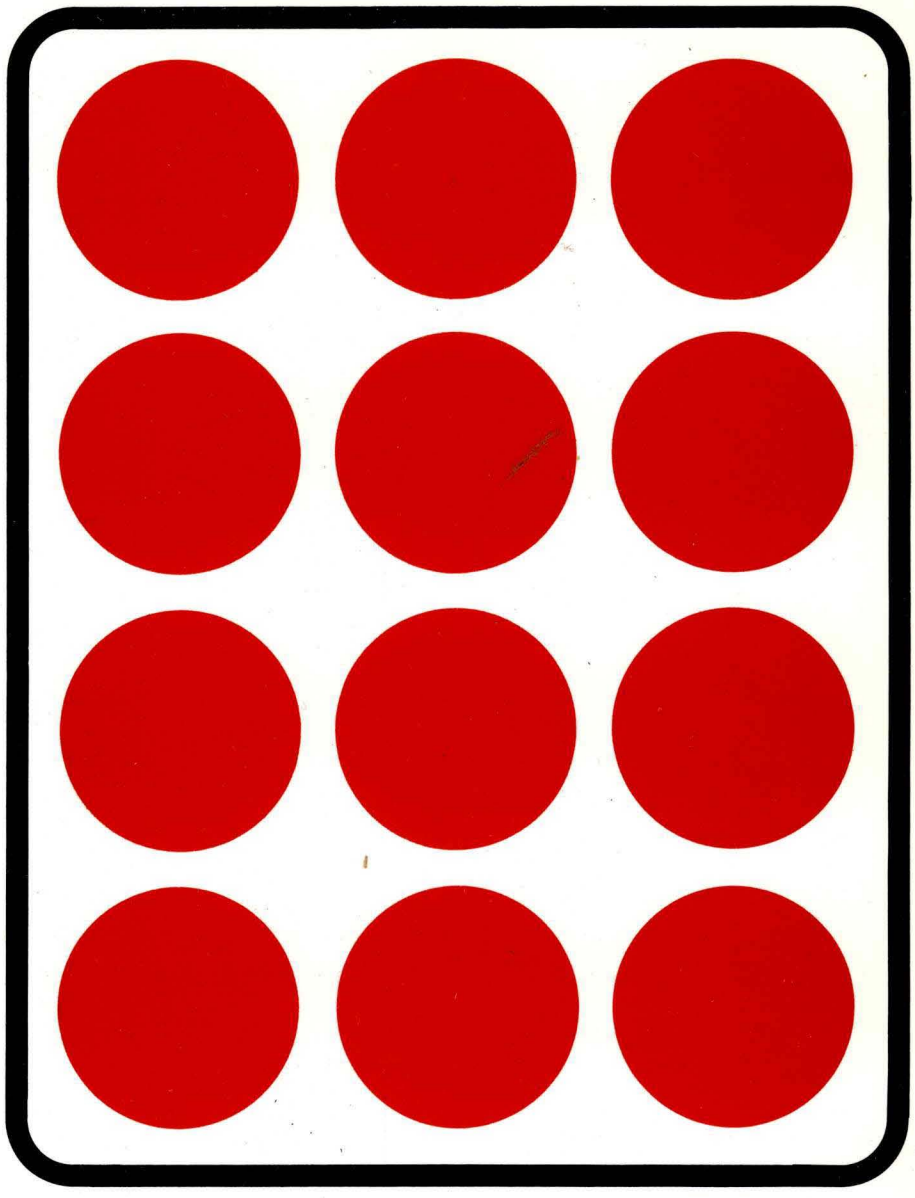
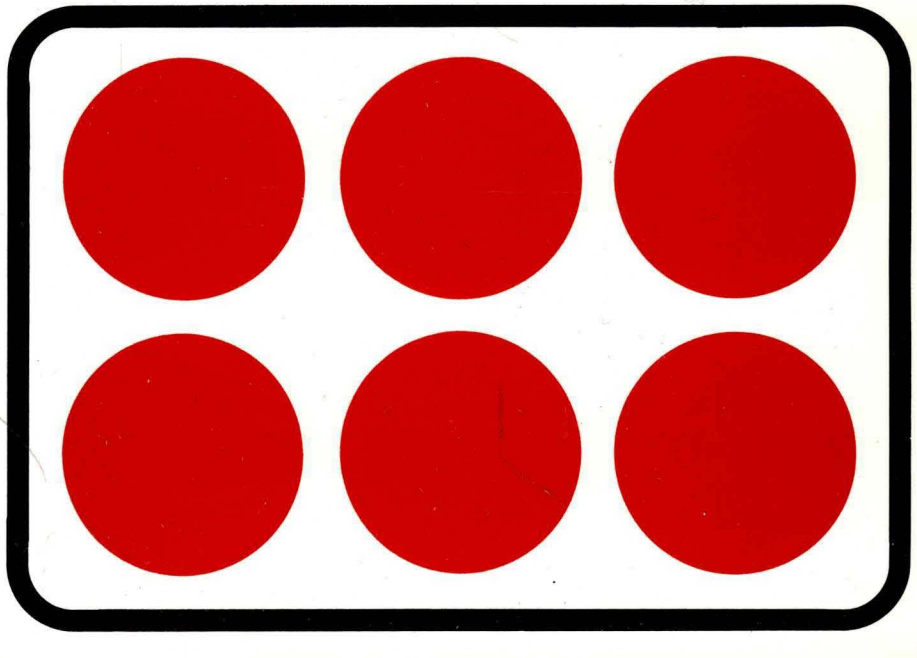


1992 DISK/TREND® REPORT

FLEXIBLE DISK DRIVES



1992 DISK/TREND® REPORT

FLEXIBLE DISK DRIVES

November, 1992

DISK/TREND, Inc.
1925 Landings Drive
Mountain View, California 94043

Telephone: 415/961-6209
Facsimile: 415/969-2560

FOREWORD

The floppy disk drive industry has lost several manufacturers with small market shares since last year, the continuation of an established trend. However, the remaining drive manufacturers, especially those with high market shares already established, have enjoyed a year of growth that was much stronger than most of them anticipated. The price wars among the personal computer manufacturers have kept PC shipments at high levels even during the economic recession, and the impact on floppy drive shipments has been obvious.

We're looking forward to a continuation of the industry trends already under way -- a growing proportion of half inch high microfloppies, gradual growth for the 2.88 megabyte models, and expansion of the market for high capacity floppies. And it's necessary to expect even further consolidation, with fewer companies participating in the industry next year.

The DISK/TREND Report on flexible disk drives has been part of our annual series since the report's first year, sixteen years ago, and we hope to continue it indefinitely. The DISK/TREND Report on optical disk drives was published in July, and a separate report on rigid disk drives was published in October.

We are always willing to help you at any time by providing additional information on the industry which we may have available. And, as always, we welcome and appreciate your suggestions for improvements in the DISK/TREND Report.

James N. Porter

Robert H. Katzive

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INTRODUCTION

The DISK/TREND Report has a new look this year

The typography has been updated, but we've been careful to maintain the same organization of all data throughout the report to avoid confusing long-term users.

All data is now given in FORMATTED capacities

As we mentioned in the introduction to last year's DISK/TREND Report, we had arrived at the conclusion that it was time to start identifying floppy drives by formatted capacities, instead of by unformatted capacities. Unformatted capacities have been used since the first DISK/TREND Report in 1977, but in recent years most of the industry has begun to use formatted capacities in describing all disk drives, whether floppy, rigid or optical. Starting with this edition of the DISK/TREND Report, formatted capacities have been shown for most flexible disk drives. Formatted capacities are also used in the report's tables and text -- so you will find typical references to 5.25 inch drives with "1.2 megabyte" capacities instead of "1.6 megabytes" and 3.5 inch drives with "1.44 megabyte" capacities instead of "2.0 megabytes".

Please note how prices are reported

Because there are many new users of the DISK/TREND Report each year, it is always helpful to point out that all disk drive sales revenues are reported at the level of the first public sale, at the estimated transaction price, whether the sale occurs at the captive end user, PCM/Reseller, or OEM/Integrator levels. We do not arbitrarily convert sale prices to either the end user or factory level, but report them at the level at which they actually occur.

The Definitions section may answer your questions

Even if you are thoroughly familiar with the industry's terminology, you will find it helpful to review the definitions section of the report. Several terms with conflicting meanings have been resolved on an arbitrary basis. For example, even a simple term such as "manufacturer" may have multiple meanings. When disk drives are produced for a drive manufacturer by a second manufacturer on a contract basis, using designs in which the first manufacturer has a proprietary interest, we have credited the first manufacturer in DISK/TREND revenue and shipment statistics.

SUMMARY: FLEXIBLE DISK DRIVES

Industry size

Strong personal computer shipments during the last year surprised the computer industry and pushed floppy drive shipments to higher levels than expected. Led by rising microfloppy drive shipments, worldwide shipments for all types of floppy drives rose to 48 million units in 1991 and are projected to increase to 54.5 million drives in 1995. Total sales revenues for floppy drives dipped 5.4% in 1991, to $2,491,300,000, and the total is expected to be slightly lower in 1995 despite increased unit shipments, at $2,403,300,000.

Sales revenues continue to lag behind shipment levels due to intense price competition between the Japanese manufacturers which dominate the floppy drive industry and the continuing changes in product mix. 5.25 inch drives continue to be displaced by microfloppy drives, which have been priced lower than 5.25 inch drives during recent years.

Microfloppy drives, which provided 68.4% of all floppy drive unit shipments in 1991, carried an overall average OEM price of $42 in 1991. Microfloppy 1995 unit shipments are expected to be 79.5% of the 1995 total, with the average OEM price that year dropping to $36. Average OEM prices for 5.25 inch drives were $49 in 1991 and are projected at $42 in 1995, but 5.25 inch drives are forecasted to drop from 31.3% of total shipments in 1991 to 17.8% in 1995.

Also contributing to declining total revenues is the trend toward reduced production of captive floppy drives. A modest increase in shipments of captive microfloppy drives will not be enough to overcome falling shipments of older configurations, and overall captive sales revenue for floppy drives is projected to drop from $408.3 million in 1991 to $286.5 million in 1995.

The continuing price declines for mature floppy drive products would cause even steeper drops in total revenue if newer floppy drive configurations, selling at higher prices, were not growing. However, shipments of 2.88 megabyte 3.5 inch drives and high capacity floppy drives are expected to increase rapidly through 1995, and the higher average unit prices for both types of drives will soften the overall price decline.

TABLE 1

CONSOLIDATED WORLDWIDE REVENUES

ALL EXISTING FLEXIBLE DISK DRIVE GROUPS

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1991		Forecast							
	Revenues		1992		1993		1994		1995	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	54.4	68.6	56.9	71.2	78.3	102.3	79.1	107.6	67.6	95.9
OEM/Integrator	3.5	4.0	.7	1.2	27.7	32.2	46.5	54.3	73.1	91.0
TOTAL U.S. NONCAPTIVE	57.9	72.6	57.6	72.4	106.0	134.5	125.6	161.9	140.7	186.9
TOTAL U.S. REVENUES	57.9	72.6	57.6	72.4	106.0	134.5	125.6	161.9	140.7	186.9
Non-U.S. Manufacturers										
Captive	34.4	408.3	25.7	336.4	21.3	311.2	20.0	300.9	22.0	286.5
PCM/Reseller	217.8	315.7	243.8	362.3	287.3	439.1	293.7	455.0	287.9	458.4
OEM/Integrator	627.1	1,694.7	679.5	1,708.5	660.5	1,623.9	673.7	1,539.5	725.7	1,471.5
TOTAL NON-U.S. REVENUES	879.3	2,418.7	949.0	2,407.2	969.1	2,374.2	987.4	2,295.4	1,035.6	2,216.4
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	937.2	2,491.3	1,006.6	2,479.6	1,075.1	2,508.7	1,113.0	2,457.3	1,176.3	2,403.3

Marketing channels

There has been another sharp drop in the number of manufacturers participating in the flexible disk drive industry during the last year. The 1992 total is 26 manufacturers of flexible disk drives, down 10 from last year -- and less than half of the peak of 58 companies in 1986.

The total number of floppy drive manufacturers headquartered in Asian countries declined from 25 in 1991 to 20 in 1992, as several companies with low shipment levels dropped out of the business. 17 of the remaining Asian manufacturers are Japanese companies, a group which includes all of the world's leading manufacturers of floppy drives. Other Asian manufacturers are finding it difficult to stay in the floppy drive business, due to the low prices which have resulted from intense competition for market share between the Japanese companies.

The remaining four U.S. manufacturers are all producers of specialized floppy drives, mostly in the high capacity group. The South American manufacturers, all Brazilian companies, now consist of only two companies, as the opening of the Brazilian computer market to outside competitors has displaced most local manufacturers with low volume production. Floppy drives are no longer produced in Western Europe, and the political changes in the previous Eastern Bloc have eliminated the markets for the older drive models in production until recent years.

Captive floppy revenues are trending down, from 16.4% of the 1991 total to an estimated 11.9% in 1995, as shipment leadership in both desktop and portable personal computers continually includes more manufacturers which do not produce floppy drives. Worldwide revenues in the PCM/Reseller channel are forecasted to increase from 15.4% of the 1991 total to 23.1% of the 1995 total, strengthened by upgrades to existing systems and the continuing need to maintain media interchange.

Although total unit shipments of noncaptive drives are expected to continue increasing through 1995, revenues for drives sold in the OEM/Integrator channel are expected to decline an average of 1.8% in the 1991-95 period. Average selling prices in the OEM/Integrator channel are declining faster than the unit shipments are increasing, forcing a decline in total sales revenue.

TABLE 2

CONSOLIDATED WORLDWIDE REVENUES
ALL EXISTING FLEXIBLE DISK DRIVE GROUPS
MARKET CLASS REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	1991 Revenues $M	1991 Revenues %	Forecast 1992 $M	Forecast 1992 %	Forecast 1993 $M	Forecast 1993 %	Forecast 1994 $M	Forecast 1994 %	Forecast 1995 $M	Forecast 1995 %
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
	--		--		--		--		--	
PCM/Reseller	68.6	2.7%	71.2	2.8%	102.3	4.0%	107.6	4.3%	95.9	3.9%
	+2.5%		+3.8%		+43.7%		+5.2%		-10.9%	
OEM/Integrator	4.0	.1%	1.2	--	32.2	1.2%	54.3	2.2%	91.0	3.7%
	-31.0%		-70.0%		--		+68.6%		+67.6%	
Total U.S. Manufacturers	72.6	2.8%	72.4	2.8%	134.5	5.2%	161.9	6.5%	186.9	7.6%
	-11.1%		-.3%		+85.8%		+20.4%		+15.4%	
Non-U.S. Manufacturers										
Captive	408.3	16.3%	336.4	13.5%	311.2	12.4%	300.9	12.2%	286.5	11.9%
	-22.6%		-17.6%		-7.5%		-3.3%		-4.8%	
PCM/Reseller	315.7	12.6%	362.3	14.6%	439.1	17.5%	455.0	18.5%	458.4	19.0%
	-1.4%		+14.8%		+21.2%		+3.6%		+.7%	
OEM/Integrator	1,694.7	68.3%	1,708.5	69.1%	1,623.9	64.9%	1,539.5	62.8%	1,471.5	61.5%
	-.5%		+.8%		-5.0%		-5.2%		-4.4%	
Total Non-U.S. Manufacturers	2,418.7	97.2%	2,407.2	97.2%	2,374.2	94.8%	2,295.4	93.5%	2,216.4	92.4%
	-5.2%		-.5%		-1.4%		-3.3%		-3.4%	
Worldwide Recap										
Captive	408.3	16.4%	336.4	13.6%	311.2	12.4%	300.9	12.2%	286.5	11.9%
	-23.9%		-17.6%		-7.5%		-3.3%		-4.8%	
PCM/Reseller	384.3	15.4%	433.5	17.5%	541.4	21.6%	562.6	22.9%	554.3	23.1%
	-.7%		+12.8%		+24.9%		+3.9%		-1.5%	
OEM/Integrator	1,698.7	68.2%	1,709.7	68.9%	1,656.1	66.0%	1,593.8	64.9%	1,562.5	65.0%
	-.6%		+.6%		-3.1%		-3.8%		-2.0%	
Total All Manufacturers	2,491.3	100.0%	2,479.6	100.0%	2,508.7	100.0%	2,457.3	100.0%	2,403.3	100.0%
	-5.4%		-.5%		+1.2%		-2.0%		-2.2%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Product mix

5.25 inch floppy drives surprised the industry again in 1991 with another year of slight growth in shipments, and the aging product group is expected to complete another year of modest growth in 1992. The only reason for the perseverance of the 5.25 inch floppy format is the continuing need of business personal computer users to interchange diskettes between new PC models, which almost always are equipped with 3.5 inch floppy drives, and older personal computers equipped with 5.25 inch drives.

However, the long-term outlook remains bleak for 5.25 inch drives, which will continue to be supplanted by microfloppies in new system models. The forecast is for a decline from 1991's total of 15.0 million drives to a low of 9.7 million drives in 1995.

The 1991-92 strength in personal computer shipments, boosted by lower prices, faster processors and improved software, has provided stronger demand for microfloppy drives than previously expected. Worldwide 1991 unit shipments climbed 11.4%, to 32.8 million drives, and continuing growth in personal computers and other applications is expected to drive the 1995 total to 43.3 million microfloppy drives. The average annual increase in unit shipments for microfloppy drives during the five year period covered by this report is 8%, but falling average unit prices will hold the average annual increase in revenues during the same period to 2.8%.

1991 shipments of high capacity floppy drives over 5 megabytes were 99,700 units, a 22.6% increase over the previous year, due to strong shipments of 5.25 inch Bernoulli drives. However, during the next few years the momentum of the 5.25 inch format is expected to wane, and 3.5 inch drives will soon dominate shipments in this product group, with sales stimulated by demand for a backup device which maintains media compatibility with lower capacity diskettes. Despite several manufacturing delays, "floptical" drives using an optical tracking method are now available in quantity from two U.S. firms which have established manufacturing partnerships with two Japanese companies. 1995 overall unit shipments for the product group are projected at 1,450,000 drives, of which 92.7% are expected to be 3.5 inch models.

Figure 1

CHANGING PRODUCT MIX

Worldwide Flexible Disk Drive Revenue

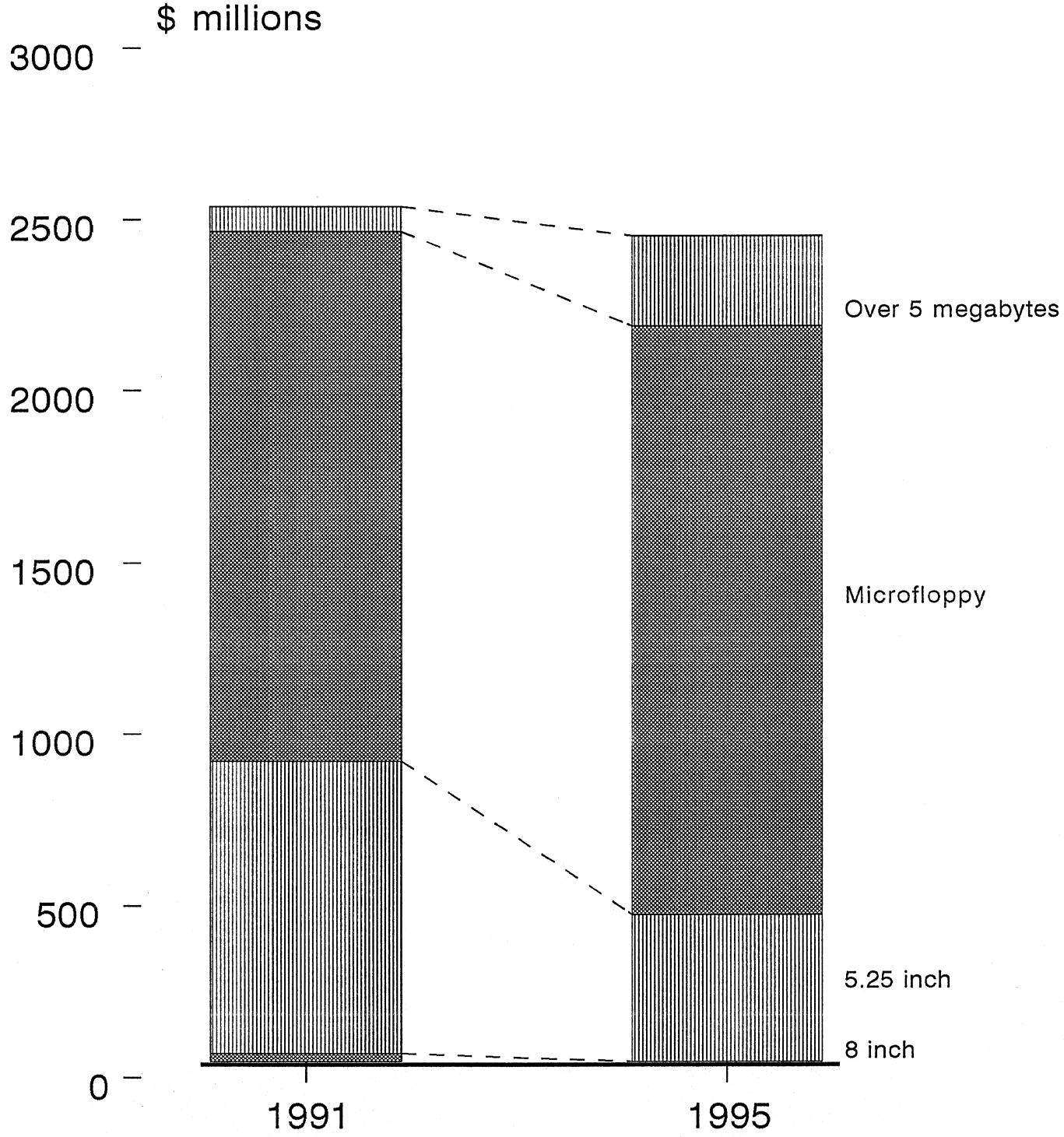

TABLE 3

WORLDWIDE SHIPMENTS

PRODUCT CATEGORY SUMMARY

ALL MANUFACTURERS

Units: Thousands Dollars: $ Million		1991 Shipments Ship	1991 Shipments %	1992 Ship	1992 %	1993 Ship	1993 %	Forecast 1994 Ship	Forecast 1994 %	Forecast 1995 Ship	Forecast 1995 %
8 INCH DRIVES											
	Units	76.0	-46.3	49.2	-35.2	33.2	-32.5	17.0	-48.7	--	--
	$M	25.3	-57.9	16.1	-36.3	10.8	-32.9	5.5	-49.0	--	--
5.25 INCH DRIVES											
	Units	15,019.9	+.4	15,158.7	+.9	14,295.0	-5.6	12,410.0	-13.1	9,705.0	-21.7
	$M	849.3	-16.1	793.3	-6.5	704.2	-11.2	574.6	-18.4	427.8	-25.5
MICROFLOPPY DRIVES											
	Units	32,819.3	+11.4	35,682.0	+8.7	38,480.0	+7.8	41,055.0	+6.6	43,315.0	+5.5
	$M	1,543.8	+3.7	1,597.4	+3.4	1,654.1	+3.5	1,674.3	+1.2	1,712.6	+2.2
DRIVES OVER 5 MEGABYTES											
	Units	99.7	+22.6	144.9	+45.3	506.1	+249.2	905.0	+78.8	1,450.0	+60.2
	$M	72.9	+.8	72.8	-.1	139.6	+91.7	204.6	+46.5	264.3	+29.1
TOTAL ALL DRIVES											
	Units	48,014.9	+7.6	51,034.8	+6.2	53,314.3	+4.4	54,387.0	+2.0	54,470.0	+.1
	$M	2,491.3	-5.3	2,479.6	-.4	2,508.7	+1.1	2,459.0	-1.9	2,404.7	-2.2

Note: Percentage figures refer to year-to-year growth rates.

