starting in August, 1977. MFE's established marketing capabilities for cassette drives overlap the floppy market -- but the built-in lag time in OEM sales programs should preclude early volume shipments unless the firm has done a good reselling preselling job.

MICRO PERIPHERALS, INC.
4724 Woodley
Sepulveda, CA 91343

213/894-4076

1976 FDD sales: --

Micro Peripherals is a new privately held company formed in 1977 by key engineering personnel from Orbis (now part of the Perkin-Elmer Wango operation). A 5.25 inch drive has been announced for first shipment in October, 1977, with an 8 inch, two side drive to follow in January, 1978. The company has indicated that its strategy will be to target efforts to OEM accounts requiring fairly small annual shipments (under 1,000 units).

MICROPOLIS CORPORATION
9017 Reseda Boulevard
Northridge, CA 91424

213/349-2328

1976 FDD sales: --

Micropolis was founded in 1977 by Stuart Mabon and Eric Dunstan, two ex-founders of Pertec in 1967, as a privately held company. Micropolis initiated shipments in July, 1977, of a high performance 5.25 inch drive, incorporating 100 TPI, the first on the market. The company's strategy has been to exploit the immediate business available for 5.25 inch drives from retail computer stores serving hobbyists, with a long-term interest in the slower-developing OEM market.

PER SCI, INC.
12210 Nebraska Avenue
West Los Angeles, CA 90025

213/820-3764

1976 FDD sales: \$500,000

Per Sci is a privately held company, founded in 1974. Alone among current floppy drive manufacturers, Per Sci offers voice coil head positioning, with resultant average access time equivalent to rigid disk drives. This advantage, combined with several other features, has created a special market segment for Per Sci, at prices well above the industry average. The company's sales were minimal through 1976, but have increased substantially in 1977. Per Sci is apparently here to stay.

PERTEC COMPUTER CORPORATION
 Pertec Division
 9600 Irondale Avenue
 Chatsworth, CA 91311

213/882-0030

1976 FDD sales: \$2,700,000

1976 total net sales: \$94,520,000
 (Fiscal year ended 3/25/77)

Net income: \$4,691,000

Pertec entered the floppy drive business in 1974, with moderate success through 1976. However, the company's acquisitions in 1976-77 of CMC, iCOM and MITS have supplied significant additional sales channels for Pertec to develop new business in floppy drive subsystems. Internal marketing structures have been reorganized, and development programs initiated for 5.25 inch and 8 inch, two sided floppy drives. Over the next year or two, the challenge will be to fully develop the organization's potential market in small subsystems, without losing emphasis in the rapidly growing OEM market for bare-bones drives. It's an interesting management problem.

REMEX DIVISION
 EX-CELL-O CORPORATION
 1733 Alton Street
 Irvine, CA 92713

714/557-6860

1976 FDD sales: \$400,000

1976 total net sales: \$416,109,726

Net income: \$25,471,883

Remex is primarily a manufacturer of punched paper tape equipment, an area in which it is an industry leader. The firm originally entered the floppy drive business as a reseller of Orbis drives, then started its own manufacturing program in 1975. Remex benefited from the availability of CDC technical personnel who did not wish to make the move to Oklahoma City with CDC's manufacturing operation. As a late starter in floppy drive manufacturing, Remex has found it difficult to sell drives in the OEM market, and appears to be concentrating on the sale of subsystems to systems houses.

SHUGART ASSOCIATES
 415 Oakmead Parkway
 Sunnyvale, CA 94086

408/733-0100

1976 FDD sales: \$14,400,000

Shugart Associates seems to have done everything right in the floppy drive business, including having an early financial crisis. The aftermath of that difficulty resulted in a sharply defined corporate objective to specialize in the floppy drive business, combined with a shoo-down, practical management. The firm's engineering talent had already

designed floppy drives at IBM and Memorex, so they were able to put a reliable IBM compatible drive into production very early. The marketing game-plan was sound: Sell to OEMs with direct salesmen, price aggressively, ship evaluation units that really work and respond to customer requests promptly. Fortunately for Shugart, no one else did all this nearly as well, with the result that no one else today has a market share nearly as large.

For the second act, Shugart capitalized on a dominant industry market position to establish an industry standard with the introduction of the 5.25 inch drive in 1976, achieving substantial initial orders and early volume production -- followed by a sharp price cut to consolidate that success. That was followed by the industry's earliest independent deliveries of 8 inch, two side drives -- and early volume production.

The third act (not necessarily the last) is now being played. On August 1, 1977, a letter of intent was announced, covering acquisition of Shugart by Xerox, with final agreement expected within 60 days and consummation by the end of 1977. The usual assurances regarding continuity of management were made. Assuming the deal goes through: If Xerox provides mostly expansion capital and not too much direction, the Shugart steamroller could keep rolling on nicely for some time. The epilogue will have to come later.

SYCOR, INC.

100 Phoenix Drive
Ann Arbor, MI 48104

313/971-0900

1976 FDD sales: \$4,300,000

1976 total net sales: \$67,241,000

Net income: \$5,207,000

Sycor is a leading producer of intelligent terminals which started floppy drive production in 1974. The firm offers floppy drives in the OEM markets, along with digital cassette drives and other hardware. To date, however, Sycor's penetration of the OEM market for floppy drives has been slight, and the company remains primarily a captive producer.

SYKES DATATRONICS, INC.

375 Orchard Street
Rochester, NY 14606

716/458-8000

1976 FDD sales: \$1,200,000

1976 total net sales: \$3,611,124
(Fiscal year ended 2/28/77)

Net income: \$159,531

Sykes specializes in cassette, cartridge and floppy subsystems for use with terminals, minicomputers and microcomputers. Floppy drive

manufacturing was initiated under an Orbis license, with all drives sold as complete subsystems.

WANGO, INC.

Subsidiary of Perkin-Elmer Corporation
Perkin-Elmer Data Systems Group
5404 Jandy Place
Los Angeles, CA 90066

213/390-8081

1976 FDD sales: \$1,400,000

1976 total net sales: \$349,341,000

Net income: \$20,524,000

Wangco acquired the Orbis floppy drive operation shortly after being acquired itself by Perkin-Elmer in June, 1976. Wangco starts out in the floppy drive business with a fairly small established OEM customer base and the impending loss of Orbis's largest customer, DRI, which is starting its own manufacturing program. However, Wangco's established marketing capability in small tape and rigid disk drives, combined with potentially attractive captive production for Interdata and the P-E terminal division, should enable the firm to reach an attractive balance of high production and low costs. Wangco has already moved to fill-out the product line with a 5.25 inch drive, plus an 8 inch, two side drive due late in 1977.