Figure 2

CHANGING PRODUCT MIX

Worldwide Flexible Disk Drive Shipments
All Manufacturers

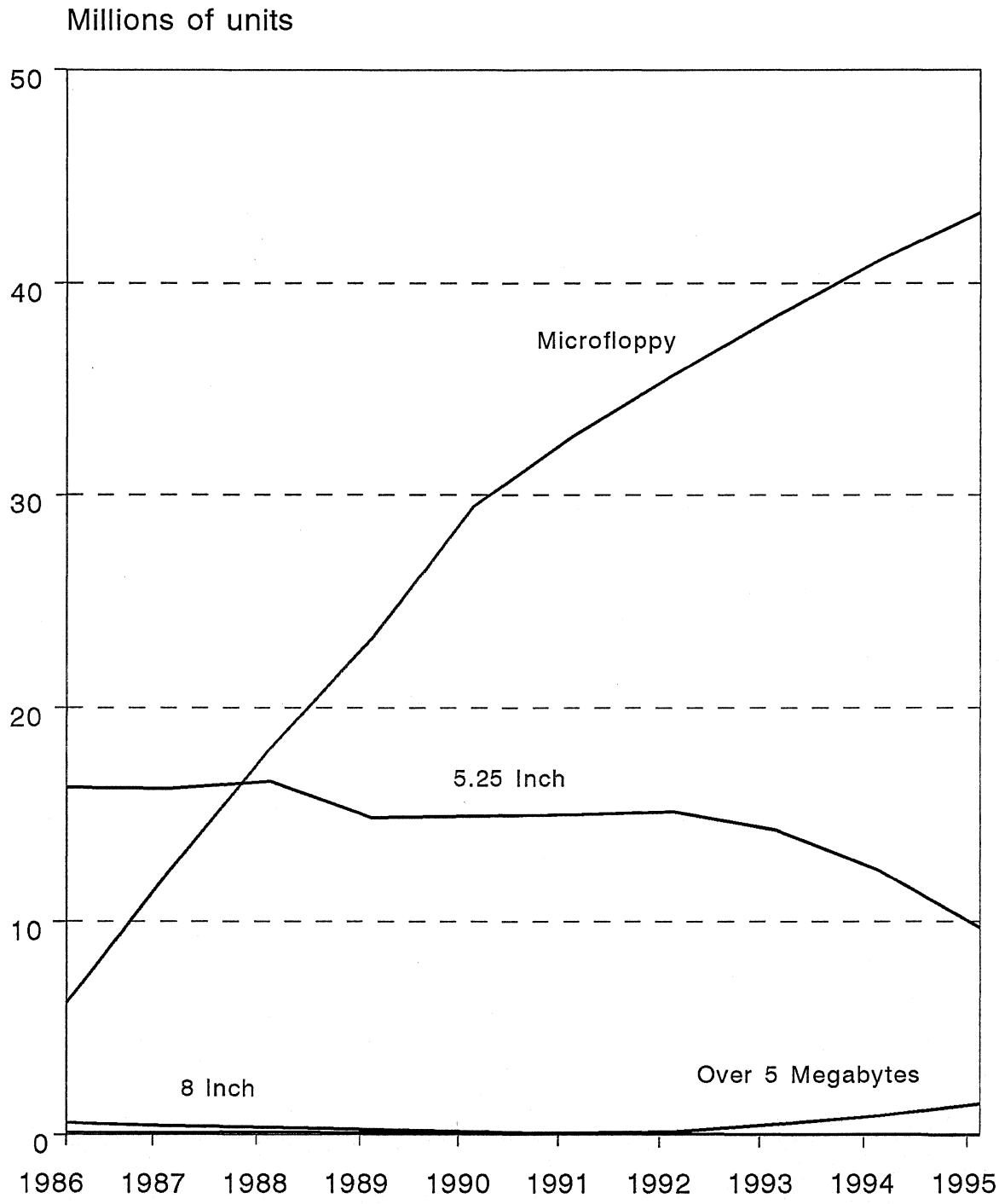

TABLE 4

WORLDWIDE SHIPMENTS

PRODUCT CATEGORY SUMMARY

MANUFACTURERS OF NON-CAPTIVE DRIVES

Units: Thousands Dollars: $ Million		1991 Shipments Ship	 %	1992 Ship	 %	1993 Ship	 %	Forecast 1994 Ship	 %	 1995 Ship	 %
8 INCH DRIVES											
	Units	49.0	-29.7	30.8	-37.1	18.0	-41.5	9.0	-50.0	--	--
	$M	13.4	-25.9	7.8	-41.7	4.0	-48.7	1.9	-52.5	--	--
5.25 INCH DRIVES											
	Units	14,180.2	+6.3	14,388.7	+1.4	13,685.0	-4.8	11,995.0	-12.3	9,480.0	-20.9
	$M	687.2	-1.8	670.1	-2.4	612.7	-8.5	516.5	-15.7	398.5	-22.8
MICROFLOPPY DRIVES											
	Units	30,941.3	+9.6	33,915.5	+9.6	36,580.0	+7.8	39,055.0	+6.7	41,210.0	+5.5
	$M	1,309.8	+.2	1,392.7	+6.3	1,441.2	+3.4	1,457.9	+1.1	1,495.8	+2.5
DRIVES OVER 5 MEGABYTES											
	Units	99.4	+22.7	144.7	+45.5	506.1	+249.7	840.0	+65.9	1,320.0	+57.1
	$M	72.6	+.8	72.6	--	139.6	+92.2	180.1	+29.0	222.5	+23.5
TOTAL ALL DRIVES											
	Units	45,269.9	+8.5	48,479.7	+7.0	50,789.1	+4.7	51,899.0	+2.1	52,010.0	+.2
	$M	2,083.0	-.6	2,143.2	+2.8	2,197.5	+2.5	2,156.4	-1.8	2,116.8	-1.8

Note: Percentage figures refer to year-to-year growth rates.

Figure 3

CHANGING PRODUCT MIX

Noncaptive Flexible Disk Drive Shipments

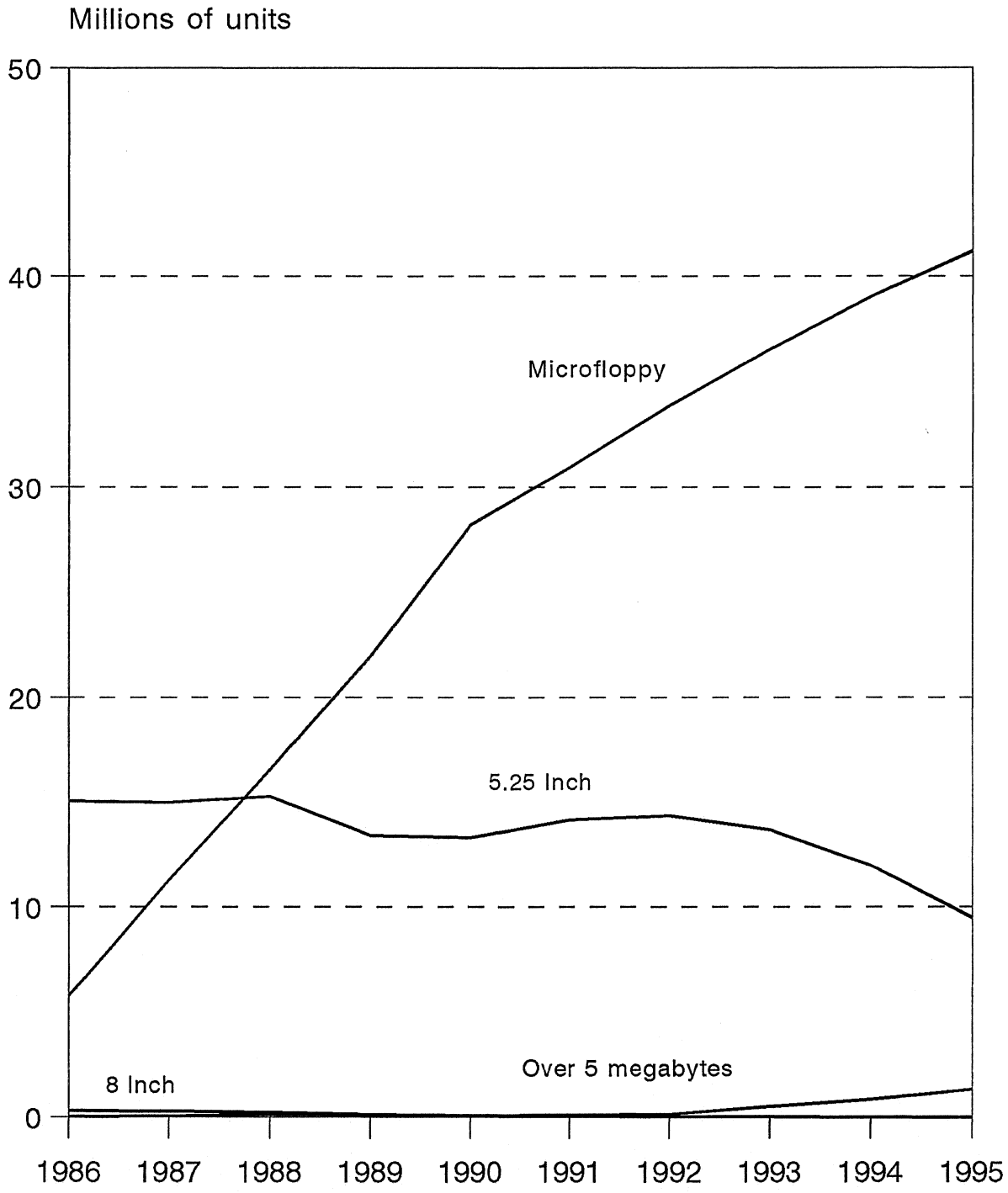

TABLE 5

1991 ESTIMATED MARKET SHARES

WORLDWIDE REVENUES OF ALL FLEXIBLE MAGNETIC DISK DRIVES
(Value of non-U.S. currencies estimated at average 1991 rates)

	CAPTIVE		PCM/RESELLER		OEM/INTEGRATOR		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
Iomega	--	--	66.0	17.2	3.5	.2	69.5	2.8
Other U.S.	--	--	2.6	.7	.5	--	3.1	.1
U.S. Total	--	--	68.6	17.9	4.0	.2	72.6	2.9
NON-U.S. MANUFACTURERS								
Chinon	--	--	54.3	14.1	130.4	7.7	184.7	7.4
Citizen	--	--	1.9	.5	124.0	7.3	125.9	5.1
Matsushita Communication Ind.	--	--	8.2	2.1	222.3	13.1	230.5	9.3
Matsushita Electronic Components	--	--	--	--	50.5	3.0	50.5	2.0
Mitsubishi Electric	4.4	1.1	21.9	5.7	84.9	5.0	111.2	4.5
Mitsumi Electric	--	--	31.8	8.3	88.4	5.2	120.2	4.8
NEC	317.0	77.6	--	--	46.6	2.7	363.6	14.6
Seiko Epson	10.4	2.5	19.3	5.0	131.5	7.7	161.2	6.5
Sony	8.5	2.1	13.0	3.4	307.6	18.1	329.1	13.2
Teac	--	--	59.6	15.5	291.0	17.1	350.6	14.1
Toshiba	--	--	22.4	5.8	26.6	1.6	49.0	2.0
Y-E Data	.4	.1	42.9	11.2	114.3	6.7	157.6	6.3
Other Non-U.S.	67.6	16.6	40.4	10.5	76.6	4.5	184.6	7.4
Non-U.S. Total	408.3	100.0	315.7	82.1	1,694.7	99.8	2,418.7	97.1
WORLDWIDE TOTAL	408.3	100.0	384.3	100.0	1,698.7	100.0	2,491.3	100.0

TABLE 6

Codes: C = Captive
P = PCM
O = OEM

CURRENT PRODUCT LINES
MANUFACTURERS OF FLEXIBLE DISK DRIVES

Codes:

Capacity	8"	5.25"	MICRO
<=.5 MB =	.5	.5	.5
.6 MB =	.6		
.7 MB =		.7	.7
1.2 MB =	1.2	1.2	1.2
1.4 MB =			1.4
2.4 MB =		2.4	
2.88 MB =			2.88

High Capacity= 8:(MB) 5:(MB) 3:(MB)

Formatted capacities shown for all drives

DISK/TREND PRODUCT GROUP:		13	14	15	16
U.S. MANUFACTURERS	TYPE	8 INCH	5.25 INCH	MICRO FLOPPIES	HIGH CAPACITY >5 MB
Brier Technology	P,O				3:21/44
Insite Peripherals	O				3:21
Iomega	P,O				3:20,5:21/44/90/150
Miltope	O	.5/.6/1.2			
ASIAN MANUFACTURERS					
Alps Electric	O			.7/1.2/1.4/2.88	
Brother	C,O			.5	
Canon	O		.5/.7/1.2	.7/1.2/1.4	
Chinon	O		.5/.7/1.2	.5/.7/1.2/1.4/2.88	
Citizen	O			.7/1.2/1.4/2.88	
Ergo	C,O			.7/1.4	
Hitachi	O				8:6
Mantec Technology	P		.5/1.2		
Matsushita Communication Indust.	O	.6/1.2	.5/1.2	.7/1.2/1.4/2.88	
Matsushita Electronic Components	O			.7/1.2/1.4/1.6	
Mitsubishi Electric	O		.5/.7/1.2	.7/1.2/1.4/2.88	
Mitsumi Electric	O		.7/1.2	.7/1.2/1.4/2.88	
NEC	C,O	.6/1.2	.7/1.2	.5/.7/1.2/1.4	3:10
Safronic	O		.5/1.2	.7/1.4	
Samsung Electronics	C,O		.7/1.2	.7/1.4/2.88	
Seiko Epson	O		.5/.7/1.2	.7/1.2/1.4/2.88	
Sony	C,O			.7/1.4/2.88	
Teac	O		.5/.7/1.2	.7/1.2/1.4/2.88	
Toshiba	O		.5/.7/1.2	.7/1.4/2.88	
Y-E Data	O	.6	.7/1.2/2.4	.7/1.2/1.4/2.88	3:20
SOUTH AMERICAN MANUFACTURERS					
Multidigit	O		.5/1.2		
Vitoria Tecnologia	P		.5/1.2	.7/1.4	

Application mix

As the dominance of microfloppy drives continued to increase in 1991 for all floppy drive applications, their share of the personal computer market became even stronger than in previous years. While 5.25 inch drives declined to 32.1% of total floppy drive unit shipments for personal computer applications in 1991, the share held by microfloppy drives increased to 67.7%. Because of the demand by PC end users for media interchange capability between floppy drive formats of different sizes, a high percentage of the 5.25 inch drives were installed in systems which also use microfloppy drives. By 1995, the 5.25 inch share of personal computer applications is projected to be down to 19.7% and microfloppies will be up to 77.3%, joined by high capacity floppy drives with 2.9%.

As personal computers have expanded the range of applications served, new computer markets have been created. Personal computers have taken over a significant share of the functions previously served by dedicated application systems, as well as those of minicomputers and mainframes.

As the role of personal computers has increased, so has that of the floppy drives used with almost all PCs. However, there are now signs that the percentage share of worldwide floppy drive shipments held by business personal computers may be saturating, as the home computer market appears headed for higher growth and as many new notebook portable computers appear without floppy drives.

Significant growth is forecasted for consumer and hobby computers, which are expected to use 5.5 million floppy drives in 1995. These applications consumed 3.2% of all floppy drive shipments in 1991, and the forecast for 1995 will constitute 10.1% of the worldwide total for all floppy drives. Most of the 1995 total will be microfloppies.

The proportion of floppy disk drives used in dedicated office systems continues to slide, as personal computers displace many specialized systems in both office and nonoffice environments. In 1995 the share of total floppy drive shipments used with dedicated office systems is expected to be down to 4.0%. All of the other floppy drive applications are relatively minor, and none is expected to increase its portion of total shipments through 1995.

TABLE 7

FLEXIBLE DISK DRIVE APPLICATIONS SUMMARY

CONSOLIDATED WORLDWIDE SHIPMENTS

	1991 Estimate					1995 Projection				
	All FDD	8" All Types	5.25" All Types	Micro Floppy	Over 5 MB	All FDD	8" All Types	5.25" All Types	Micro Floppy	Over 5 MB
MAINFRAME/SUPERMINI General purpose										
Units (000)	96.7	27.8	--	68.9	--	43.3	--	--	43.3	--
Share %	.2%	36.6%	--	.2%	--	.1%	--	--	.1%	--
MINICOMPUTERS AND MULTIPLE USER MICROS Including networks										
Units (000)	889.6	9.4	450.6	426.7	2.9	906.8	--	242.6	649.7	14.5
Share %	1.9%	12.3%	3.0%	1.3%	2.8%	1.7%	--	2.5%	1.5%	1.0%
PERSONAL COMPUTERS Single user										
Units (000)	41,888.9	22.5	13,426.3	28,349.3	90.8	45,097.4	--	8,909.3	34,868.6	1,319.5
Share %	87.1%	29.7%	89.4%	86.4%	91.2%	82.8%	--	91.8%	80.5%	91.0%
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application										
Units (000)	2,814.1	10.2	749.5	2,051.2	3.2	2,157.2	--	417.3	1,732.6	7.3
Share %	5.9%	13.4%	5.0%	6.3%	3.2%	4.0%	--	4.3%	4.0%	.5%
NON-OFFICE SYSTEMS AND WORKSTATIONS Dedicated application										
Units (000)	526.2	6.1	120.2	397.1	2.8	460.2	--	48.5	346.5	65.2
Share %	1.1%	8.0%	.8%	1.2%	2.8%	.8%	--	.5%	.8%	4.5%
CONSUMER AND HOBBY COMPUTERS										
Units (000)	1,526.8	--	240.3	1,286.5	--	5,516.1	--	58.2	5,414.4	43.5
Share %	3.2%	--	1.6%	3.9%	--	10.1%	--	.6%	12.5%	3.0%
OTHER APPLICATIONS										
Units (000)	272.6	--	33.0	239.6	--	289.0	--	29.1	259.9	--
Share %	.6%	--	.2%	.7%	--	.5%	--	.3%	.6%	--
TOTAL, ALL APPLICATIONS										
Units (000)	48,014.9	76.0	15,019.9	32,819.3	99.7	54,470.0	--	9,705.0	43,315.0	1,450.0
Share %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	--	100.0%	100.0%	100.0%

TECHNICAL REVIEW

Competing technologies

1992 has been a year for the flexible disk drive industry to build upon the substantial gains in form factor and capacity for 3.5 inch drives that became available in 1991. 12.7 millimeter (half inch) high drives are available from several sources, while 2.88 megabyte drives are in use in over 30 models of IBM computers. 20 megabyte drives now shipping have extended the choices available for removable storage and should reinforce the strong position held by floppy disk drives as the low cost removable storage device of choice for most small computing systems.

There are other technologies attempting to compete with floppy drives, but they are either too slow, too expensive, or are not standardized for universal data interchange. Flexible disk drives have succeeded because they offer low cost, random access, interchange standards and media removability. Any competing technology must offer significant improvements at a competitive price.

Flexible disk drives continue to evolve. Ever-smaller form factors, higher capacities, more effective designs and lower cost manufacturing methods sustain floppy drive cost-effectiveness against competitive data storage technologies. Consequently, alternate technologies find only limited success in breaking into floppies' established markets, although some displacement of floppy drives is occurring in notebook and hand-held computers where there is insufficient space or power for floppy drives. The high capacity and low profile floppy drive designs now on the market clearly show the result of ongoing innovation in the floppy disk drive industry.

A few alternative storage technologies briefly reviewed below have the potential to challenge flexible disk drives in selected markets:

* Small rigid disk drives: Rapid growth of small Winchester drives has displaced large quantities of floppy drives which otherwise would have been sold, but availability of these rigid disk drives has also served to increase the size of the total market for small computer systems, and boost the market for floppy drives. For most systems using small fixed disk drives, a companion removable media recording device is necessary to provide for software distribution, save/restore of programs and files,

and backup to protect against hardware, software or operator failure. Most of the time, that removable device is a floppy disk drive. With the 1987 arrival of 3.5 inch floppy drives in IBM desktop personal computers, many organizations have had to increase the total number of floppy drives owned in order to maintain a universal data interchange capability among their PC populations.

Today's rigid disk challenge to flexible disk drives is most effectively presented by both disk cartridge drives and small removable fixed disk drives. Small disk cartridge drives, some with capacities as high as 105 megabytes, offer one of the best ways to accomplish fast save/restore of files. They also have access times fast enough to be satisfactory as basic system disks, in lieu of fixed Winchester drives. However, drive and media costs are expensive compared to flexible drives. Furthermore, 5.25 inch removable cartridge drives have not been able to compete in form factor with low profile floppy drives, although SyQuest's 3.5 and 2.5 inch cartridge drives may prove to be more of a contender in this respect, and the OEM price of the 2.5 inch SyQuest drive competes well against that of high capacity floppy drives. Specialized products, such as the Iomega Bernoulli disk drives, now with capacities up to 150 megabytes, provide competition for rigid disk drives, supplying performance, removability and high capacity.

* Semiconductor memory: Semiconductor DRAM memory is too expensive to compete directly with floppy disk drives. Furthermore, the EEPROM or battery-backed SRAM chips required to preserve data during power off periods cost even more, nor is it certain that they will be available in the high densities anticipated for future DRAMs. Ferroelectric memory shows some promise of being a significant future competitor due to its inherent nonvolatility and a production process similar to that of the well understood CMOS, but is unlikely to be a significant competitor until after 1994.

  Flash memory, a form of electrically alterable nonvolatile memory, is a possible alternative to floppy disk drives in cases where high performance or resistance to shock and vibration is more important than low cost. As of mid-1992, flash memory OEM prices are being quoted in the range of $30 to $50 per megabyte, and are projected by semiconductor manufacturers to decrease to the $10 per megabyte range by mid-decade. These price levels may provide an acceptable comparison to floppy drive prices for a minority of users, provided that not more than a few pieces of semiconductor "media" are required during the lifetime of the system.

  The price of semiconductor memory is inexorably declining. The factory level cost per megabyte is expected to be in the range of one dollar by the late nineties for DRAMs and flash memory and about two dollars per megabyte for SRAMs. By comparison, floppy disk media is expected to cost about fifty cents per megabyte in the same period. However, for semiconductor memory to continue to advance as expected, difficult

problems in manufacturing technology must be overcome -- especially those concerned with producing narrower line widths. The rate of development will slow down as the plant and equipment costs increase and lead times for advanced manufacturing and production equipment become significantly longer.

Small plastic cards containing IC memory chips have begun challenging floppy disk drives in selected applications such as games, palmtop computers, medical history storage, programming for electronic musical instruments, and type font storage for printers. Typically the size of a credit card, the cards may use PROM, EPROM, EEPROM or flash memory depending upon whether the application requires read-only, write-once or rewritable storage. While more expensive than floppy disk media, the cards are less vulnerable, though not immune, to handling damage.

Flash memory chips can be configured as additional system memory or organized to mimic the file structure of a disk drive. Packaging is typically on a credit card sized plug-in card. Card capacity now ranges from .25 to 20 megabytes, and 40 megabyte cards are anticipated soon. Packaging and the system interface for flash memory and other semiconductor memory cards have been standardized through the joint efforts of PCMCIA (Personal Computer Memory Card International Association) and JEIDA (Japan Electronic Industry Development Association). PCMCIA, founded in 1989, claims over 150 members representing semiconductor, connector, component and system manufacturers.

There are a number of different technologies for implementing flash memory, some of which have characteristics that will limit acceptability to system manufacturers, such as 12 volt operation. All flash memory is subject to a lifetime limitation ranging from 10,000 to 100,000 write/erase cycles, depending upon the fabrication technology used. Not all bytes degrade at the same rate, so "bad track" detection methods can be used to extend chip operating life. For applications where use is read-only or read-mostly, flash memory has acceptable longevity.

While flash memory offers very fast read performance and read data transfer rates, write performance is limited by the need to erase blocks of bytes before new data can be written and can be as much as 50-100 times slower. However, because power demand is low and power up time is fast, flash memories are attractive to manufacturers of notebook and subnotebook systems where battery life is limited and resistance to mechanical shock and vibration is necessary.

Semiconductor memory can compete effectively with floppy drives in a limited number of applications requiring very small system size, low power, specialized functionality or ruggedness, but will not be a near-term significant competitor in general purpose systems because of the relatively high price of the removable semiconductor assembly compared to floppy disk media.

* Erasable optical disks: The possibility for inroads into the market for flexible high capacity floppy disk drives exists with reversible optical disk systems. Low-end erasable optical drives offer higher capacities than flexible disk drives and average access times equivalent to those offered by some of today's small magnetic rigid disk drives. However, inferior performance and high relative cost compared to rigid magnetic disk drives has kept production levels low and relegated them to niche applications until technology improves and increasing volume lowers costs. 3.5" erasable optical drives have capacity substantially above the ranges likely to be reached by flexible disk drives, so there will be little reason for direct competition. Due to optical disk drive complexity and the thickness of optical disk cartridges, optical drives will have great difficulty in matching the 3/4 inch high and 1/2 inch high form factors which dominate the 3.5 inch floppy drives used in most applications.

  Drive and media costs for erasable optical storage are far above the costs of conventional floppy technology, and it is unlikely that floppy drives will be impacted soon. However, competition between sub-3.5 inch optical drives and very high-end floppy drives may eventually occur. Sony's audio 2 inch M-O drive may eventually appear in the form of a 40-80 megabyte computer peripheral at a competitive price obtained by leveraging from the anticipated large production volume of audio products. Small optical drive prices may someday approach high capacity floppy drive prices, as floppy drive capacity increases above 20 megabytes, although floppy media will remain less expensive than optical media. Both products will compete against tape drives for save/restore applications in small systems and personal computers and will be appropriate for program and data interchange for powerful personal computers and network servers.

* Nonreversible optical disks: The first optical disk recording systems to enter the market were "nonreversible" or "write-once" systems. Write-once 5.25 inch and 12 inch drives are being shipped in modest quantities, and CD format writable disk drives in 4.72 inch half high form factor are being shipped in small numbers, but at high cost.

  Because they have track densities approaching 16,000 tracks per inch, write-once drives are capable of higher areal densities than magnetic recording techniques now in use. Capacity of 5.25 inch drives is typically 325 megabytes per disk side, while 12 inch drives offer up to 4.5 gigabytes per side. The drives are used in optical library based storage systems accessing large numbers of optical disks under system control.

  High cost, high capacity, and write-once related system complexities mean that there will be no impact by write-once disks on floppy drives used in their traditional roles. Even the highest capacity floppy drives using conventional technologies will not compete with write-once drives -- the product characteristics and applications are mutually exclusive.

* Read-only optical disks: The read-only optical disk category is dominated by the CD-ROM. Storage capacities of 550 to 650 megabytes are typical of these products. CD-ROM technology borrows heavily from the designs of the 4.72 inch CD audio players now in volume production, resulting in relatively low manufacturing costs, but also low performance. CD-ROM acceptance benefits from industry agreement on the CD standards developed jointly by Sony and Philips and the format standard developed by the High Sierra group. 3.15 inch CD-ROM drives were introduced by Sony in 1990, but have not been widely accepted.

  Most read-only optical drives are essentially part of a data distribution system and will be used with small systems to provide personal access to large amounts of information. They are expected to have no impact on the floppy drive's role in providing backup capabilities for small systems but will have a modest impact on the use of floppy disk drives for distribution of software for personal computers and other small systems. Even where CD-ROM appears as a system peripheral device, floppy disk drives continue to be required, because only selected software will be distributed on CD-ROM for some years to come. However, software requiring 20 megabytes or more will be increasingly distributed on CD-ROM as the population of CD-ROM drives grows, because CD-ROM replication costs of one to two dollars compare well with floppy media and duplication costs where multiple disks are required.

* Tape drives: Disk drive capacities used with most small computer systems are now above 40 megabytes and functional requirements for a removable media backup device cannot be met conveniently by today's mainstream flexible disk drives. Floppies' comparatively limited capacity is usually adequate for applications with which the typical file is also small, such as with word processing systems and home computers. But if files are typically large, if a database management system is used, or if it is necessary to back up an entire rigid disk for protection at the end of each day, most of today's floppies are not the best answer. While the new 3.5 inch high capacity floppies being developed by Insite Peripherals, NEC, Citizen, Brier Technology, and others may improve the position of the floppy drive as a backup vehicle, high tape capacities that may exceed a gigabyte even for small form factor devices basically keep tape and floppies in different application assignments.

  Digital cassette and tape cartridge drives were available before most of today's floppy drives, but shipments of these drives have never approached those for floppies. The reasons lie in the inability of tape drives to offer fast direct access to individual data records, generally higher prices for the tape drives and media, and until recent years, a lack of industry-wide standards for interfaces and media interchange. Media unit costs are substantially above those for floppy disk media, though lower on a cost per megabyte basis.

The streaming tape cartridge drives now offered by several manufacturers are frequently used for save-and-restore and backup operations. Streamers have been available from several suppliers during recent years, but with different interfaces and recording formats from each manufacturer -- a situation which discouraged many system manufacturers from investing in the controller and software development needed to use these drives. However, the advent of high capacity small Winchester drives provided the stimulus for most of the tape cartridge drive manufacturers to quickly agree on common standards for interfaces and recording formats.

Tape standards, plus new tape cartridge drives designed to the same form factor as 3.5 inch and 5.25 inch Winchesters, have resulted in significant penetration by tape cartridge streamers in the backup market for Winchester disk drives. 4 and 8 millimeter helical scan drives provide backup for rigid drives in the gigabyte and up class, but none of these drives are really competing with floppy drives.

The new generation of high capacity floppy drives will extend the capacity range over which floppies can compete for a role as a backup device to 20-40 megabytes and, eventually, to 80 megabytes. Larger rigid drives will continue to create a demand for tape streamers, helical scan tape drives, or removable rigid disk drives for backup functions. However, floppy drives will undoubtedly continue to be used on many small systems with large capacity Winchester drives. Their role will include software distribution and data interchange, and they will remain a convenient backup method for the small files which must be backed up on a day to day basis.

* Telecommunications: While not strictly a storage technology, telecommunication techniques are being used for data interchange involving notebook and smaller computers where space is insufficient for floppy drives as well as other mandatory functions. The impact of telecommunications is mostly on hand-held or notebook computers and is expected to have a minor negative impact on the demand for floppy drives in future systems.

Flexible disk drive enhancements

Through 1976, IBM led the way in introducing new floppy disk drive technology, but after IBM's 1976 introduction of the two sided 8 inch drive, leadership shifted to Shugart Associates and its successors in the 5.25 inch segment of the market. In 1985, IBM announced that it would phase out production of floppy disk drives, but production continued at a low level until 1990. By the late 1970s, Shugart Associates had shrunk IBM's original technology down to the 5.25 inch format, executing one of the most influential repackaging jobs of all time. By 1989, industry shipments of 3.5 inch drives exceeded 5.25 inch shipments.

The floppy formats which have created the most impact in recent years are the Nippon Telephone & Telegraph 1.2 megabyte version of the 5.25 inch drive, the Sony 3.5 inch, 1.44 megabyte microfloppy, and, most recently, the 2.88 megabyte 3.5 inch drive pioneered by Toshiba. Without IBM's leadership, the industry took years to reach a consensus on these formats, while passing others by. And after all the confusion, IBM finally endorsed both the 1.2 megabyte 5.25 inch and the 3.5 inch (including the 1.44 megabyte version) formats through product introductions. The 2.88 megabyte version first appeared in an IBM system in 1991 and is now available in approximately 30 IBM system models.

The thrust of floppy drive innovation has currently shifted to two areas: Decreasing height and increasing capacity. The vertical form factor for the newest 3.5 inch drives has decreased to 1/2 inch, spurred by the requirements of notebook system producers, while drives with capacities over 20 megabytes have entered production. 40 megabyte capacity by late 1993 is a possibility.

There are many potential technical improvements in flexible disk drive recording technology, each waiting for the backing of an influential firm in the industry. It is expected that by using improved head positioning systems, multigap heads and high capacity media, manufacturers of flexible disk drives will be able to eventually expand capacity well beyond 40 megabytes while retaining downward compatibility.

Here are some areas where potential advancements in flexible disk drive technology are likely to occur:

* Form factor: The newest 3.5 inch floppy drives now in production require approximately 1/2 inch of vertical front panel space. The smaller volume

permits designers of laptop and notebook computers to reduce weight and system package size and to match the heights of new 2.5 inch and 1.8 inch rigid disk drives.

Drives ranging from 15 to 19 millimeter height are currently offered as "3/4 inch" drives. Whatever height eventually becomes the industry standard, 3/4 inch high drives are gradually displacing one inch high floppy disk drives, much as the one inch high units have already largely displaced the 1.625 inch form factor. The 1/2 inch high profile floppy drives will be widely used in notebook computers and are also expected to find early usage in subsystems which combine a 3.5 inch drive with a 5.25 inch drive in a single unit designed to be used in a 1.625 inch slot in desktop systems.

* Media: The polyester substrate used with flexible disks suffers from limitations in its dimensional stability which derive from the manufacturing process used. As a result, today's mainstream floppy drive products using open loop head positioning systems for low cost are limited to 48 TPI with 8 inch drives, 96 TPI with 5.25 inch drives, and 135 TPI with microfloppy drives. The relatively small tonnage of polyester required for diskettes did not inspire plastics manufacturers to invest heavily in research targeted at dimensional stability improvements until the last few years, when the quantities became too large to ignore. However, the magnetic recording industry has been actively developing several methods of increasing track recording density with active servo tracking.

  Some substrate materials do offer high stability and resistance to environmental degradation, but are very expensive relative to polyester films and are unlikely to be widely adopted.

* Longitudinal particulate coatings: Oxide coatings have been the mainstream coating technology for floppy disks. 300 Oersted coatings capable of 5,000 to 6,000 flux changes per inch (FCI) were used on 8 inch and early 5.25 inch diskettes, while 600 Oersted cobalt modified oxide coatings are currently in use on most high density 5.25 inch and microfloppy diskettes. Cobalt modified oxide coatings typically achieve 8,000 to 10,000 FCI for 5.25 inch drives and 17,434 FCI for the 1.44 megabyte microfloppies in common use.

  Oxide coatings are beginning to be displaced by higher performance coatings using barium ferrite and metal powder. The 2.88 megabyte 3.5 inch floppy drive introduced by Toshiba and others records at 34,768 FCI and Citizen has demonstrated a 20.6 megabyte drive (formatted) that records at 43,000 FCI on metal powder media. The U.S. producers of very high capacity floppy drives have tended to favor barium ferrite because of its similarities in manufacturing to the familiar oxide coatings and a belief that it can, with further development, be used to reach capacities of 40 to 50 megabytes per diskette. Japanese producers tend to favor metal powder coatings because of their inherently higher perform-

ance, previous experience with metal powder in entertainment products, and a strong industry position in metal powder media.

Several Japanese drive and media producers have participated in preparing a proposed standard for 10, 20 and 40 megabyte floppy drives under the auspices of JEIDA (Japan Electronic Industry Development Association). It is intended that drives will have downward read/write compatibility with .7 and 1.44 megabyte drives. This tentative standard has been held up in procedural steps until the participating manufacturers are satisfied that a market of adequate size exists and to observe the early market reaction to the Insite and Iomega "floptical" marketing programs.

Manufacturers of flexible media and magnetic particles have promising programs under way to improve the density of longitudinal particulate recording. Based on the information available, it appears that conventional recording methods are being stretched at least to 45,000 FCI now and can be extended further within a few years. Longitudinal particulate recording has many good years left, with the full exploitation of its potential recording density probably to be paced primarily by market forces.

* Isotropic coatings: It is theoretically possible, by reducing the length of magnetic particles, which are normally very long and thin, to resolve magnetic flux changes at much higher densities. It has been demonstrated that such diskettes could be recorded at more than 50,000 BPI. Since diskettes suitable for isotropic recording may be produced in great quantities on coating equipment widely used by media manufacturers today, this technology could be of great interest to the industry if certain thermal instability problems associated with cobalt modification of very small particles can ever be resolved.

* Perpendicular recording: Perpendicular recording offers great potential for increased recording densities on flexible disks. The flying head technology used with rigid disks requires a high revolution rate, which results in very high data transfer rates with perpendicular recording -- faster than most systems and controllers are now ready to handle. However, the contact recording method used with flexible disk drives and the slower rates of revolution encountered, combined with the very high densities of perpendicular recording, could produce transfer rates comparable to the small Winchester disk drives now in wide use.

  Several firms have announced tentative specifications for small flexible disk drives using perpendicular recording. Toshiba pioneered development of barium ferrite recording technology for flexible disk drives, and after several years of tentative market exploration introduced a 2.88 megabyte drive in 1988. Toshiba's design maintains the industry standard open loop 135 TPI density, and the program has been joined by Teac, Sony and other drive and media producers. All of these 2.88 megabyte drives claim full interchange compatibility with .7 and 1.44 megabyte media.

Many of the proposed flexible disk drives using perpendicular recording would require disks with sputtered chromium-cobalt magnetic surfaces. Sputtering technology is highly developed, but throughput is relatively slow. If the millions of low cost diskettes necessary to support any significant penetration of the flexible disk market by perpendicular recording are to be produced by sputtering, major improvements in production rates are probably necessary.

* Track density: As discussed above, media dimensional stability limitations effectively hold track densities to the ranges now employed, if low cost open loop head positioning systems are to be used. It is possible to increase track densities through the use of prerecorded servo information on disks combined with a closed loop head positioning system, but the industry has been slow to move in that direction because of the general desire to hold costs as low as possible and lack of an industry standard.

  Initially, two manufacturers of high capacity 5.25 inch drives attempted to develop the high capacity market using different methods of achieving higher track density. However, Amlyn's late production start spoiled its chance for acceptance of the reference track technology employed in its 3.2 megabyte drive, and the firm closed down operations. Drivetec was more successful in getting started, however, and began shipping its 3.3 megabyte two sided drive in mid-1983. Drivetec used embedded servo information on each diskette to provide tracking information and insure media interchange. Drivetec has since ceased operations, but licensed its technology to Eastman Kodak. Eastman Kodak started production of the 3.3 megabyte drive in 1984, and subsequently produced 6.6, 12 and 24 megabyte drives operating at 384, 333 and 666 TPI, respectively.

  Iomega developed a unique design, widely known as the Bernoulli box, that reaches 2,117 tracks per inch in a media cartridge of unconventional design. The Iomega design uses the aerodynamic effects of the rapidly spinning disk to properly position the media relative to the head.

  Brier Technology's 3.5 inch drive uses preformatted disks and offers a formatted capacity of 21.4 megabytes and 35 millisecond average head positioning time. A track density of 777 TPI is used. Insite Peripherals achieves a track density of 1,245 TPI using optical tracking of a servo pattern imprinted on the disk surface by a laser or impressed in a mold.

* Heads: The new generations of high capacity floppy drives are using multifunction head designs to provide read/write/erase capability at multiple densities. This feature allows downward compatibility for 3.5 inch 2.88 megabyte drives with .7 and 1.44 megabyte drives. All of the high capacity floppy disk drives in the 20 megabyte or higher range currently contemplated for production will use multigap heads to achieve downward compatibility. The newer 20 megabyte drives currently offer compatibility with .7 and 1.44 megabyte 3.5 inch floppy drives. Ferrite head technology is typically used.

* Servo technology: The higher track densities being employed in the new generations of flexible disk drives require the use of closed loop head positioning systems. Some, such as Brier's multiple frequency embedded servo and Insite's optical tracking scheme, are innovative and have the potential to set new standards if widely adopted by other companies. Brier writes a servo track on the media at a frequency much lower than the data recording frequency, then uses filtering to separate the readback signal into a data component and a servo tracking component. Insite applies a reflective track pattern to the media surface, and employs simple optics with an inexpensive LED light source to monitor head position.

* Disk diameter: In 1987, smaller diameter flexible disk drives began to receive some notice. 2 inch drives were announced by two firms, but acceptance has been limited. Matsushita Communication Industrial's design approach mapped a standard 3.5 inch 1 megabyte drive format onto 2 inch media and won a major OEM contract for a notebook computer, but the unconventional, noninterchangeable media failed to win broad acceptance.

  Sony has been producing drives and media based upon a video drive used in the Mavica camera. While the Sony specifications are impressive -- 819 kilobyte formatted capacity, 14.3 megabits/second data transfer rate and 3,600 RPM rotation rate -- incompatibility with standard floppy disk drive controllers impedes acceptance. Lack of media interchange capability with the 3.5 inch floppy drives, now the dominant standard for office computers, also restrains the industry's enthusiasm.

  While no 2.5 inch drives have yet appeared, the success of the rigid disk drive 2.5 inch and smaller formats will probably eventually create a demand for smaller floppy drives for use in notebook computers. However, the resistance of end users to dealing with yet another floppy drive format may limit that market opportunity to very thin 3.5 inch floppy drive models.

* Encoding and error correction: Effective linear bit density can be improved beyond the raw flux change density by the use of appropriate data encoding schemes which are used with rigid and optical drives. High capacity floppy drives with capacities of 20 megabytes and more are the primary users of sophisticated coding techniques such as 2,7 RLL code (Citizen), 1,7 RLL code (Insite Peripherals) and 1,8 RLL code (Iomega Bernoulli drives).

  Error correction is starting to appear as a feature of high capacity floppy drives, and is required for reliable performance as capacities climb and the effect of media defects becomes more important.

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 classification

Market class is used here, arbitrarily, to differentiate captive, PCM/Reseller and OEM/Integrator disk drive marketing activities.

Captive: Disk drives manufactured internally or by a subsidiary of a computer manufacturer, and sold or leased primarily for use with systems offered by the manufacturer. Note that the term is used to describe the products, not the manufacturer; drives sold to PCM/Reseller or OEM/Integrator market classes are classified accordingly.

Example:

* Drives made by Sony or Samsung and sold with their own computer systems to end users are considered captive, if internally manufactured, or made by a subsidiary.

Noncaptive: Any public sale or lease by any disk drive manufacturer, except sales or leases of internally manufactured drives by computer system manufacturers primarily for use with their own systems. Both PCM/Reseller and OEM/Integrator shipments are included in the noncaptive sales channel.

Examples:

* Shipments by NEC are noncaptive, except for drives sold with systems by the parent company or other subsidiaries.

* Shipments by Teac are noncaptive.

PCM/Reseller: Disk drives sold or leased by "plug compatible manufacturers" or their distributing organizations directly to end users for use with systems sold by another manufacturer. Also includes drives sold in the "aftermarket" -- shipments by drive manufacturers to subsystem producers, distributors, retail chains, mail order firms and individual dealers. It includes drives to be connected to systems of all types, including personal computers, minicomputers and mainframes, or drives sold as add-on devices by dealers and distributors.

Examples:

* Disk drives sold by Iomega to end users of IBM or Apple systems.

* Standard drives sold by drive manufacturers to distributors or dealers are considered to be PCM/Reseller drives.

OEM/Integrator: Drives sold by the original producer to system manufacturers which resell them as part of complete computer systems. Also includes sales to system integrators or value-added resellers which combine finished system components and software to provide complete systems for specific applications. Sales by a disk drive manufacturer to a second drive manufacturer for resale are included only in shipment totals for the originating drive manufacturer, except when drives are produced on a contract manufacturing basis with a design supplied by the disk drive manufacturer which finally sells the drive to a third party.

Example:

* Drives sold by independent drive manufacturers to IBM or other system manufacturers for use with personal computers are considered to be OEM/Integrator drives.

Geographic classification

Geographic analysis is based upon U.S. and non-U.S. regions. Together, these two regions comprise the worldwide market.

U.S. vs. Worldwide SHIPMENTS: Shipments are classified U.S. or worldwide depending on the country in which the headquarters of the purchasing company is located.

Examples:

* OEM shipments to a European system manufacturer are included in the worldwide totals, even if drives are integrated into a system within the United States.

* An OEM shipment by a Japanese drive manufacturer to a U.S.-based system manufacturer is included in U.S. totals, even if the drive is integrated into a system in Hong Kong, regardless of the final destination of systems in which the drives are used.

U.S. vs. 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:

* Insite Peripherals is considered a U.S. manufacturer, even though most of its disk drives are produced on a contract manufacturing basis outside the United States.

* Alps Electric is considered a non-U.S. manufacturer, even though some of the firm's floppy drives may be manufactured in the U.S.

Units of measurement

Spindles: The basic unit in counting disk drives. One spindle consists of the disk drive mechanism required to utilize a single disk. All DISK/TREND unit totals are counted in spindles.

Revenue: Based on sales of disk drives alone, as normally sold by individual manufacturers. Controllers sold as separate units are not included, nor are spare parts or service. Sale prices are estimated public sale transaction prices, whether at captive end user, PCM/Reseller or OEM/Integrator levels. All prices are in 1992 constant dollars.

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

Examples:

* Enhancements such as double density versions of existing drive configurations and revised encoding schemes are anticipated in DISK/TREND forecasts.

* Innovations such as nonstandard size disks or new physical configurations may require establishment of new DISK/TREND product groups.

Application Classification

Shipments of disk drives are classified by the following computer applications:

Mainframe/superminicomputer: Disk drives attached to the processor or to a terminal associated with a mainframe or superminicomputer.

Minicomputers/multiple user microcomputers: Drives attached to mid-range general-purpose processors typically serving multiple users, including network file servers. Examples: IBM System AS/400, DEC 433MP, Hewlett-Packard 3000.

Personal computers: Attached to a general purpose microcomputer normally used by a single user, including desktop and portable models. Examples: IBM PS/2, Apple Macintosh, Dell NL25.

Office systems/workstations: Specialized equipment for dedicated use in specific office applications such as word processing, electronic typewriters, electronic mail or document storage. Specialized hardware is normally used. Examples: Wang OIS series, Toshiba TOSFILE.

Nonoffice systems/workstations: Attached to dedicated processors and workstations used in a nonoffice application, such as order processing/shipping, point of sale, medical, factory production control, law enforcement, military, CAD/CAM/CAE, etc.

Consumer and hobby computers: Systems sold primarily to consumers for nonbusiness applications. Examples: Commodore 64, MSX systems, most Atari models. Multimedia systems for home use, such as the Commodore CDTV, are also included in this category.

Other applications: Any application not included above, including non-conventional uses such as intelligent fax machines, sewing machines, copiers, musical instruments and intelligent personal communication devices.

FLEXIBLE DISK DRIVES, 8 INCH

Coverage

Examples of flexible disk drives in this group include:

One side

Miltope	DD 400

Two sides

Hitachi	FDD-412
Matsushita Communication Ind.	JA-751
Miltope	DD 450
NEC	FD 1165
Y-E Data	YD-180

The first flexible disk drives were all 8 inch models, and until the early 1980s this group generated a majority of all floppy drive shipments. However, with the growth of smaller floppy drives and the decline in shipments of 8 inch models, the number of participating manufacturers has shrunk to the short list above.

The "full size" OEM drives in this group were generally designed to the same physical dimensions as the Shugart Associates 801. Almost all of the many OEM 8 inch drives introduced during the 1980's were "half high" models, which now constitute most of the industry's remaining shipments of 8 inch floppy drives.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1991	1992	1993	1994	1995
U.S. manufacturers	.5	.5	--	--	--
All manufacturers	25.3	16.1	10.8	5.5	--

Worldwide shipments for 8 inch one sided drives peaked in 1981, at 746,600 units, and two sided drives peaked two years later, with 1,275,900 units. During the last 10 years, there has been an unending decline in shipments of 8 inch floppy drives. Total 1991 shipments were 76,000 drives, a drop of 46.3% from the previous year, and the total for 1992 is expected to be down another 35.2%, to 49,200 drives.

FLEXIBLE DISK DRIVES, 8 INCH

1992 DISK/TREND REPORT

In recent years, the largest factor in maintaining shipments of drives in this product group has been continuing usage of the two sided 8 inch format in the Japanese domestic market for office computers. But the tide has long since turned. 8 inch drives were displaced first by the 1.2 megabyte 5.25 inch models, and later by the 3.5 inch drives used in most of the newer systems.

Production of 8 inch floppy drives in the United States and Europe consists only of shipments by a single manufacturer for specialized militarized systems. Most U.S. disk drive manufacturers have long since terminated their floppy drive production programs, and U.S. system manufacturers have shifted to smaller diameter floppy drives for personal computers, specialized workstations and most terminals, leaving systems now approaching the end of their manufacturing cycles as the principal remaining market for 8 inch floppy drives.

Shugart Associates, the early leader in floppy drive shipments, was sold in 1986, after years of decline under inept Xerox ownership. The Narlinger Group, now operating as Shugart Corporation, acquired the Shugart Associates 8 inch floppy product line, as well as the 8 inch floppy drives purchased from Siemens, Tandon and Control Data. For several years Shugart provided most of the remaining small U.S. OEM shipments, but became inactive in the area as inventories were depleted.

Y-E Data has dominated noncaptive shipments in this product group during recent years, and held 65.3% of 1991 worldwide shipments.

Marketing trends

The drives in this product group are considered obsolete by most system manufacturers, and the current rate of decline in shipments is expected to continue. The group's slow death continues, as older computer systems using the drives linger on in the marketplace. The remaining markets will be primarily in domestic Japan, with final shipments expected in 1994.

This product group's current lack of vigor is traceable to a combination of factors: (1) Rapid development during the 1980s of the 5.25 and 3.5 inch formats, offering capacities equaling those of 8 inch drives at much lower prices, (2) Reliability problems most manufacturers experienced with 8 inch, two sided

drives in the late 1970's, which kept many OEMs from committing to the format, and (3) Lack of further development of the 8 inch drive format by IBM, which inhibited manufacturers of OEM drives from investing in higher density versions.

In Japan's domestic market, demand for 8 inch drives continued to grow after the U.S. market started to decline. But despite the popularity of the format in Japan, most manufacturers of small office computer systems felt the pressure to move to desktop versions of their older systems, and the 1.2 megabyte 5.25 inch floppy drive developed under the sponsorship of Nippon Telephone & Telegraph made it possible to do so. More recent availability of 3.5 inch drives in this capacity range have intensified the problem for 8 inch drives.

Technical trends

With the exception of limited programs by Burroughs, PerSci, and Elcomatic, there have been few serious attempts to introduce higher capacity drives in this group. The key reason that development of 8 inch drives has been stuck at 1.2 megabytes since 1976 was IBM's lack of innovation in the area.

Several OEM drive manufacturers were ready to introduce new drives for years, with most planning various track following methods, to make possible increased track density. These plans were generally set back by the reliability problems which were experienced by two sided 8 inch floppy drives until the end of the 1970's, and by the hope of most manufacturers that IBM would take the lead in establishing a new high capacity format, preferably with an improved, higher density media standard. After all the waiting, the momentum passed to the smaller diameter floppy formats.

Forecasting assumptions

1. IBM will continue the use of 3.5 inch floppy drives for new versions of its personal computer and other small systems, and will not resume internal production of 8 inch drives.

2. Other system manufacturers will continue to move to smaller drives, causing a continuing reduction in worldwide shipments of 8 inch drives, with the last shipments in 1994.

TABLE 8

FLEXIBLE DISK DRIVES, 8 INCH

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1991		Forecast							
	Revenues		1992		1993		1994		1995	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	.5	--	.5	--	--	--	--	--	--
TOTAL U.S. NONCAPTIVE	--	.5	--	.5	--	--	--	--	--	--
TOTAL U.S. REVENUES	--	.5	--	.5	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	.2	11.9	--	8.3	--	6.8	--	3.6	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	2.4	12.9	1.7	7.3	1.1	4.0	.4	1.9	--	--
TOTAL NON-U.S. REVENUES	2.6	24.8	1.7	15.6	1.1	10.8	.4	5.5	--	--
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	2.6	25.3	1.7	16.1	1.1	10.8	.4	5.5	--	--
OEM Average Price ($000)	.235	.274	.212	.253	.220	.222	.200	.211	--	--

TABLE 9

FLEXIBLE DISK DRIVES, 8 INCH

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1991		Forecast							
	Shipments		1992		1993		1994		1995	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	.1	--	.1	--	--	--	--	--	--
TOTAL U.S. NONCAPTIVE	--	.1	--	.1	--	--	--	--	--	--
TOTAL U.S. SHIPMENTS	--	.1	--	.1	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	1.0	27.0	--	18.4	--	15.2	--	8.0	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	10.2	48.9	8.0	30.7	5.0	18.0	2.0	9.0	--	--
TOTAL NON-U.S. SHIPMENTS	11.2	75.9	8.0	49.1	5.0	33.2	2.0	17.0	--	--
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	11.2	76.0	8.0	49.2	5.0	33.2	2.0	17.0	--	--
Cumulative Shipments (Units in millions)										
IBM	1.2	1.8	1.2	1.8	1.2	1.8	1.2	1.8	1.2	1.8
Non-IBM	4.1	10.3	4.1	10.4	4.1	10.4	4.1	10.4	4.1	10.4
WORLDWIDE TOTAL	5.3	12.1	5.3	12.2	5.3	12.2	5.3	12.2	5.3	12.2

TABLE 10
FLEXIBLE DISK DRIVES, 8 INCH
WORLDWIDE SHIPMENTS (000)
DRIVE HEIGHT ANALYSIS

	1991 Shipments		Forecast							
			1992		1993		1994		1995	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	--		--		--		--		--	
Full Size	--	--	--	--	--	--	--	--	--	--
Non-Captive Total	.1		.1		--		--		--	
Full Size	.1	100.0%	.1	100.0%	--	--	--	--	--	--
Total U.S.	.1		.1		--		--		--	
Full Size	.1	100.0%	.1	100.0%	--	--	--	--	--	--
NON-U.S. MANUFACTURERS										
Captive Total	27.0		18.4		15.2		8.0		--	
Full Size	.1	.4%	--	--	--	--	--	--	--	--
Half High	26.9	99.6%	18.4	100.0%	15.2	100.0%	8.0	100.0%	--	--
Non-Captive Total	48.9		30.7		18.0		9.0		--	
Full Size	--	--	--	--	--	--	--	--	--	--
Half High	48.9	100.0%	30.7	100.0%	18.0	100.0%	9.0	100.0%	--	--
Total Non-U.S.	75.9		49.1		33.2		17.0		--	
Full Size	.1	.1%	--	--	--	--	--	--	--	--
Half High	75.8	99.9%	49.1	100.0%	33.2	100.0%	17.0	100.0%	--	--
WORLDWIDE RECAP										
Total Worldwide Shipments	76.0		49.2		33.2		17.0		--	
	-46.3%		-35.2%		-32.5%		-48.8%		--	
Full Size	.2	.3%	.1	.2%	--	--	--	--	--	--
	-97.1%		-50.0%		--		--		--	
Half High	75.8	99.7%	49.1	99.8%	33.2	100.0%	17.0	100.0%	--	--
	-43.6%		-35.2%		-32.3%		-48.8%		--	

Notes: Percentage figures with plus/minus signs refer to year-to-year growth rates.

TABLE 11

FLEXIBLE DISK DRIVES, 8 INCH

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1991 Estimate Units (000)	1991 Estimate %	1995 Projection Units (000)	1995 Projection %
MAINFRAME/SUPERMINI				
General purpose	27.8	36.6	--	--
MINICOMPUTERS AND MULTIUSER MICROS				
Business and professional, including networks	9.4	12.3	--	--
PERSONAL COMPUTERS				
Business and professional, single user	22.5	29.7	--	--
OFFICE SYSTEMS AND WORKSTATIONS				
Dedicated application and electronic typewriters	10.2	13.4	--	--
NONOFFICE SYSTEMS AND WORKSTATIONS				
Technical, distribution, medical, other specialized	6.1	8.0	--	--
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	--	--	--	--
Total	76.0	100.0	--	--

TABLE 12

FLEXIBLE DISK DRIVES, 8 INCH

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1991 Net Shipments			
	To United States Destinations		Worldwide	
Drive Manufacturers	Units (000)	%	Units (000)	%
Y-E Data	10.0	98.0	32.0	65.3
Other U.S.	--	--	.1	.2
Other Non-U.S.	.2	2.0	16.9	34.5
TOTAL	10.2	100.0	49.0	100.0

FLEXIBLE DISK DRIVES, 5.25 INCH

1992 DISK/TREND REPORT

FLEXIBLE DISK DRIVES, 5.25 INCH

Coverage

Examples of flexible disk drives in this group include:

One side: 48 tracks per inch

Chinon	FZ-501A
Mantec	MTL-FD102E/C

Two sides: 48 tracks per inch, .360 megabyte

Canon	MD 5201
Chinon	FZ-502
Mantec	MTL-FD128
Matsushita Communication Ind.	JA-455
Mitsubishi Electric	MF501C
Multidigit	DF0511
Safronic	DS-51A
Seiko Epson	SD-621L
Teac	FD-55BR
Toshiba	ND-0401
Y-E Data	YD-580

Two sides: 96 tracks per inch, .7 megabyte

Teac	FD-55FR

Two sides: 96 tracks per inch, 1.2 megabytes

Canon	MD-5501
Chinon	FZ-506
Mantec	MTL-FD228
Matsushita Communication Ind.	JU-475
Mitsubishi Electric	MF504C, MF504S
Mitsumi Electric	D 509V2
Multidigit	DF1622
NEC	FD 1157D, FD 1158C
Safronic	DS-53A
Samsung Electronics	SFD-560D
Seiko Epson	SD-680L
Teac	FD-55GR, FD-55GFR
Toshiba	ND-0801
Vitoria Tecnologia	DV 5200
Y-E Data	YD-380B

Two sides: 96 tracks per inch, 2.4 megabytes

Y-E Data	YE-801

The basic standards for physical size and recording format for this product group were created by the 1976 introduction of the Shugart SA 400, the original minifloppy. Early growth in small microcomputer systems inspired several innovative one sided 5.25 inch drives, some of which achieved success until the industry's movement to two sided versions. Starting with the 1989 edition of the DISK/TREND Report, all 5.25 inch drives were combined into a single product group, replacing separate groups for one and two sided drives, in view of the continuing shipment decline of one sided 5.25 inch flexible disk drives.

Because of the continued shrinkage in the physical size of computer systems, reduced drive height became an extremely active area of innovation. Half high drives, pioneered by Tandon and Alps Electric and now offered by most drive manufacturers, have become the standard for 5.25 inch floppy drives.

Two sided 5.25 inch floppy drives became a reality in 1978. The original 48 TPI drives were joined by 96 TPI drives from Tandon, Micro Peripherals and Micropolis in 1980. However, a more influential development occurred in 1982, when 1.2 megabyte 5.25 inch drives were first shipped by Y-E Data, designed to a standard coordinated by Nippon Telephone and Telegraph. IBM's 1984 introduction of the PC AT, using Y-E Data's 1.2 megabyte drive, stampeded the market into rapid worldwide usage of the 1.2 megabyte 5.25 inch format.

Drivetec's half high drive using an embedded servo technique -- with 192 TPI, and capacity of 2.4 megabytes -- was a technical success and a commercial failure. The company closed down in early 1985, but had licensed Eastman Kodak to make the drive. Eastman Kodak started production of a drive compatible with Drivetec's unit in 1984, later challenged by other 2.4 megabyte formats from Matsushita Communication Industrial and Y-E Data. Usage of 2.4 megabyte drives has been limited, due to lack of industry standards and the movement to 3.5 inch microfloppies.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1991	1992	1993	1994	1995
U.S. manufacturers	--	--	--	--	--
All manufacturers	849.3	793.3	704.2	574.6	427.8

Despite the industry's expectations, shipments of 5.25 inch floppy drives have stubbornly refused to collapse. After peaking in 1988 with 16.5 million drives, total shipments of 5.25 inch drives were down 10.1% in 1989, but shipments were up slightly in 1990 and again in 1991. 1992's worldwide shipments of 5.25 inch drives are forecasted at 15,158,700 units, another increase of almost one percent.

However, total 1991 revenues for the product group continued to decline, under pressure from lower average unit prices. The $849.3 million total for the group was down 16.1% from 1990, and a further decline of 6.5% is expected for 1992 as prices continue to fall, lowering total revenues for the year to $793.3 million. Average unit prices for OEM drives declined from $114 in 1984 to $49 in 1991, with a further reduction expected in 1991, to $47. Major Japanese floppy drive producers have concentrated on aggressive cost reduction programs, including product redesign and plant relocation, which have resulted in continuing price competition.

The slight overall growth in 5.25 inch floppy drive shipments is being driven by continuing strong demand for 1.2 megabyte models, which are expected to provide 96.8% of 1992 total shipments for 5.25 inch drives. However, this product configuration is losing momentum. Shipments of 1.2 megabyte drives were up 17.4% in 1991, to 13.6 million drives, but unit shipment growth in 1992 is expected to be only 7.5%. The rate of decline for .360 megabyte drives is increasing. Total shipments of .360 megabyte drives were 1.3 million drives in 1991, down 57.9%, and 1992's estimated worldwide unit shipments are only 447,500, a drop of 66.2%.

1.2 megabyte two sided 5.25 inch floppy drives were used predominantly with IBM PC AT personal computers, plus the clones offered by numerous manufacturers. IBM moved on to the PS/2 personal computer family, using 3.5 inch microfloppies, but the older IBM standards have been tough to kill. Despite abandonment by IBM, the PC AT standard has continued its momentum and has contributed to continuing sales of 1.2 megabyte two sided 5.25 inch drives with numerous AT clones.

Underlying the current strength in 5.25 inch drive shipments is the desire by many buyers of new personal computer models to maintain the ability to inter-

change diskettes with older PC's. This demand has caused a high proportion of new PC models to be shipped with both 5.25 and 3.5 inch floppy drives.

89.4% of 1991's shipments of 5.25 inch floppy drives were used with personal computers, with minor usage attributed to consumer and hobby computers, office systems and minicomputer applications. As 5.25 inch floppy drive shipments decline during the next few years, the percentage destined for personal computer applications is expected to increase slightly.

Teac, which has led in noncaptive shipments for this product group since 1989, held 26.1% of the worldwide 1991 total, for 3,703,000 drives. Matsushita Communication Industrial shipped 2,680,000 drives, for 18.9%, and Chinon shipped 2,040,000 drives, for 14.4%.

Marketing trends

In spite of the current strong shipments of 1.2 megabyte drives, this group is expected to decline at an accelerating rate during the 1993-95 period. The most significant negative factors for 5.25 inch floppy drive shipments will be the fact that 3.5" are favored by most PC manufacturers because of smaller physical size, higher capacity and lower price, combined with a reduced need for media interchange between 5.25 and 3.5 inch drives. As more users reach the stage when all of the PC's in their companies are able to utilize 3.5 inch diskettes, fewer will feel the need to buy new PC's which also contain a 5.25 inch floppy drive.

Total unit shipments of 5.25 inch floppy drives are forecasted to be only 9.7 million in 1995, an average annual decline of 13.5% in the 1993-95 period. Total revenue for the product group will decline at a more rapid pace than the shipment decline, averaging -18.4% annually during 1993-95, with the 1995 revenue total projected at $427.8 million.

Technical trends

It is considered unlikely that drive manufacturers will devote their resources to further product development for most of the products in this group, considering the outlook for declining production and the obvious need to place development priorities in other product areas.

An interesting improvement in drive packaging is represented by the Teac introduction in 1991 of a 1 inch high 1.6 megabyte 5.25 inch drive. Three companies had previously introduced "one third high" 5.25 inch drives in the early 1980s, but the demand at that time was limited and all of those models eventually disappeared from the market.

However, the Teac 1 inch high drive may find a more interesting reception, since the firm is offering it in a combination unit with a .5 inch high 3.5 inch drive. Teac's 5.25/3.5 combination can be mounted in a personal computer's half high 5.25 inch slot, providing a significant improvement in interchange flexibility for AT clones.

It now appears that drive manufacturers will devote no further effort to development of capacity increases for 5.25 inch floppy drives. After several programs during the 1980s using embedded servo techniques, the only remaining 3.3 megabyte 5.25 inch floppy drive still in production is the simpler design by Y-E Data.

Y-E Data's drive employs the standard 96 TPI, with standard track positioning, and doubles the linear density, to maintain full read and write compatibility with both 1.0 and 1.6 megabyte diskettes, even though a special diskette is required for usage at 3.3 megabytes.

Forecasting assumptions

1. The existing momentum of the PC AT format will decline slowly, insuring a residual market for 1.2 megabyte 5.25 inch drives for several years.
2. A positive growth rate for personal computers will be maintained.
3. The dollar/yen exchange rate will stay in the current range, and the major Japanese floppy disk drive producers will continue to gradually lower average noncaptive prices.

TABLE 13

FLEXIBLE DISK DRIVES, 5.25 INCH

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1991		Forecast							
	Revenues		1992		1993		1994		1995	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. NONCAPTIVE	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	8.3	162.1	3.2	123.2	3.0	91.5	2.1	58.1	1.3	29.3
PCM/Reseller	108.6	152.9	111.9	152.7	125.1	169.0	113.9	152.8	93.7	126.7
OEM/Integrator	201.4	534.3	207.3	517.4	173.9	443.7	141.7	363.7	105.2	271.8
TOTAL NON-U.S. REVENUES	318.3	849.3	322.4	793.3	302.0	704.2	257.7	574.6	200.2	427.8
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	318.3	849.3	322.4	793.3	302.0	704.2	257.7	574.6	200.2	427.8
OEM Average Price ($000)	.049	.049	.047	.047	.045	.045	.043	.043	.042	.042

TABLE 14

FLEXIBLE DISK DRIVES, 5.25 INCH

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1991		Forecast							
	Shipments		1992		1993		1994		1995	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. NONCAPTIVE	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	49.0	839.7	20.0	770.0	20.0	610.0	15.0	415.0	10.0	225.0
PCM/Reseller	2,273.0	3,250.9	2,476.0	3,375.5	2,845.0	3,835.0	2,650.0	3,550.0	2,230.0	3,015.0
OEM/Integrator	4,119.0	10,929.3	4,393.0	11,013.2	3,865.0	9,850.0	3,295.0	8,445.0	2,505.0	6,465.0
TOTAL NON-U.S. SHIPMENTS	6,441.0	15,019.9	6,889.0	15,158.7	6,730.0	14,295.0	5,960.0	12,410.0	4,745.0	9,705.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	6,441.0	15,019.9	6,889.0	15,158.7	6,730.0	14,295.0	5,960.0	12,410.0	4,745.0	9,705.0
Cumulative Shipments (Units in millions)										
IBM	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
Non-IBM	67.7	139.8	74.6	155.0	81.3	169.3	87.3	181.7	92.0	191.4
WORLDWIDE TOTAL	68.1	140.3	75.0	155.5	81.7	169.7	87.7	182.2	92.4	191.9

TABLE 15

FLEXIBLE DISK DRIVES, 5.25 INCH

WORLDWIDE SHIPMENTS (000)

TRACK DENSITY ANALYSIS

	1991 --Shipments--		Forecast 1992		1993		1994		1995	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	--		--		--		--		--	
Non-Captive Total	--		--		--		--		--	
Total U.S.	--		--		--		--		--	
NON-U.S. MANUFACTURERS										
Captive Total	839.7		770.0		610.0		415.0		225.0	
48 TPI	67.8	8.1%	--	--	--	--	--	--	--	--
96 TPI .7 MB	--	--	--	--	--	--	--	--	--	--
96 TPI 1.2 MB	771.9	91.9%	770.0	100.0%	610.0	100.0%	415.0	100.0%	225.0	100.0%
Non-Captive Total	14,180.2		14,388.7		13,685.0		11,995.0		9,480.0	
48 TPI	1,257.0	8.9%	447.5	3.1%	240.0	1.8%	95.0	.8%	25.0	.3%
96 TPI .7 MB	33.0	.2%	25.0	.2%	10.0	.1%	--	--	--	--
96 TPI 1.2 MB	12,890.2	90.9%	13,916.2	96.7%	13,435.0	98.1%	11,900.0	99.2%	9,455.0	99.7%
Total Non-U.S.	15,019.9		15,158.7		14,295.0		12,410.0		9,705.0	
48 TPI	1,324.8	8.8%	447.5	3.0%	240.0	1.7%	95.0	.8%	25.0	.3%
96 TPI .7 MB	33.0	.2%	25.0	.2%	10.0	.1%	--	--	--	--
96 TPI 1.2 MB	13,662.1	91.0%	14,686.2	96.8%	14,045.0	98.2%	12,315.0	99.2%	9,680.0	99.7%
WORLDWIDE RECAP										
Total Worldwide Shipments	15,019.9		15,158.7		14,295.0		12,410.0		9,705.0	
	+.4%		+.9%		-5.7%		-13.1%		-21.8%	
48 TPI	1,324.8	8.8%	447.5	3.0%	240.0	1.7%	95.0	.8%	25.0	.3%
	-57.9%		-66.2%		-46.3%		-60.4%		-73.6%	
96 TPI .7 MB	33.0	.2%	25.0	.2%	10.0	.1%	--	--	--	--
	-80.2%		-24.2%		-60.0%		--		--	
96 TPI 1.2 MB	13,662.1	91.0%	14,686.2	96.8%	14,045.0	98.2%	12,315.0	99.2%	9,680.0	99.7%
	+17.4%		+7.5%		-4.3%		-12.3%		-21.4%	

Notes: 1. Percentage figures with plus/minus signs refer to year-to-year growth rates.
2: Track densities greater than 96 TPI are grouped with 96 TPI 1.2 MB totals.

TABLE 16

FLEXIBLE DISK DRIVES, 5.25 INCH

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1991 Estimate Units (000)	1991 Estimate %	1995 Projection Units (000)	1995 Projection %
MAINFRAME/SUPERMINI				
General purpose	--	--	--	--
MINICOMPUTERS AND MULTIUSER MICROS				
Business and professional, including networks	450.6	3.0	242.6	2.5
PERSONAL COMPUTERS				
Business and professional, single user	13,426.3	89.4	8,909.3	91.8
OFFICE SYSTEMS AND WORKSTATIONS				
Dedicated application and electronic typewriters	749.5	5.0	417.3	4.3
NONOFFICE SYSTEMS AND WORKSTATIONS				
Technical, distribution, medical, other specialized	120.2	.8	48.5	.5
CONSUMER AND HOBBY COMPUTERS	240.3	1.6	58.2	.6
OTHER APPLICATIONS	33.0	.2	29.1	.3
Total	15,019.9	100.0	9,705.0	100.0

TABLE 17

FLEXIBLE DISK DRIVES, 5.25 INCH

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1991 Net Shipments			
	To United States Destinations		Worldwide	
Drive Manufacturers	Units (000)	%	Units (000)	%
Teac	1,468.0	23.0	3,703.0	26.1
Matsushita Communication Ind.	760.0	11.9	2,680.0	18.9
Chinon	1,195.0	18.7	2,040.0	14.4
Seiko Epson	964.0	15.1	1,209.0	8.5
Y-E Data	273.0	4.3	889.0	6.3
Mitsumi Electric	410.0	6.4	840.0	5.9
Mitsubishi Electric	400.0	6.3	645.0	4.6
Safronic	195.0	3.1	514.0	3.6
Toshiba	488.0	7.6	488.0	3.4
Canon	180.0	2.8	440.0	3.1
Other U.S.	--	--	--	--
Other Non-U.S.	59.0	.8	732.2	5.2
TOTAL	6,392.0	100.0	14,180.2	100.0

FLEXIBLE DISK DRIVES, MICROFLOPPIES

1992 DISK/TREND REPORT

FLEXIBLE DISK DRIVES, MICROFLOPPIES

Coverage

Examples of flexible disk drives in this group include:

3.5" disk diameter, one side, 67.5 TPI

Brother	FB 100

3.5" disk diameter, one side, 135 TPI

Brother	FB 015

3.5" disk diameter, two sides, 135 TPI, .7 megabyte

Alps Electric	DFR 423
Chinon	F-354
Citizen	OSDC, V1DC
Matsushita Communication Ind.	JU-253A
Matsushita Electronic Comp.	EME-213
Mitsubishi Electric	MF353C
Mitsumi Electric	D357C
NEC	FD 1037A, FD 1038A
Seiko Epson	SMD-380
Sony	MP-F11W
Teac	FD-235F
Y-E Data	YD-645C

3.5" disk diameter, two sides, 135 TPI, 1.2 megabytes

Alps Electric	DFP 643
Canon	MD 3511
Citizen	OSDB, V1DB
Matsushita Communication Ind.	JU-255
Matsushita Electronic Comp.	EME-262
Mitsubishi Electric	MF354C
Mitsumi Electric	D358T3
NEC	FD 1137C
Seiko Epson	SMD-1020
Teac	FD-235GF, FD-05GF
Y-E Data	YD-686C

3.5" disk diameter, two sides, 135 TPI, 1.44 megabytes

Alps Electric	DFP 723, DF 324H
Canon	MD 3611
Chinon	FT-357, FP-357
Citizen	OSDA, W1DA
Ergo	MD-21
Matsushita Communication Ind.	JU-257A
Matsushita Electronic Comp.	EME-263, EME-274

3.5" disk diameter, two sides, 135 TPI, 1.44 megabytes (continued)

Mitsubishi Electric	MF355C, MF355E
Mitsumi Electric	D359C
NEC	FD 1137H, FD 1139H
Safronic	DS-34A
Samsung Electronics	SFD-321D
Seiko Epson	SMD-340
Sony	MP-F17W, MP-F320
Teac	FD-235HF, FD-05HF
Toshiba	ND-3561
Vitoria Tecnologia	DV 3200
Y-E Data	YD-701B, YD-702F

3.5" disk diameter, two sides, 135 TPI, 2.88 megabytes

Alps Electric	DFR 823
Chinon	FZ-358
Citizen	OSDG, V1DF
Matsushita Communication Ind.	JU-259A
Mitsubishi Electric	MF 356C
Mitsumi Electric	D352T2
Samsung	SFD-342K
Seiko Epson	SMD-1060
Sony	MP-F40W
Teac	FD-235J
Toshiba	ND-3571
Y-E Data	YD-742

2.0" disk diameter, 254 TPI

Sony	PDD-110

All microfloppy drives with formatted capacities less than 5 megabytes and disk diameters of 3.5 inches or less are included in this product group. The separate types of products include: (1) 3.5 inch drives, both one and two sided versions, which are now manufactured by 19 companies and (2) 2 inch drives, currently offered only by Sony.

All 3.5 inch drives are derived from the Sony microfloppy first shipped in 1982, with modifications to achieve logical file organization similar to the larger diskette drives which preceded it in the market. Drives with capacities of one megabyte or less use 6,250 bytes per track, the same track capacity as "double density" 5.25 inch diskettes, and also use 40 or 80 tracks per side to maintain file compatibility with 5.25 inch diskettes.

1.2 and 1.44 megabyte 3.5 inch drives were announced in 1985, and are intended for use with the high density media originally proposed by Sony, and operating at up to 17,434 BPI, using the 135 TPI standard of today's production drives. All current 1.2 and 1.44 megabyte drives claim "downward compatibility," the ability to read and write on lower capacity diskettes. After the adoption of 1.44 megabyte drives by IBM in April, 1987, for the PS/2 systems, most major manufacturers of microfloppy drives added drives with the same capacity.

Most manufacturers of 3.5 inch drives have also made the transition from the earlier 41.3 millimeter high drives ("half high", in 5.25 inch drive terms) to the 25.4 millimeter (one inch) high drives pioneered by Citizen in 1984. Many companies are also shipping drives with heights of 17-19 millimeters (3/4 inch), again prompted by Citizen, which started shipments of 3/4 inch high models in the Spring of 1989. Citizen started shipping 15 millimeter high models in the second quarter of 1991, followed by Teac's introduction of 12.7 millimeter (one half inch) high drives for shipment in the fourth quarter of 1991 -- which, in turn, prompted many other drive manufacturers to join the movement to half inch high drives.

The 3 inch microfloppy format has lost all of its original adherents including the last holdout, Matsushita Electronic Components, and is now out of production. 2 inch drives are currently produced only by Sony, but with a limited market. Initial shipments of 2 inch drives with notebook computers encountered resistance from buyers who did not want to bother with interchange problems, and there have not been enough applications in home computers, electronic typewriters and games to maintain growth for the 2 inch format. While there may still be a future for a 2 inch or smaller floppy format, there is no consensus in the industry on format or interchange standards, and most of the drive manufacturers do not appear to be interested.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1991	1992	1993	1994	1995
U.S. manufacturers	--	--	--	--	--
All manufacturers	1,543.8	1,597.4	1,654.1	1,674.3	1,712.6

Despite the economic recession of 1991-92, shipments of microfloppies have remained high and continue to grow at levels higher than previously forecasted. Although the expectations of the personal computer industry's managements during mid-1991 were grim, PC shipments continued to grow throughout 1991 and 1992, resulting in a shortage of hard disk drives and increased shipments of microfloppy drives.

1991 microfloppy worldwide revenues totaled $1,543,800,000, up 3.7% over the previous year, and 1992 revenues are forecasted at $1,597,400,000, a further increase of 3.4%. Total microfloppy drive shipments were 32.8 million units in 1991, 11.4% over the 1990 total. 1992 unit shipments are continuing to increase, with a total of 35.7 million drives forecasted for the year, up 8.7%.

During recent years, overall average prices for microfloppy drives have declined, despite the continuous upgrading of the industry's overall product mix to higher capacity drives. The average price for all microfloppy drives was $59 in 1988, $51 in 1989, $46 in 1990 and $42 in 1991. However, the decrease in average prices is expected to be only $1 in 1992, and the rate of annual decline in the overall average price may be slowing down with the sales growth of newer thin form factors and higher capacity drives, at higher typical prices.

Shipments of microfloppy drives with capacities of .7 megabyte or less continue to decline and represent only 14.4% of 1991's worldwide unit shipments. The 1.44 megabyte models now offered by nearly all major floppy drive manufacturers have become the industry's major products, stimulated by IBM's 1987 adoption of 1.44 megabyte drives for PS/2 personal computers.

The similar 1.2 megabyte drives are used mostly in Japan, primarily by NEC and with computers designed to be compatible with NEC's personal computer product line. 1991 shipments of 1.2/1.44 megabyte drives provided 84.3% of the total of all microfloppy formats.

IBM's long-expected adoption of the 2.88 megabyte microfloppy format finally occurred in 1991. 2.88 megabyte drives are expected to become an important part of the industry in future years, but shipments in 1991 were only 446,300 drives, as many system manufacturers delayed adoption until IBM's intentions became clear. Even with IBM's subsequent utilization of the 2.88 megabyte format with 30 individual PS/2 models announced during 1992, the majority of

system manufacturers are moving slowly to adopt it. The major negative influence holding down wider usage of 2.88 megabyte drives is the drives' higher selling price, with current average OEM prices about 65% higher than those of 1.44 megabyte drives. 1992 shipments of 2.88 megabyte drives are expected to be 1.2 million drives, 3.2 % of the overall microfloppy total.

The average height of microfloppy drive mechanisms continues to shrink. One inch high (25.4 millimeter) drives became the dominant form factor several years ago, and have shown continuing strength in the face of competition from new drives in thinner physical formats. But shipment growth for 1 inch high drives is now expected to slow, with only a slight increase expected next year. Intense competition has come from drives with smaller heights -- initially 19 millimeters, then 17 millimeters, more recently 15 millimeters, and in late 1991 12.7 millimeters. Drives with less than 1 inch height are expected to provide 17.6% of total 1992 unit shipments.

Shipments of all drives with disks less than 3.5 inches in diameter are grouped together in the disk diameter tables for this product group. Shipments of 3 inch drives declined during recent years and ended in 1991. The major market for these drives was the European home computer market, but newer systems with other data storage devices eventually prevailed. 3 inch drives never significantly penetrated the United States market, and after an early lead were overtaken in the Japan domestic market by 3.5 inch drives.

The subgroup for less than 3.5 inch drives also includes 2 inch drives, now available only in the Sony format. But 2 inch drives obviously cannot provide physical diskette compatibility with 3.5 inch or 5.25 inch drives, and potential users have demonstrated considerable sales resistance for business computer applications, where convenient media interchange is essential. 2 inch drives are likely to remain limited in the near future to typewriter and game applications, for which they are clearly well suited.

Personal computer applications continued to dominate the shipments of microfloppy drives in 1991, with 86.4% of the worldwide total. However, personal computer applications are expected to take a smaller share of 1995's total shipments, totaling only 80.5%, as consumer and hobby applications increase from 3.9% in 1991 to 12.5% in 1995.

Sony has maintained its momentum in microfloppy drive shipments, capturing 21.9% of 1991 noncaptive worldwide unit shipments, for 6.7 million drives. Teac continued to hold second place with 13.3%, and Citizen retained third place with 10.5%.

Marketing trends

The role of microfloppy drives as the principal removable recording devices used with small computer systems is assured through 1995, the forecast horizon for this edition of the DISK/TREND Report. As a result, total microfloppy unit shipments are expected to reach 43.3 million drives in 1995. Average annual unit shipments are forecasted to increase during 1993-95 at the rate of 6.6% per year.

Total revenues for the product group will increase at a slower rate, due to declining OEM prices. The average annual increase for 1993-95 is expected to be only 2.3%, with 1995 revenues forecasted at $1,712,600,000. The decline in average OEM prices through 1995 is expected to be less than in recent years, partially offset by the increasing share of the microfloppy total held by 2.88 megabyte drives, which will continue to command prices higher than the average for the product group.

Despite IBM's increasing usage of 2.88 megabyte drives, most of the other personal computer manufacturers are moving to the format very slowly. The major problem for most system manufacturers is the price differential between 2.88 megabyte drives and 1.44 megabyte drives, the current industry standard. During a period of intense price competition in the personal computer industry, aggressive cost reduction programs are underway and few system manufacturers have been willing to add significantly to their product costs.

2.88 megabyte drives are priced about $25 higher than 1.44 megabyte drives in 1992, but the differential in 1995 is expected to be less than $10, as production quantities increase. Despite initial hesitancy, PC manufacturers are expected to gradually add 2.88 megabyte drives, first with high-end models, then more broadly, responding to evolving software and user preferences. 1995 shipments of 2.88 megabyte drives are forecasted at 5.5 million units, 12.7% of the unit shipments for that year.

Unit shipments of 1.2/1.44 megabyte drives are expected to continue growing through 1995, but at a slowing pace. Their share of the product group total is now at its peak, limited by growth of 2.88 megabyte drive shipments. The portion of total microfloppy drive shipments held by 1.2/1.44 megabyte drives during the 1992/93 period is estimated at 87.8% of the product group total and is forecasted to decline to 84.3% in 1995. Shipments of drives with capacities of .7 megabyte or less have been dropping rapidly and the average annual shipment decline for these drives is expected to be 25.9% during 1993-95.

Drive heights are expected to continue to shrink. While 1 inch high drives are expected to account for 73.8% of 1992 microfloppy drive shipments, their share in 1995 is forecasted to be down to 51.7%. Drives with heights less than 1 inch will be the big gainers, and are expected to provide 46.6% of 1995 shipments. Shipments of drives more than 1 inch high, now all 1.625 inches in height, are expected to drop from 1992's 8.6% to only 1.7% in 1995.

In the early 1980's there was no standard for the critical height dimension for 3.5 inch drives. Following Sony's original introduction of two inch high drives in 1982, many other manufacturers settled on 1.625 inches (41.3 millimeters -- the same as 5.25 inch half high drives). While 1.625 inches became widely used, many of the same manufacturers also offered drives with 28, 30 or 32 millimeter heights.

Amidst the confusion, Citizen Watch entered the microfloppy business with one inch high drives in 1984, with no immediate impact. However, during the last six years, all significant producers of 3.5 inch drives added one inch high models, now the dominant physical configuration, and the worldwide standard for desktop personal computers.

Citizen's 1989 introduction of 3/4 inch drives again exerted a strong influence on the industry. Most of the other Japanese floppy drive manufacturers have also announced 3/4 inch high drives, stimulated by the potential market in very small portable computers. Strictly speaking, 3/4 inches is 19.05 millimeters, but the 3/4 inch microfloppy drives announced to date have been in a range of 17 to 19 millimeters. Citizen's 1990 introduction of 15 millimeter high models also stimulated many competitors to announce microfloppy drives with similar height, but it is now clear that there was more to come.

Both Teac and Mitsumi Electric announced 12.7 millimeter (exactly one half inch) high drives in 1991, and there is now a widespread belief in the industry that half inch high drives will become a major standard in the industry, despite the introduction by a few other drive manufacturers of drives with even less height. Reinforcing this belief is the expected movement to 12.7 millimeter height for the 2.5 inch and smaller hard disk drives used with notebook computers.

It is believed that many manufacturers of notebook computers will provide the option of a 3.5 inch floppy drive, assuming that users want a floppy drive with their notebook computers enough to tolerate the slight increase in size and weight. In this market environment, the slight improvement in package size provided by the 12.7 millimeter high drives will be highly valued.

Technical trends

The only significant potential problem for the industry in establishing large-scale production of 2.88 megabyte drives is availability of the multifunction head required to provide downward compatibility with .7 and 1.44 megabyte drives, but it appears that there will be adequate production of the new heads by the end of 1992.

The next challenge for most manufacturers of 3.5 inch drives will be packaging problems in reducing the height of the drive to meet the demand for half inch high drives -- and hold down costs at the same time. It has been very expensive and technically difficult for most manufacturers to match competition with continually smaller drive configurations. But the changes have been achievable, once production of smaller motors and other key components became available.

Many manufacturers have found it convenient to use belt drive arrangements instead of the direct drive motors common with most of today's floppy drives and preferred by the majority of system manufacturers. Several small format drives using direct drive motors have been announced, but considerable effort will probably be expended to explore various mechanical designs before an industry consensus on this point is reached.

Forecasting assumptions

1. 3.5 inch drives with heights less than 1 inch will rival 1 inch high drives for shipment leadership by 1995, and 1.44 megabyte drives will maintain shipment leadership through 1995.

2. IBM will continue worldwide usage of 3.5 inch floppy drives with all newly introduced personal computers and will continue to expand usage of 2.88 megabyte 3.5 inch drives on selected systems.

3. A positive growth rate for personal computers will continue through 1995.

4. The dollar/yen exchange rate will stay in the current range, and prices for noncaptive microfloppy drives will continue to decline at the forecasted rate.

TABLE 18

FLEXIBLE DISK DRIVES, MICROFLOPPIES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1991		Forecast							
	Revenues		1992		1993		1994		1995	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. NONCAPTIVE	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	25.9	234.0	22.5	204.7	18.3	212.9	16.1	216.4	16.0	216.8
PCM/Reseller	109.2	162.8	131.9	209.6	162.2	270.1	178.1	299.7	190.6	326.6
OEM/Integrator	423.3	1,147.0	470.2	1,183.1	483.8	1,171.1	525.0	1,158.2	606.7	1,169.2
TOTAL NON-U.S. REVENUES	558.4	1,543.8	624.6	1,597.4	664.3	1,654.1	719.2	1,674.3	813.3	1,712.6
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	558.4	1,543.8	624.6	1,597.4	664.3	1,654.1	719.2	1,674.3	813.3	1,712.6
OEM Average Price ($000)	.043	.042	.042	.041	.040	.039	.038	.037	.036	.036

TABLE 19

FLEXIBLE DISK DRIVES, MICROFLOPPIES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1991 Shipments		Forecast							
			1992		1993		1994		1995	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. NONCAPTIVE	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	266.0	1,878.0	241.5	1,766.5	205.0	1,900.0	179.0	2,000.0	170.0	2,105.0
PCM/Reseller	2,527.1	3,780.1	3,123.5	5,019.5	4,005.0	6,655.0	4,615.0	7,780.0	5,065.0	8,710.0
OEM/Integrator	9,727.2	27,161.2	11,122.0	28,896.0	12,065.0	29,925.0	13,875.0	31,275.0	16,610.0	32,500.0
TOTAL NON-U.S. SHIPMENTS	12,520.3	32,819.3	14,487.0	35,682.0	16,275.0	38,480.0	18,669.0	41,055.0	21,845.0	43,315.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	12,520.3	32,819.3	14,487.0	35,682.0	16,275.0	38,480.0	18,669.0	41,055.0	21,845.0	43,315.0
Cumulative Shipments (Units in millions)										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	53.2	127.8	67.7	163.5	83.9	202.0	102.6	243.0	124.4	286.3
WORLDWIDE TOTAL	53.2	127.8	67.7	163.5	83.9	202.0	102.6	243.0	124.4	286.3

TABLE 20

FLEXIBLE DISK DRIVES, MICROFLOPPIES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1991 Revenues			Forecast 1992			1993			1994			1995	
	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	3.5" SS	3.5" DS
U.S. MANUFACTURERS														
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS														
Captive	8.4	23.1	202.5	5.5	23.1	176.1	2.7	19.9	190.3	.6	15.3	200.5	10.2	206.6
				-34.5%	--	-13.0%	-50.9%	-13.9%	+8.1%	-77.8%	-23.1%	+5.4%	-33.3%	+3.0%
PCM/Reseller	--	--	162.8	--	--	209.6	--	--	270.1	--	--	299.7	--	326.6
						+28.7%			+28.9%			+11.0%		+9.0%
OEM/Integrator	1.1	--	1,145.9	.5	--	1,182.6	.3	--	1,170.8	.3	--	1,157.9	--	1,169.2
	-91.3%	-100.0%	-2.1%	-54.5%	--	+3.2%	-40.0%	--	-1.0%	--	--	-1.1%	--	+1.0%
TOTAL NON-U.S. REVENUES	9.5	23.1	1,511.2	6.0	23.1	1,568.3	3.0	19.9	1,631.2	.9	15.3	1,658.1	10.2	1,702.4
WORLDWIDE RECAP														
Captive	8.4	23.1	202.5	5.5	23.1	176.1	2.7	19.9	190.3	.6	15.3	200.5	10.2	206.6
	+12.0%	+26.9%	+30.0%	-34.5%	--	-13.0%	-50.9%	-13.9%	+8.1%	-77.8%	-23.1%	+5.4%	-33.3%	+3.0%
PCM/Reseller	--	--	162.8	--	--	209.6	--	--	270.1	--	--	299.7	--	326.6
	--	--	+32.7%	--	--	+28.7%	--	--	+28.9%	--	--	+11.0%	--	+9.0%
OEM/Integrator	1.1	--	1,145.9	.5	--	1,182.6	.3	--	1,170.8	.3	--	1,157.9	--	1,169.2
	-91.3%	-100.0%	-2.1%	-54.5%	--	+3.2%	-40.0%	--	-1.0%	--	--	-1.1%	--	+1.0%
Total Revenues	9.5	23.1	1,511.2	6.0	23.1	1,568.3	3.0	19.9	1,631.2	.9	15.3	1,658.1	10.2	1,702.4
	-53.0%	+25.5%	+4.3%	-36.8%	--	+3.8%	-50.0%	-13.9%	+4.0%	-70.0%	-23.1%	+1.6%	-33.3%	+2.7%
ANNUAL SHARE, BY DIAMETER	.6%	1.5%	97.9%	.4%	1.4%	98.2%	.2%	1.2%	98.6%	.1%	.9%	99.0%	.6%	99.4%

TABLE 21

FLEXIBLE DISK DRIVES, MICROFLOPPIES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1991 Shipments			Forecast 1992			1993			1994			1995	
	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	3.5" SS	3.5" DS
U.S. MANUFACTURERS														
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS														
Captive	60.0	259.0	1,559.0	40.0	259.0	1,467.5	20.0	231.0	1,649.0	5.0	180.0	1,815.0	120.0	1,985.0
PCM/Reseller	--	--	3,780.1	--	--	5,019.5	--	--	6,655.0	--	--	7,780.0	--	8,710.0
OEM/Integrator	24.0	--	27,137.2	10.0	--	28,886.0	5.0	--	29,920.0	5.0	--	31,270.0	--	32,500.0
TOTAL NON-U.S. SHIPMENTS	84.0	259.0	32,476.3	50.0	259.0	35,373.0	25.0	231.0	38,224.0	10.0	180.0	40,865.0	120.0	43,195.0
WORLDWIDE RECAP														
Captive	60.0	259.0	1,559.0	40.0	259.0	1,467.5	20.0	231.0	1,649.0	5.0	180.0	1,815.0	120.0	1,985.0
	+15.4%	+29.4%	+59.6%	-33.3%	--	-5.9%	-50.0%	-10.8%	+12.4%	-75.0%	-22.1%	+10.1%	-33.3%	+9.4%
PCM/Reseller	--	--	3,780.1	--	--	5,019.5	--	--	6,655.0	--	--	7,780.0	--	8,710.0
	--	--	+57.7%	--	--	+32.8%	--	--	+32.6%	--	--	+16.9%	--	+12.0%
OEM/Integrator	24.0	--	27,137.2	10.0	--	28,886.0	5.0	--	29,920.0	5.0	--	31,270.0	--	32,500.0
	-90.8%	-100.0%	+6.2%	-58.3%	--	+6.4%	-50.0%	--	+3.6%	--	--	+4.5%	--	+3.9%
Total Shipments	84.0	259.0	32,476.3	50.0	259.0	35,373.0	25.0	231.0	38,224.0	10.0	180.0	40,865.0	120.0	43,195.0
	-73.1%	+26.7%	+12.3%	-40.5%	--	+8.9%	-50.0%	-10.8%	+8.1%	-60.0%	-22.1%	+6.9%	-33.3%	+5.7%
ANNUAL SHARE, BY DIAMETER	.3%	.8%	98.9%	.1%	.7%	99.2%	.1%	.6%	99.3%	--	.4%	99.6%	.3%	99.7%

TABLE 22

FLEXIBLE DISK DRIVES, MICROFLOPPIES

WORLDWIDE SHIPMENTS (000)

DRIVE HEIGHT ANALYSIS

	1991		Forecast							
	--Shipments--		1992		1993		1994		1995	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	--		--		--		--		--	
Non-Captive Total	--		--		--		--		--	
Total U.S.	--		--		--		--		--	
NON-U.S. MANUFACTURERS										
Captive Total	1,878.0		1,766.5		1,900.0		2,000.0		2,105.0	
Less than 1 inch	798.0	42.6%	1,182.0	67.0%	1,440.0	75.9%	1,665.0	83.4%	1,855.0	88.2%
1 inch	761.0	40.5%	285.5	16.2%	209.0	11.0%	150.0	7.5%	130.0	6.2%
More than 1 inch	319.0	16.9%	299.0	16.8%	251.0	13.1%	185.0	9.1%	120.0	5.6%
Non-Captive Total	30,941.3		33,915.5		36,580.0		39,055.0		41,210.0	
Less than 1 inch	4,981.1	16.1%	5,107.5	15.1%	8,560.0	23.4%	13,065.0	33.6%	18,305.0	44.5%
1 inch	22,683.2	73.4%	26,013.0	76.8%	26,115.0	71.5%	24,825.0	63.6%	22,275.0	54.1%
More than 1 inch	3,277.0	10.5%	2,795.0	8.1%	1,905.0	5.1%	1,165.0	2.8%	630.0	1.4%
Total Non-U.S.	32,819.3		35,682.0		38,480.0		41,055.0		43,315.0	
Less than 1 inch	5,779.1	17.6%	6,289.5	17.6%	10,000.0	26.0%	14,730.0	36.0%	20,160.0	46.6%
1 inch	23,444.2	71.5%	26,298.5	73.8%	26,324.0	68.5%	24,975.0	60.8%	22,405.0	51.7%
More than 1 inch	3,596.0	10.9%	3,094.0	8.6%	2,156.0	5.5%	1,350.0	3.2%	750.0	1.7%
WORLDWIDE RECAP										
Total Worldwide Shipments	32,819.3		35,682.0		38,480.0		41,055.0		43,315.0	
	+11.4%		+8.7%		+7.8%		+6.6%		+5.5%	
Less than 1 inch	5,779.1	17.6%	6,289.5	17.6%	10,000.0	26.0%	14,730.0	36.0%	20,160.0	46.6%
	+128.9%		+8.8%		+59.0%		+47.3%		+36.8%	
1 inch	23,444.2	71.5%	26,298.5	73.8%	26,324.0	68.5%	24,975.0	60.8%	22,405.0	51.7%
	+1.9%		+12.1%		--		-5.1%		-10.2%	
More than 1 inch	3,596.0	10.9%	3,094.0	8.6%	2,156.0	5.5%	1,350.0	3.2%	750.0	1.7%
	-8.4%		-13.9%		-30.3%		-37.3%		-44.4%	

Notes: Percentage figures with plus/minus signs refer to year-to-year growth rates.

TABLE 23

FLEXIBLE DISK DRIVES, MICROFLOPPIES

WORLDWIDE SHIPMENTS (000)

DRIVE CAPACITY ANALYSIS

	1991 --Shipments--		Forecast							
			1992		1993		1994		1995	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	--		--		--		--		--	
Non-Captive Total	--		--		--		--		--	
Total U.S.	--		--		--		--		--	
NON-U.S. MANUFACTURERS										
Captive Total	1,878.0		1,766.5		1,900.0		2,000.0		2,105.0	
.7 Megabyte or Less	343.0	18.3%	304.0	17.2%	255.0	13.4%	185.0	9.3%	120.0	5.7%
1.2/1.44 Megabytes	1,535.0	81.7%	1,462.5	82.8%	1,630.0	85.9%	1,740.0	87.1%	1,810.0	86.1%
2.88 Megabytes	--	--	--	--	15.0	.7%	75.0	3.6%	175.0	8.2%
Non-Captive Total	30,941.3		33,915.5		36,580.0		39,055.0		41,210.0	
.7 Megabyte or Less	4,393.0	14.2%	2,911.0	8.6%	2,325.0	6.4%	1,795.0	4.6%	1,170.0	2.8%
1.2/1.44 Megabytes	26,102.0	84.5%	29,843.0	88.1%	32,115.0	87.9%	33,765.0	86.6%	34,670.0	84.2%
2.88 Megabytes	446.3	1.3%	1,161.5	3.3%	2,140.0	5.7%	3,495.0	8.8%	5,370.0	13.0%
Total Non-U.S.	32,819.3		35,682.0		38,480.0		41,055.0		43,315.0	
.7 Megabyte or Less	4,736.0	14.4%	3,215.0	9.0%	2,580.0	6.7%	1,980.0	4.8%	1,290.0	3.0%
1.2/1.44 Megabytes	27,637.0	84.3%	31,305.5	87.8%	33,745.0	87.8%	35,505.0	86.6%	36,480.0	84.3%
2.88 Megabytes	446.3	1.3%	1,161.5	3.2%	2,155.0	5.5%	3,570.0	8.6%	5,545.0	12.7%
WORLDWIDE RECAP										
Total Worldwide Shipments	32,819.3		35,682.0		38,480.0		41,055.0		43,315.0	
	+11.4%		+8.7%		+7.8%		+6.6%		+5.5%	
.7 Megabyte or Less	4,736.0	14.4%	3,215.0	9.0%	2,580.0	6.7%	1,980.0	4.8%	1,290.0	3.0%
	-28.8%		-32.1%		-19.7%		-23.2%		-34.8%	
1.2/1.44 Megabytes	27,637.0	84.3%	31,305.5	87.8%	33,745.0	87.8%	35,505.0	86.6%	36,480.0	84.3%
	+21.4%		+13.2%		+7.7%		+5.2%		+2.7%	
2.88 Megabytes	446.3	1.3%	1,161.5	3.2%	2,155.0	5.5%	3,570.0	8.6%	5,545.0	12.7%
	+988.5%		+160.2%		+85.5%		+65.6%		+55.3%	

Notes: Percentage figures with plus/minus signs refer to year-to-year growth rates.

TABLE 24

FLEXIBLE DISK DRIVES, MICROFLOPPIES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1991 Estimate Units (000)	1991 Estimate %	1995 Projection Units (000)	1995 Projection %
MAINFRAME/SUPERMINI				
General purpose	68.9	.2	43.3	.1
MINICOMPUTERS AND MULTIUSER MICROS				
Business and professional, including networks	426.7	1.3	649.7	1.5
PERSONAL COMPUTERS				
Business and professional, single user	28,349.3	86.4	34,868.6	80.5
OFFICE SYSTEMS AND WORKSTATIONS				
Dedicated application and electronic typewriters	2,051.2	6.3	1,732.6	4.0
NONOFFICE SYSTEMS AND WORKSTATIONS				
Technical, distribution, medical, other specialized	397.1	1.2	346.5	.8
CONSUMER AND HOBBY COMPUTERS	1,286.5	3.9	5,414.4	12.5
OTHER APPLICATIONS	239.6	.7	259.9	.6
Total	32,819.3	100.0	43,315.0	100.0

TABLE 25

FLEXIBLE DISK DRIVES, MICROFLOPPIES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1991 Net Shipments			
	To United States Destinations		Worldwide	
Drive Manufacturers	Units (000)	%	Units (000)	%
Sony	2,937.0	24.0	6,786.0	21.9
Teac	1,377.0	11.2	4,107.0	13.3
Citizen	1,295.0	10.6	3,252.0	10.5
Matsushita Communication Ind.	560.0	4.6	2,570.0	8.3
Y-E Data	827.0	6.8	2,414.0	7.8
Seiko Epson	863.1	7.0	2,098.1	6.8
Mitsumi Electric	935.0	7.6	2,095.0	6.8
Chinon	1,237.0	10.1	1,882.0	6.1
Mitsubishi Electric	1,329.0	10.9	1,759.0	5.7
Matsushita Electronic Comp.	--	--	1,388.0	4.5
NEC	3.0	--	659.0	2.1
Toshiba	635.2	5.2	635.2	2.1
Other U.S.	--	--	--	--
Other Non-U.S.	256.0	2.0	1,296.0	4.1
TOTAL	12,254.3	100.0	30,941.3	100.0

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

1992 DISK/TREND REPORT

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

Coverage

Examples of flexible disk drives in this group include:

5.25" Bernoulli principle drives

Iomega	B144, Bernoulli 90

8" flexible disk drives

Hitachi	FDD 441

5.25" flexible disk drives

Hitachi	FDD 541

3.5" flexible disk drives

Brier Technology	BR 3225, BR 3220
Insite Peripherals	I325VM
Iomega	Io20S
NEC	FD 1335C, FD 1335H
Y-E Data	YD-750

All types of floppy drives with capacities over 5 megabytes have been consolidated into this section. The functional and physical characteristics of these products are varied, and are individually discussed below. Unfortunately, there has been no industry agreement on media interchange standards, and most of the high capacity floppy drives announced to date are incapable of interchanging diskettes with drives of other manufacturers, except for the downward compatibility with lower capacity standard floppy drives claimed by manufacturers of some 3.5 inch drives.

Iomega's Bernoulli principle drives: Iomega's drives use the Bernoulli effect to control head/disk spacing. These are high performance drives, using flexible disks in a removable rigid cartridge, and a sophisticated internal air flow system to maintain the proper position of the disk relative to the recording head. A voice coil rotary head positioning system, in conjunction with an embedded servo, provides average seek times equivalent to many rigid disk drives.

Iomega started deliveries of the original 8 inch 10 megabyte Alpha-10 in September, 1982, and replaced it with a half high model in 1984, followed by a 21

megabyte version in 1985. A 5 megabyte full size 5.25 inch drive was introduced in 1983, followed by a 21 megabyte half high model in 1986, a 44 megabyte version in 1989, and the current 90 megabyte model in July, 1991.

Other flexible disk drives: For several years the technology required for production of higher capacity floppy drives using conventional recording techniques has been available, and several approaches have been offered. Hitachi was the first to offer drives in this group, starting with a 6.15 megabyte 8 inch drive in 1984, followed in 1985 by a 4.15 megabyte 5.25 inch drive. The 5.25 inch Hitachi drive has been retained in this product group for clarity, even though its capacity is slightly below the 5 megabyte threshold for the group, in view of this year's change to formatted capacities in the DISK/TREND Report. Both of these drives have been used only in limited applications, and only in Japan.

The newest developments in other high capacity floppies involve 3.5 inch drives announced by Brier Technology and Insite Peripherals, plus several drives by Japanese companies. Because 3.5 inch microfloppies have become the standard floppy format for most personal computer systems, it is expected that all new activity during the next few years in the high capacity floppy drive marketplace will involve 3.5 inch drives.

NEC delivered its 9.4 megabyte drive in August, 1988, using it with NEC systems for the domestic Japanese market, and in 1990 superseded it with a 10.18 megabyte model which incorporates read and write compatibility with .7 and 1.44 megabyte diskettes. Both drives employ embedded servos, and use metal powder media.

Brier Technology has announced 21 megabyte 3.5 inch drives using a unique "dual level" or "buried" recording system in which embedded servo information occupies the same position as data tracks without reducing track capacity. The first version of the 21 megabyte Brier drive was delivered in early 1990, and a new drive with downward read/write compatibility to .7 and 1.44 megabyte diskettes is currently scheduled for delivery in early 1993.

Insite Peripherals achieved quick fame in the industry by announcing its trademarked "floptical" technology, a combination of optical tracking methods with conventional magnetic recording. Insite uses a reflective servo pattern applied to the surface of standard 3.5 inch diskettes to achieve high track density

(1,245 TPI), resulting in a capacity of 21 megabytes, in a 1 inch high drive with downward compatibility to .7 and 1.44 megabyte diskettes.

Insite is currently delivering a new version of the drive which provides downward read/write compatibility with .7 and 1.44 megabyte 3.5 inch drives, and which is manufactured for Insite on a contract basis by Matsushita Kotobuki Electronics. Insite also has licensed the floptical technology to Iomega, which is currently introducing drives compatible with Insite's, using Chinon as a contract manufacturing source.

Several Japanese manufacturers have announced (and de-announced) various high capacity 3.5 inch floppy drives, including Matsushita Communication Industrial, Citizen, Y-E Data and others. It is not clear that any of the currently announced drives will be produced in quantity, since Japan Electronic Industry Development Association (JEIDA) has organized a standards committee to attempt to achieve common standards for 20 and 40 megabyte drives to be produced by Japanese floppy drive manufacturers. This activity has apparently been in a holding pattern during most of 1992, while the manufacturers involved pursue a "wait and see" policy, while assessing the market reception to the "floptical" drives offered by Insite and Iomega.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1991	1992	1993	1994	1995
U.S. manufacturers	72.1	71.9	134.5	161.9	186.9
All manufacturers	72.9	72.8	139.6	202.9	262.9

1991 unit shipments and revenues for this product group are above last year's forecast, because of strong shipments of 5.25 inch Bernoulli drives. 1992 unit shipments and revenues are increasing, but are estimated to be well below the previous forecast, due to delays in establishing quantity shipments of 3.5 inch drives. 99,780 drives were shipped worldwide in 1991, and 144,900 are estimated for 1992, with 5.25 inch drives still holding 65% of the total.

Iomega's Bernoulli principle drives: Although Iomega's original 8 inch drives have long-since peaked and went out of production last year, shipments of the

firm's 5.25 inch Bernoulli drives are still growing each year. Most of the 5.25 inch drives shown in this product group's revenue and shipment tables are Iomega's Bernoulli models.

Iomega's Bernoulli drives compete primarily with small Winchester disks, removable rigid disk cartridge drives, and small erasable optical disk drives, rather than with most of the flexible disk drives available in the past, due to their capacity, performance, and pricing.

Because of the unique characteristics of its drives and lack of effective second sources, Iomega has achieved most of its sales successes through its program to sell Bernoulli Box subsystems in the personal computer add-on market with distribution through dealers. For years, Iomega's main difficulty in selling to major system manufacturers on an OEM basis has been lack of alternate sources for the company's drives. The products are unique, and system manufacturers, as always, are reluctant to take a chance on a sole-sourced disk drive of a unique design. Attempts to establish token alternate sources in Japan and the U.S. have been abortive.

The market for 8 inch Bernoulli drives is now gone, and Iomega's drive shipments are currently all 5.25 inch models, totaling 87,900 drives in 1991. Iomega has continually upgraded the range of capacities available in the 5.25 inch drive series. 1992 shipments have become predominantly the 90 megabyte drive introduced in 1991, replacing the 44 megabyte (1989) and 21 megabyte (1986) models.

Other flexible disk drives: Until the last 12 month period, most of the non-Bernoulli high capacity drives produced were 5.25 inch drives previously introduced by Konica, Eastman Kodak (later sold by Verbatim), and Data Technology (now Qume). While Qume's 10 megabyte drives built most of the group's shipment momentum, they were quickly replaced by the 20 megabyte models sold by both Qume and Verbatim. But time has passed by this group of 5.25 inch drives, and only Hitachi is still producing some older 5.25 inch and 8 inch models, at low production levels.

After numerous delays, 3.5 inch high capacity floppy drives with 20 megabytes capacity became available in volume from Insite in the first half of 1992 and from Iomega late in the year. Due to the late start, the DISK/TREND forecast of

3.5 inch drives in this product group for 1992 has been lowered to 50,500 units, substantially less than last year's forecast.

All of the U.S. manufacturers of high capacity 3.5 inch floppy drives have made arrangements for contract manufacturing of downward compatible drives by Japanese manufacturers. The firms now prepared to produce large quantities of drives are Insite, with manufacturing by Matsushita-Kotobuki Electronics, and Insite's licensee Iomega, with manufacturing by Chinon. Potential first shipments of floppy drives under the proposed JEIDA 20 megabyte standard by Japanese drive manufacturers cooperating with the program are uncertain.

The future of most high capacity flexible disk drives will probably be found as backup devices used with Winchester disk drives and in applications such as data logging, in which access time is not a factor. Cartridge tape drives are the established competitor in these applications, and the new floppy drives could have a friendly reception as a tape drive replacement by end users and system OEMs, both of whom usually respond favorably to faster performance and easier system integration.

Marketing trends

Stimulated by rapid growth for 3.5 inch drives, shipments of floppy drives over 5 megabytes are expected to grow rapidly through 1995. The average annual 1993-95 growth rate is forecasted at 129.4%, with worldwide shipments for 1995 climbing to 1,450,000 drives. Although sales revenues are not expected to rise as rapidly, due to major reductions in average unit price, revenues for 1995 are projected at $264,300,000, three and a half times higher than 1991.

Most sales for high capacity 3.5 inch floppy drives are currently through the PCM/Reseller channel, responding to users' demand for improved backup for personal computer graphics, desktop publishing and other applications with capacity requirements higher than those of conventional floppy drives. Because of the large latent demand believed to exist for improved system backup devices, rapid PCM/Reseller growth is expected for this product group now that adequate production is available, at least for "floptical" drives. OEM/Integrator shipments are also expected to start at a substantial level in 1993, for both personal computer and workstation applications.

Although 3.5 inch drives are expected to prevail in the high capacity floppy drive market, there will be many challenges along the way. The most important of these is the lack of a consensus in the industry on just what formats should be used. The Insite "floptical" standard is currently in the lead, reinforced by two credible drive manufacturing organizations and major media manufacturers.

The leading Japanese floppy drive manufacturers are currently observing the market response to the "floptical" program, now that large scale production is available, and probably can be expected to formulate their response next year. If significant OEM adoptions occur in 1993, many will probably negotiate to join the "floptical" standard. If the market response is weak, it would not be surprising to see a rebirth of activity in the JEIDA standards committee assigned to develop a high capacity floppy standard, and the eventual emergence of a new, higher capacity standard supported by several major floppy drive manufacturers.

In the meantime, 5.25 inch Bernoulli drives are still expected to grow in shipments for the next two years, although at a much lower level than 3.5 inch drives. The peak for 5.25 inch drives is forecasted at 120,000 units in 1994. Iomega's 150 megabyte drives now being introduced are expected to quickly become the 5.25 inch shipment leader.

Technology trends

The major product development challenges in this product group during the remainder of the 1990's will be to increase capacity and lower product cost. If high capacity floppy drives are to achieve prominence in data storage markets, they must offer sufficient capacity to be attractive for most small system backup requirements and they must provide aggressive price competition to tape cartridge drives, removable hard disk drives and erasable optical disk drives.

Since the 3.5 inch form factor for data storage products in this class is clearly destined to prevail, the development task will be to increase capacities beyond the 20 megabytes now available and to achieve the design simplification required for low manufacturing cost.

Brier Technology, the first company to announce a specific high capacity 3.5 inch floppy drive, uses a "dual servo" technique, in order to avoid wasting valu-

able capacity in each data track for servo information. The Japanese floppy drive manufacturers cooperating with the JEIDA standardization program are using conventional embedded (interspersed) servo technology, and some plan to offer floppy drives capable of letting the individual user write the embedded servo data as part of the diskette initialization.

Insite Peripherals' optical tracking method is perhaps the most innovative approach, with obvious potential for greater capacity and low manufacturing costs. Insite's reflective servo pattern is imprinted on the diskette as part of the media manufacturing process, and potentially will increase the media manufacturing cost only slightly when high shipment levels are achieved.

None of the above product designs provide for media interchange except among drives of the same type, plus lower capacity 3.5 inch drives. All serious contenders have announced downward read/write compatibility with 1 and 2 megabyte formats, but the likelihood that 4 megabyte floppy drives will also become an industry standard poses an additional compatibility requirement.

Of course, none of the interesting technical developments in this field will see wide application unless producible at low cost. This is not going to be easy, since these drives will require sophisticated head positioning systems, multifunction heads, high density encoding schemes, error correction capability, high reliability and embedded controllers. Furthermore, the media must be priced low enough to avoid buyer resistance, while still offering long life, adequate durability and easy handling. It's definitely a difficult development task, but without low costs these drives will occupy only a small market niche.

Forecasting assumptions

1. Volume production of 3.5 inch high capacity drives from multiple vendors will be available in 1993-95 period.

2. OEM adoptions of 3.5 inch high capacity floppy drives will start during 1993, including usage by significant personal computer manufacturers.

3. Shipments of 5.25 inch Bernoulli drives will peak in 1994.

TABLE 26

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1991		Forecast							
	Revenues		1992		1993		1994		1995	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	54.4	68.6	56.9	71.2	78.3	102.3	79.1	107.6	67.6	95.9
OEM/Integrator	3.5	3.5	.7	.7	27.7	32.2	46.5	54.3	73.1	91.0
TOTAL U.S. NONCAPTIVE	57.9	72.1	57.6	71.9	106.0	134.5	125.6	161.9	140.7	186.9
TOTAL U.S. REVENUES	57.9	72.1	57.6	71.9	106.0	134.5	125.6	161.9	140.7	186.9
Non-U.S. Manufacturers										
Captive	--	.3	--	.2	--	--	1.8	22.8	4.7	40.4
PCM/Reseller	--	--	--	--	--	--	1.7	2.5	3.6	5.1
OEM/Integrator	--	.5	.3	.7	1.7	5.1	6.6	15.7	13.8	30.5
TOTAL NON-U.S. REVENUES	--	.8	.3	.9	1.7	5.1	10.1	41.0	22.1	76.0
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	57.9	72.9	57.9	72.8	107.7	139.6	135.7	202.9	162.8	262.9
OEM Average Price ($000)	.574	.500	.400	.298	.183	.181	.156	.157	.139	.140

TABLE 27

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1991		Forecast							
	Shipments		1992		1993		1994		1995	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	72.6	91.4	110.5	140.0	225.0	300.0	275.0	380.0	290.0	415.0
OEM/Integrator	6.0	6.0	1.0	1.0	151.0	176.0	300.0	350.0	530.0	660.0
TOTAL U.S. NONCAPTIVE	78.6	97.4	111.5	141.0	376.0	476.0	575.0	730.0	820.0	1,075.0
TOTAL U.S. SHIPMENTS	78.6	97.4	111.5	141.0	376.0	476.0	575.0	730.0	820.0	1,075.0
Non-U.S. Manufacturers										
Captive	--	.3	--	.2	--	--	5.0	65.0	15.0	130.0
PCM/Reseller	--	--	--	--	--	--	10.0	15.0	25.0	35.0
OEM/Integrator	.1	2.0	1.5	3.7	10.0	30.1	40.0	95.0	95.0	210.0
TOTAL NON-U.S. SHIPMENTS	.1	2.3	1.5	3.9	10.0	30.1	55.0	175.0	135.0	375.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	78.7	99.7	113.0	144.9	386.0	506.1	630.0	905.0	955.0	1,450.0
Cumulative Shipments (Units in thousands)										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	636.3	788.2	749.3	933.1	1,135.3	1,439.2	1,765.3	2,344.2	2,720.3	3,794.2
WORLDWIDE TOTAL	636.3	788.2	749.3	933.1	1,135.3	1,439.2	1,765.3	2,344.2	2,720.3	3,794.2

TABLE 28

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1991 Revenues			Forecast								
	1992			1993		1994		1995	
	3.5"	5.25"	8"	3.5"	5.25"	8"	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"
U.S. MANUFACTURERS												
PCM/Reseller	2.5	65.0	1.1	10.7	60.5	--	33.3	69.0	41.6	66.0	43.4	52.5
OEM/Integrator	--	3.5	--	--	.7	--	31.5	.7	54.3	--	91.0	--
TOTAL U.S. REVENUES	2.5	68.5	1.1	10.7	61.2	--	64.8	69.7	95.9	66.0	134.4	52.5
NON-U.S. MANUFACTURERS												
Captive	--	--	.3	--	--	.2	--	--	22.8	--	40.4	--
PCM/Reseller	--	--	--	--	--	--	--	--	2.5	--	5.1	--
OEM/Integrator	.2	.2	.1	.6	.1	--	5.1	--	15.7	--	30.5	--
TOTAL NON-U.S. REVENUES	.2	.2	.4	.6	.1	.2	5.1	--	41.0	--	76.0	--
WORLDWIDE RECAP												
Captive	--	--	.3	--	--	.2	--	--	22.8	--	40.4	--
	--	--	--	--	--	-33.3%	--	--	--	--	+77.2%	--
PCM/Reseller	2.5	65.0	1.1	10.7	60.5	--	33.3	69.0	44.1	66.0	48.5	52.5
	+733.3%	+3.8%	-72.5%	+328.0%	-6.9%	--	+211.2%	+14.0%	+32.4%	-4.3%	+10.0%	-20.5%
OEM/Integrator	.2	3.7	.1	.6	.8	--	36.6	.7	70.0	--	121.5	--
	--	-11.9%	-88.9%	+200.0%	-78.4%	--	--	-12.5%	+91.3%	--	+73.6%	--
Total Revenues	2.7	68.7	1.5	11.3	61.3	.2	69.9	69.7	136.9	66.0	210.4	52.5
	+800.0%	+2.8%	-71.2%	+318.5%	-10.8%	-86.7%	+518.6%	+13.7%	+95.9%	-5.3%	+53.7%	-20.5%
ANNUAL SHARE, BY DIAMETER	3.7%	94.3%	2.0%	15.5%	84.3%	.2%	50.2%	49.8%	67.6%	32.4%	80.1%	19.9%

TABLE 29

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1991 Shipments			Forecast								
				1992			1993		1994		1995	
	3.5"	5.25"	8"	3.5"	5.25"	8"	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"
U.S. MANUFACTURERS												
PCM/Reseller	9.0	81.6	.8	47.0	93.0	--	185.0	115.0	260.0	120.0	310.0	105.0
OEM/Integrator	--	6.0	--	--	1.0	--	175.0	1.0	350.0	--	660.0	--
TOTAL U.S. SHIPMENTS	9.0	87.6	.8	47.0	94.0	--	360.0	116.0	610.0	120.0	970.0	105.0
NON-U.S. MANUFACTURERS												
Captive	--	--	.3	--	--	.2	--	--	65.0	--	130.0	--
PCM/Reseller	--	--	--	--	--	--	--	--	15.0	--	35.0	--
OEM/Integrator	1.1	.7	.2	3.5	.2	--	30.0	.1	95.0	--	210.0	--
TOTAL NON-U.S. SHIPMENTS	1.1	.7	.5	3.5	.2	.2	30.0	.1	175.0	--	375.0	--
WORLDWIDE RECAP												
Captive	--	--	.3	--	--	.2	--	--	65.0	--	130.0	--
	--	--	--	--	--	-33.3%	--	--	--	--	+100.0%	--
PCM/Reseller	9.0	81.6	.8	47.0	93.0	--	185.0	115.0	275.0	120.0	345.0	105.0
	--	+19.6%	-74.2%	+422.2%	+14.0%	--	+293.6%	+23.7%	+48.6%	+4.3%	+25.5%	-12.5%
OEM/Integrator	1.1	6.7	.2	3.5	1.2	--	205.0	1.1	445.0	--	870.0	--
	+1,000.0%	-10.7%	-84.6%	+218.2%	-82.1%	--	--	-8.3%	+117.1%	--	+95.5%	--
Total Shipments	10.1	88.3	1.3	50.5	94.2	.2	390.0	116.1	785.0	120.0	1,345.0	105.0
	--	+16.6%	-72.3%	+400.0%	+6.7%	-84.6%	+672.3%	+23.2%	+101.3%	+3.4%	+71.3%	-12.5%
ANNUAL SHARE, BY DIAMETER	10.1%	88.7%	1.2%	35.0%	65.0%	--	77.2%	22.8%	86.8%	13.2%	92.9%	7.1%

TABLE 30

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1991 Estimate Units (000)	1991 Estimate %	1995 Projection Units (000)	1995 Projection %
MAINFRAME/SUPERMINI				
General purpose	--	--	--	--
MINICOMPUTERS AND MULTIUSER MICROS				
Business and professional, including networks	2.9	2.9	14.5	1.0
PERSONAL COMPUTERS				
Business and professional, single user	90.8	91.1	1,319.5	91.0
OFFICE SYSTEMS AND WORKSTATIONS				
Dedicated application and electronic typewriters	3.2	3.2	7.3	.5
NONOFFICE SYSTEMS AND WORKSTATIONS				
Technical, distribution, medical, other specialized	2.8	2.8	65.2	4.5
CONSUMER AND HOBBY COMPUTERS	--	--	43.5	3.0
OTHER APPLICATIONS	--	--	--	--
Total	99.7	100.0	1,450.0	100.0

TABLE 31

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1991 Net Shipments			
	To United States Destinations		Worldwide	
Drive Manufacturers	Units (000)	%	Units (000)	%
Iomega	70.6	89.7	87.9	88.4
Other U.S.	8.0	10.2	9.5	9.6
Other Non-U.S.	.1	.1	2.0	2.0
TOTAL	78.7	100.0	99.4	100.0

1992 DISK/TREND REPORT

FLEXIBLE DISK DRIVE SPECIFICATIONS

Coverage

The product specification section of this report includes most flexible disk drives intended for computer data storage which are now in production or announced, arranged alphabetically by manufacturer.

Specifications of drive models sold by computer system manufacturers but purchased on an OEM basis from others have been included in a few cases for clarity. Not listed in most cases are captive drives which are similar to OEM models made by the same manufacturer. In some cases, drives made by one drive manufacturer and resold by another drive manufacturer have been included for identification purposes.

Capacities

Starting with this edition of the DISK/TREND Report, formatted capacities have been shown for most flexible disk drives, to be consistent with the disk drive industry's trend to identify all drives by formatted capacities. Previously, unformatted capacities were used with most drives, but the movement to embedded controllers in rigid disk drives and high capacity floppy drives has meant that many drives are now specified in formatted capacities, and most users normally identify floppy drives by formatted 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 flexible disk. When more than one figure is given in the specifications for "Total capacity", the highest number is usually the maximum capacity for which the drive is designed. The lower capacity levels also shown indicate the additional densities at which the drive is designed to operate, which in some cases require setting switches on the drive.

Accuracy

All information has been cross-checked for accuracy. However, it is anticipated that some errors may be included, since many manufacturers' published

specifications do not cover all of the items listed, and numerous verbal inquiries were necessary. Your corrections will be most welcome and will be included in the next edition.

DISK/TREND product groups

In most cases the product groups used for individual drives are clear, but a few arbitrary decisions have been made. Please note that all drives with capacities over 5 megabytes have been placed in the high capacity group, regardless of disk diameter.

1992 DISK/TREND product groups for flexible disk drives

Group number	Drives included
13.	Flexible disk drives, 8 inch
14.	Flexible disk drives, 5.25 inch
15.	Flexible disk drives, microfloppies
16.	Flexible disk drives, over 5 megabytes

MANUFACTURER	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC
DRIVE	DF 313H	DF 314H	DF 323H	DF 324H	DFR 423
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.4	F: .7/1.2	F: .7/1.4	F: .7
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680	F: 4,608/9,216	F: 4,608
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184	8714/17434	8714/14184	8714/17434	8717
Rotational speed (RPM)	360	300	360	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	100	83.3	100	100
Data transfer rate (KBytes/sec)	62.5/37.5	62.5/37.5	62.5/37.5	62.5/37.5	31.25
SIZE (Inches: H x W x D)	.65 x 3.8 x 5.0	.65 x 3.8 x 5.0	.48 x 3.8 x 5.0	.48 x 3.8 x 5.0	1.0 x 4.0 x 5.7
FIRST CUSTOMER SHIPMENT	4/91	4/91	4/92	4/92	5/90
COMMENTS	Direct drive	Direct drive	Direct drive	Direct drive	

MANUFACTURER	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	BRIER TECHNOLOGY
DRIVE	DFR 643	DFR 723	DFR 783	DFR 823	BR 3020
DISK/TREND GROUP	15	15	15	15	16
MARKET	OEM	OEM	OEM	OEM	OEM, PCM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.4/2.88	F: 21.4
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680/ 9,216	F: 4,608/9,216/ 18,432	**
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80/77/80	80	516
Track density (TPI)	135	135	135	135	777
Maximum linear density (BPI)	8717/14184	8717/17434	8717/14184/ 17434	8717/17434/ 34868	26000*
Rotational speed (RPM)	360	300	300/360/300	300/360	720
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Linear, Voice Coil
POSITIONING: Track to track(msec)	3	3	3	3	15
Settling time (msec)	15	15	15	15	--
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	100	100/83.3	100/83.3	41.6
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5/125	1250
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.7	1.0 x 4.0 x 5.7	1.0 x 4.0 x 5.7	1.0 x 4.0 x 5.7	1.625 x 4.0 x 5.75
FIRST CUSTOMER SHIPMENT	5/90	5/90	5/90	8/90	1Q90
COMMENTS					Dual level embedded servo 35 msec average head positioning *RLL Code **Varies by zone

MANUFACTURER	BRIER TECHNOLOGY	BRIER TECHNOLOGY	BROTHER	BROTHER	CANON
DRIVE	BR 3225	BR 3250	FB 015 FB 400	FB 100	MD 5201
DISK/TREND GROUP	16	16	15	15	14
MARKET	OEM, PCM	OEM, PCM	Captive, OEM	Captive	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	5.25"
Recording medium	Barium Ferrite	Barium Ferrite	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 21.4	F: 44.6	F: .240	F: .1024	F: .180/.360
Capacity per track (Bytes)	**	**	F:	F: 2,560	F: 2,304/4,608
Data surfaces per spindle	2	2	1	1	2
Tracks per surface	516	683	78	40	40
Track density (TPI)	777	1084	135	67.5	48
Maximum linear density (BPI)	26000*	30000*	5180	4064	2938/5876
Rotational speed (RPM)	720	720	300	300	300
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Lead Screw, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	15	15	20	60	6
Settling time (msec)	--	--	10	20	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	41.6	41.6	100	100	100
Data transfer rate (KBytes/sec)	1250	1250	19.50	15.63	15.63/31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.75	1.0 x 4.0 x 5.75	1.0 x 4.06 x 6.69	2.16 x 5.1 x 6.5	1.06 x 5.75 x 7.8
FIRST CUSTOMER SHIPMENT	1Q93	2Q93	10/87	1984	7/86
COMMENTS	Dual level embedded servo. 35 msec average head position. *RLL Code. **Varies by zone. Downward comp. with 1 & 2 MB (Read & Write)	Dual level embedded servo. 29 msec average head position. *RLL Code. **Varies by zone. Downward comp. with 1 & 2 MB (Read & Write)	FB 400 is kit for typewriter GCR encoded	Used in knitting machines	

MANUFACTURER	CANON	CANON	CANON	CANON	CANON
DRIVE	MD 5501	MD 3511 MD 3521	MD 3541	MD 3551	MD 3611 MD 3621
DISK/TREND GROUP	14	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.2	F: .7/1.2	F: .7/1.2	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80	80	80
Track density (TPI)	96	135	135	135	135
Maximum linear density (BPI)	5922/9646	8717/14527	8717/14527	8717/14527	8717/17434
Rotational speed (RPM)	360	300/360	360	360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	100/83.3	83.3	83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	250/500	37.5/62.5	37.5/62.5	250/500
SIZE (Inches: H x W x D)	1.06 x 5.75 x 7.8	1.0 x 4.0 x 5.89	.77 x 4.0 x 5.1	.61 x 3.78 x 5.12	1.0 x 4.0 x 5.89
FIRST CUSTOMER SHIPMENT	7/86	4/88	4/90	1991	4/88
COMMENTS			Direct drive motor		

MANUFACTURER	CANON	CANON	CHINON	CHINON	CHINON
DRIVE	MD 3641	MD 3651	FR-506	FZ-501A	FZ-502
DISK/TREND GROUP	15	15	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	5.25"	5.25"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.4	F: .7/1.2	F: .090/.180	F: .180/.360
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/7,680	F: 2,304/4,608	F: 2,304/4,608
Data surfaces per spindle	2	2	2	1	2
Tracks per surface	80	80	80	40	40
Track density (TPI)	135	135	96	48	48
Maximum linear density (BPI)	8717/17434	8717/17434	5922/9870	2768/5536	2938/5876
Rotational speed (RPM)	300	300	300/360	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	6	5
Settling time (msec)	15	15	15	20	20
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100/83.3	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	37.5/62.5	15.63/31.25	15.63/31.25
SIZE (Inches: H x W x D)	.77 x 4.0 x 5.1	.61 x 3.78 x 5.12	1.625 x 5.75 x 7.6	1.625 x 5.75 x 7.6	1.625 x 5.75 x 7.6
FIRST CUSTOMER SHIPMENT	4/90	1991	1091	8/83	3/87
COMMENTS	Direct drive motor				

MANUFACTURER	CHINON	CHINON	CHINON	CHINON	CHINON
DRIVE	FZ-506	FB-354 FB-354I	FB-357 FB-357I	FP-357	FT-357
DISK/TREND GROUP	14	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	3.5"	3.5"	3.5"	3.5"
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .360/.7	F: .7/1.4	F: .7/1.4	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/7,680	F: 2,304/4,608	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	96	135	135	135	135
Maximum linear density (BPI)	5922/9870	4359/8717	8717/17434	8717/17434	8717/17434
Rotational speed (RPM)	300/360	300	300	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100	100	100	100
Data transfer rate (KBytes/sec)	37.5/62.5	15.63/31.25	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 7.6	1.26 x 4.0 x 5.9	1.26 x 4.0 x 5.9	0.5 x 4.0 x 5.11	.67 x 4.0 x 5.1
FIRST CUSTOMER SHIPMENT	4/87	11/84	7/86	4Q92	2Q91
COMMENTS		FB-354I in 5.25" frame	FB-357I in 5.25" frame		

MANUFACTURER	CHINON	CHINON	CHINON	CITIZEN	CITIZEN
DRIVE	FZ-354 FZ-354I FZ-354IS	FZ-357 FZ-357I FZ-357IS	FZ-358	OSDA	OSDB
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .360/.7	F: .7/1.4	F: .7/1.4/2.88	F: .7/1.4	F: .7/1.2
Capacity per track (Bytes)	F: 2,304/4,608	F: 4,608/9,216	F: 4,608/9,216/ 18,432	F: 4,608/9,216	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80/77
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	4359/8717	8717/17434	8717/17434/ 34868	8717/17434	8717/14184
Rotational speed (RPM)	300	300	300	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	100/83.3
Data transfer rate (KBytes/sec)	15.65/31.25	31.25/62.5	31.25/62.5/125	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.11	1.0 x 4.0 x 5.11	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1Q90	1Q90	2Q91	4Q87	4Q87
COMMENTS	FZ-354I and FZ-354IS in 5.25" frame	FZ-357I and FZ-357IS in 5.25" frame			

MANUFACTURER	CITIZEN	CITIZEN	CITIZEN	CITIZEN	CITIZEN
DRIVE	OSDC	OSDD	OSDE	OSDF	OSDG
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7	F: .7	F: .7/1.2/1.4	F: .7/1.4/2.88	F: .7/1.2/2.88
Capacity per track (Bytes)	F: 4,608	F: 4,608	F: 4,608/9,216	F: 4,608/18,432	F: 4,608/18,432
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80/77	80	80/77
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717	8717	8717/17434	8717/17434/ 34868	8717/14184/ 34868
Rotational speed (RPM)	300	300	300	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	6	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	100/83.3
Data transfer rate (KBytes/sec)	31.25	31.25	31.25/62.5	31.25/62.5/125	31.25/62.5/125
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	4Q87	4Q87	4Q89	4Q90	4Q90
COMMENTS					

MANUFACTURER	CITIZEN	CITIZEN	CITIZEN	CITIZEN	CITIZEN
DRIVE	V1DA V2DA V3DA	V1DB V2DB V3DB	V1DC V2DC V3DC	V1DE V2DE V3DE	V1DF V2DF V3DF
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.2	F: .7	F: .7/1.2/1.4	F: .7/1.4/2.88
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/7,680	F: 4,608	F: 4,608/9,216	F: 4,608/18,432
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80/77/80	80/77
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/14184	8717	8717/17434	8717/14184/ 34868
Rotational speed (RPM)	300	300/360	300	300/360	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100	100/83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25	31.25/62.5	31.25/62.5/125
SIZE (Inches: H x W x D)	.59 x 3.8 x 5.1	.59 x 3.8 x 5.1	.59 x 3.8 x 5.1	.59 x 3.8 x 5.1	.59 x 3.8 x 5.1
FIRST CUSTOMER SHIPMENT	2Q91	2Q91	2Q91	2Q91	2Q93
COMMENTS	V3DA is 3 volt model	V3DB is 3 volt model	V3DC is 3 volt model	V3DE is 3 volt model	V3DF is 3 volt model

MANUFACTURER	CITIZEN	CITIZEN	CITIZEN	CITIZEN	ERGO
DRIVE	W1DA W3DA	W1DB	W1DC	W1DE	MD-21 MD-22
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	Captive, OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.2	F: .7	F: .7/1.2/1.4	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/7,680	F: 4,608	F: 4,608/9,216	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80/77/80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/14184	8717	8717/17434	8717/17434
Rotational speed (RPM)	300	300/360	300	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100	100/83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	.43 x 3.8 x 4.6	.43 x 3.8 x 4.6	.43 x 3.8 x 4.6	.43 x 3.8 x 4.6	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	2Q93	2Q93	2Q93	2Q93	1Q90
COMMENTS	W3DA is 3 volt model				MD-22 is tested to tighter specifications

MANUFACTURER	HITACHI	HITACHI	INSITE PERIPHERALS	IOMEGA	IOMEGA
DRIVE	FDD 441	FDD 541	I325VM	B120/B220 Bernoulli Box II	B144/B244 Bernoulli Box II/44
DISK/TREND GROUP	16	16	16	16	16
MARKET	OEM	OEM	OEM	PCM	PCM
MEDIA: Nominal disk diameter	8"	5.25"	3.5"	5.25"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	High Density Oxide Coated	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 6.15	F: 4.15	F: 21	F: 21.4	F: 44.5
Capacity per track (Bytes)	F: 19,968	F: 19,968	F: 13,824	F: 16,128	F: 20,480
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	154	104	753	677	1088
Track density (TPI)	96	125	1245	570	1095
Maximum linear density (BPI)	20560*	29560	23980 BPI* 17985 FCI	23511 BPI* 17633 FCI	28541 BPI* 21405 FCI
Rotational speed (RPM)	360	720	720	1845.7	2027
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Crs:Step. Motor Fine:Voice Coil	Linear, Voice Coil	Linear, Voice Coil
POSITIONING: Track to track(msec)	2	2	1	6.2 (including settling)	3.7
Settling time (msec)	15	37	15	--	--
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	41.7	41.6	16.25	14.8
Data transfer rate (KBytes/sec)	187.5	375	200	666	692.5
SIZE (Inches: H x W x D)	2.24 x 8.54 x 12.9	1.625 x 5.75 x 8.6	1.0 x 4.0 x 5.9	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	2/84	1Q85	4/91	9/87	2/89
COMMENTS	*2,7 RLL Code		*1,7 RLL Code 80 msec average position. time Optical servo track system. SCSI interface Downward comp. with 1 & 2 MB (read & write)	*1,8 RLL Code 40 msec average positioning time	*1,8 RLL Code 32 msec average positioning time

MANUFACTURER	IOMEGA	IOMEGA	IOMEGA	IOMEGA	MANTEC TECHNOLOGY
DRIVE	Bernoulli 90 Pro	Bernoulli 150	Beta-20	Io20S	MTL-FD102E/C
DISK/TREND GROUP	16	16	16	16	14
MARKET	OEM, PCM	OEM, PCM	OEM	OEM	PCM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	3.5"	5.25"
Recording medium	Metal Powder	Metal Powder	High Density Oxide Coated	Barium Ferrite	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 90	F: 150.9	F: 21.4	F: 20.8	F: .090/.180
Capacity per track (Bytes)	F: 29,696	F: 35,328	F: 16,128	F: 13,824	F: 2,304/4,608
Data surfaces per spindle	2	2	2	2	1
Tracks per surface	1516	2594	677	765	40
Track density (TPI)	1605	2117	570	1245	48
Maximum linear density (BPI)	37961 BPI* 28470 FCI	35990 BPI* 26992 FCI	23511 BPI* 17633 FCI	23980 BPI* 17985 FCI	2768/5536
Rotational speed (RPM)	2368	2368	1845.7	720	300
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Band, Stepping Motor
POSITIONING: Track to track(msec)	2.4 (including settling)	2.5 (including settling)	6.2 (including settling)	15 (including settling)	3
Settling time (msec)	--	--	--	--	16
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	12.7	12.7	16.25	41.6	100
Data transfer rate (KBytes/sec)	1173.7	5000/3000 asyn.	666	200	15.63/31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.0 x 4.0 x 6.2	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	7/91	4Q92	3Q86	4Q92	1987
COMMENTS	*1,7 RLL Code 20 msec average positioning time	*1,7 RLL Code 25 msec average positioning time Downward comp. 90 MB read/ write 44 MB read	*1,8 RLL Code 38 msec average positioning time SCSI interface	*1,7 RLL Code 65 msec average position. time Optical servo track system. SCSI interface Downward comp. with .7 & 1.4MB (Read & Write)	For use with Apple IIC and Apple IIE

MANUFACTURER	MANTEC TECHNOLOGY	MANTEC TECHNOLOGY	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	MTL-FD128	MTL-FD228	JA-751	JU-455 JA-551*	JU-475 JU-595*
DISK/TREND GROUP	14	14	13	14	14
MARKET	PCM	PCM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	8"	5.25"	5.25"
Recording medium	Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .360	F: 1.2	F: .6/1.2	F: .360	F: .360/.7 or F: .6/1.2
Capacity per track (Bytes)	F: 4,608	F: 7,680	F: 4,096/8,192	F: 4,608	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	77	77	40	77/80
Track density (TPI)	48	96	48	48	96
Maximum linear density (BPI)	5876	9646	3408/6816	5876	5922/9646
Rotational speed (RPM)	300	360	360	300	300/360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	4	3
Settling time (msec)	16	16	25	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	50	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	83.3	83.3	100	100/83.3
Data transfer rate (KBytes/sec)	31.25	31.25	31.25/62.5	31.25	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	2.2 x 8.6 x 12.1	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1987	6/88	1987	1982	1983
COMMENTS			Sold only in Japan	*Sold only in Japan	*Sold only in Japan

MANUFACTURER	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	JU-237A	JU-253	JU-253A	JU-255	JU-255A
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7	F: .7	F: .7/1.2	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608	F: 4,608	F: 4,608/7,680	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80/77	80/77
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717	8717	8717/14184	8717/14184
Rotational speed (RPM)	300	300	300	300/360	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	6	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100/83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25	31.25	31.25/37.5/62.5	31.25/37.5/62.5
SIZE (Inches: H x W x D)	.67 x 4.0 x 5.2	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	3Q90	1987	1986	1987	1987
COMMENTS	Direct drive motor 96 mm width available		Sold only in Japan	Sold only in Japan	Sold only in Japan

MANUFACTURER	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS
DRIVE	JU-257	JU-257A	JU-259A	EME-213	EME-215
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.4	F: .7/1.4/2.88	F: .7	F: 1.2
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216/ 18,432	F: 4,608	F: 7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/17434	8717/34868	8717	14528
Rotational speed (RPM)	300	300	300	300	360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	6	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	83
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5/125	31.25	62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	.67 x 3.8 x 5.3	.67 x 3.8 x 5.3
FIRST CUSTOMER SHIPMENT	1987	1987	4Q92	1989	1991
COMMENTS	Sold only in Japan	5V (single)	SCSI interface option		

MANUFACTURER	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS
DRIVE	EME-216	EME-262	EME-263	EME-264	EME-272 EME-277
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 1.6	F: .7/1.2	F: .7/1.4	F: .7	F: .7/1.2
Capacity per track (Bytes)	F: 9,216	F: 4,608/7,680	F: 4,608/9,216	F: 4,608	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	17434	8717/14528	8717/17434	8717	8717/14528
Rotational speed (RPM)	300	300/360	300	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	6	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	83/100	100	100	83/100
Data transfer rate (KBytes/sec)	62.5	31.25/62.5	31.25/62.5	31.25	31.25/62.5
SIZE (Inches: H x W x D)	.67 x 3.8 x 5.3	.67 x 3.8 x 5.3	.67 x 3.8 x 5.3	.67 x 3.8 x 5.3	.59 x 3.8 x 5.1
FIRST CUSTOMER SHIPMENT	1991	1989	1989	1989	1992
COMMENTS					

MANUFACTURER	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MILTOPE	MILTOPE
DRIVE	EME-273 EME-278	EME-274	EME-276	DD 400	DD 450
DISK/TREND GROUP	15	15	15	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	8"	8"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.2/1.4	F: .7	F: .3/.6	F: .6/1.2
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/7,680/9,216	F: 4,608	F: 4,096/8,192	F: 4,096/8,192
Data surfaces per spindle	2	2	2	1	2
Tracks per surface	80	80	80	77	77
Track density (TPI)	135	135	135	48	48
Maximum linear density (BPI)	8717/17434	8717/14528/17434	8717	3268/6536	3408/6816
Rotational speed (RPM)	300	300/360/300	300	360	360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	12	6	5
Settling time (msec)	15	15	15	10	10
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	16	16
Average rotational delay (msec)	100	100/83/100	100	83.3	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	.59 x 3.8 x 5.1	.59 x 3.8 x 5.1	.59 x 3.8 x 5.1	5.44 x 8.44 x 18.0	5.44 x 8.44 x 18.0
FIRST CUSTOMER SHIPMENT	4/91	1992	1992	1977	1980
COMMENTS				Sold as militarized subsystem	Sold as militarized subsystem

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION
DRIVE	MF 501C	MF 504C	MF 504S	MF 353C	MF 354C MF 354F
DISK/TREND GROUP	14	14	14	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	3.5"	3.5"
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .360	F: .7/1.2	F: .7/1.2	F: .7	F: .7/1.2
Capacity per track (Bytes)	F: 4,608	F: 4,608/7,680	F: 4,608/7,680	F: 4,608	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	80/77	80/77	80	80/77
Track density (TPI)	48	96	96	135	135
Maximum linear density (BPI)	5877	5922/9870	5922/9870	8717	8717/14184
Rotational speed (RPM)	300	300/360	300/360	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Spindle Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	6	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100/83.3	100	100/83.3
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	31.25/62.5	31.25	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 7.7	1.625 x 5.75 x 7.7	1.12 x 5.75 x 7.5	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	2Q88	2Q88	3Q89	2Q87	2Q87
COMMENTS					

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUMI ELECTRIC
DRIVE	MF 355C MF 355F	MF 355E	MF 355S	MF 356C MF 356F	D 509V2 D 509V3
DISK/TREND GROUP	15	15	15	15	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.4/2.88	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/18,432	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	96
Maximum linear density (BPI)	8717/17434	8717/17434	8717/17434	8717/34868	5922/9646
Rotational speed (RPM)	300	300/360	300	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3/5
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5/125	37.5/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	.58 x 3.8 x 5.0	.67 x 4.0 x 5.1	1.0 x 4.0 x 5.9	1.625 x 5.75 x 7.4
FIRST CUSTOMER SHIPMENT	2Q87	2Q91	4Q90	2Q91	4Q88
COMMENTS					

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE	D 352T2	D 357B	D 357C	D 357P2 D 357P3 D 357T2 D 357T3	D 358P3 D 358T3
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4/2.88	F: .7	F: .7	F: .7	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/18,432	F: 4,608	F: 4,608	F: 4,608	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/34768	8717	8717	8717	8718/14184
Rotational speed (RPM)	300	300	300	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	6	6	3/6	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5/125	31.25	31.25	31.25/62.5	31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 6.1	1.0 x 4.0 x 6.1	.67 x 4.0 x 6.1	1.0 x 4.0 x 6.1	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	2Q90	4/87	1Q90	4Q88	3Q91
COMMENTS				D 357P2/P3 are in 5.25" form factor	D 358P3 is in 5.25" form factor

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MULTIDIGIT
DRIVE	D 359C2	D 359F	D 359P2 D 359P3 D 359T2 D 359T3	D 281 D 284 D 286	DF0511
DISK/TREND GROUP	15	15	15		14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	72 mm	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.4	U: .064	F: .360
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216	U: 64,000	F: 4,608
Data surfaces per spindle	2	2	2	1	2
Tracks per surface	80	80	80	1	40
Track density (TPI)	135	135	135	59	48
Maximum linear density (BPI)	8717/17434	8717/17434	8717/17434	4410	5877
Rotational speed (RPM)	300	300	300	423	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	N/A	Band, Stepping Motor
POSITIONING: Track to track(msec)	6	3	3/6	N/A	6
Settling time (msec)	15	15	15	N/A	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	N/A	Continuous Contact
Average rotational delay (msec)	100	100	100	N/A	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	12.63	31.25
SIZE (Inches: H x W x D)	.67 x 4.0 x 6.1	.5 x 3.8 x 5.1	1.0 x 4.0 x 6.1	1.73 x 4.6 x 4.1	1.625 x 5.75 x 8.06
FIRST CUSTOMER SHIPMENT	1Q90	1Q92	4Q88	2/86	1985
COMMENTS			D 359P2/P3 are in 5.25" form factor	64,000 bytes in single spiral track Front loading QDM-02 is MSX subsystem	

MANUFACTURER	MULTIDIGIT	NEC	NEC	NEC	NEC
DRIVE	DF1622	FD 1165	FD 1157C	FD 1157D	FD 1158C
DISK/TREND GROUP	14	13	14	14	14
MARKET	OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	5.25"	8"	5.25"	5.25"	5.25"
Recording medium	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 1.2	F: .6/1.2	F: .7/1.2	F: .7/1.2	F: .7/1.2
Capacity per track (Bytes)	F: 7,680	F: 4,096/8,192	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	77	80	80	80
Track density (TPI)	96	48	96	96	96
Maximum linear density (BPI)	9646	3408/6816	5922/9870	5922/9870	5922/9870
Rotational speed (RPM)	360	360	300/360	300/360	300/360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	50	35	35	Continuous Contact
Average rotational delay (msec)	83.3	83.3	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.06	2.28 x 8.54 x 12.7	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.0 x 5.75 x 7.5
FIRST CUSTOMER SHIPMENT	1986	4Q81	1987	1987	2Q90
COMMENTS				With VFO	

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	FD 1158D	FD 1037A	FD 1038A	FD 1137C	FD 1137D
DISK/TREND GROUP	14	15	15	15	15
MARKET	Captive, OEM	Captive, OEM	OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	5.25"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .360/.7	F: .7	F: .7/1.2	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/7,680	F: 2,304/4,608	F: 4,608	F: 4,608/7,680	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	96	135	135	135	135
Maximum linear density (BPI)	5922/9870	4359/8717	8717	8717/14528	8717/14528
Rotational speed (RPM)	300/360	300	300	300/360	300/360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Linear, Pulse Motor	Linear, Pulse Motor	Linear, Stepping Motor	Linear, Stepping Motor
POSITIONING: Track to track(msec)	3	3	2	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	100	100	100/83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	15.63/31.25	31.25	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 5.75 x 7.5	1.0 x 4.0 x 5.1	.75 x 4.0 x 5.12	1.0 x 4.0 x 5.1	1.0 x 4.0 x 5.1
FIRST CUSTOMER SHIPMENT	3Q90	1987	1Q90	1987	1987
COMMENTS	With VFO				With VFO

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	FD 1137H	FD 1138C	FD 1138D	FD 1138H	FD 1138T
DISK/TREND GROUP	15	15	15	15	15
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	OEM	Captive, OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.2	F: .7/1.2	F: .7/1.4	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680 9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/14528	8717/14528	8717/17434	8717/14528/ 17434
Rotational speed (RPM)	300	300/360	300/360	300	300/360
PERFORMANCE					
Actuator type	Linear, Pulse Motor	Linear, Pulse Motor	Linear, Pulse Motor	Linear, Pulse Motor	Linear, Pulse Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100/83.3	100	100/83.3
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
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.1	.75 x 4.0 x 5.0	.75 x 4.0 x 5.0	.75 x 4.0 x 5.0	.75 x 4.0 x 5.0
FIRST CUSTOMER SHIPMENT	1987	1Q90	2Q90	1Q90	2Q92
COMMENTS			With VFO		

MANUFACTURER	NEC	NEC	NEC	NEC	SAFRONIC
DRIVE	FD 1139C	FD 1139H	FD 1335C	FD 1335H	DS-51A
DISK/TREND GROUP	15	15	16	16	14
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Metal Powder	Metal Powder	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.4	F: .7/1.2/10.18	F:.7/1.47/10.18	F: .360
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 19,968	F: 19,968	F: 4,608
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80/255	80/255	40
Track density (TPI)	135	135	135/431	135/431	48
Maximum linear density (BPI)	8717/14528	8717/17434	8717/14528/ 36595	8717/17434/ 36595	5876
Rotational speed (RPM)	300/360	300	360	360	300
PERFORMANCE					
Actuator type	Linear, Pulse Motor	Linear, Pulse Motor	Linear, Pulse Motor	Linear, Pulse Motor	Band, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	4
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100	83.3	83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5/1250	31.25/62.5/1250	31.25
SIZE (Inches: H x W x D)	.59 x 4.0 x 4.0	.59 x 4.0 x 4.0	1.0 x 4.0 x 5.12	1.0 x 4.0 x 5.12	1.625 x 5.75 x 7.6
FIRST CUSTOMER SHIPMENT	2/91	2/91	1/90	1/90	1989
COMMENTS			Downward comp. with 1 & 1.6 MB (Read & Write)	Downward comp. with 1 & 2 MB (Read & Write)	

MANUFACTURER	SAFRONIC	SAFRONIC	SAMSUNG ELECTRONICS	SAMSUNG ELECTRONICS	SAMSUNG ELECTRONICS
DRIVE	DS-53A	DS-34A	SFD-560D	SFD-321D	SFD-342K
DISK/TREND GROUP	14	15	14	15	15
MARKET	OEM	OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	5.25"	3.5"	5.25"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .360/1.2	F: .7/1.4	F: .7/1.2	F: .7/1.4	F: .7/1.4/2.88
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/18,432
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80/77	80	80
Track density (TPI)	96	135	96	135	135
Maximum linear density (BPI)	5876/9870	8717/17434	5922/9646	8717/17434	8717/34868
Rotational speed (RPM)	300	300	300/360	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	83.3	100	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5/125
SIZE (Inches: H x W x D)	1.625 x 5.75 x 7.6	1.0 x 4.0 x 5.9	1.625 x 5.75 x 8.0	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1989	1989	4Q87	2Q89	1Q92
COMMENTS					

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
DRIVE	SD-621L	SD-680L	SD-780	SMD-1020	SMD-1040
DISK/TREND GROUP	14	14	14	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	3.5"	3.5"
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .360	F: .7/1.2	F: .7/1.2	F: .7/1.2	F: .7/1.4
Capacity per track (Bytes)	F: 4,608	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	80	80	80	80
Track density (TPI)	48	96	96	135	135
Maximum linear density (BPI)	5876	5922/9870	5922/9870	8717/14528	1817/17434
Rotational speed (RPM)	300	300/360	360	300/360	300
PERFORMANCE					
Actuator type	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	4	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	35	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	83.3	100	100
Data transfer rate (KBytes/sec)	31.25	37.5/62.5	37.5/62.5	37.5/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 7.7	1.625 x 5.75 x 7.7	1.0 x 5.75 x 7.6	.71 x 4.0 x 5.1	.71 x 4.0 x 5.1
FIRST CUSTOMER SHIPMENT	2Q86	3Q86	4Q92	1Q90	1Q90
COMMENTS				Direct drive motor	Direct drive motor

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SONY
DRIVE	SMD-1060	SMD-1140	SMD-340	SMD-380	MP-F11W
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	Captive, OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4/2.88	F: .7/1.4	F: .7/1.4	F: .7	F: .7
Capacity per track (Bytes)	F: 4,608/18,432	F: 4,608/9,216	F: 4,608/9,216	F: 4,608	F: 4,608
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/34868	8717/17434	8717/17434	8717	8717
Rotational speed (RPM)	300	300	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	100
Data transfer rate (KBytes/sec)	31.25/62.5/125	31.25/62.5	31.25/62.5	31.25	31.25
SIZE (Inches: H x W x D)	.71 x 4.0 x 5.1	.59 x 3.8 x 4.6	1.0 x 4.0 x 5.75	1.0 x 4.0 x 5.75	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1Q91	10/92	1/89	1/89	2Q87
COMMENTS	Direct drive motor	Also 3.3 volt version			

MANUFACTURER	SONY	SONY	SONY	SONY	SONY
DRIVE	MP-F120	MP-F17W	MP-F320	MP-F40W	MP-F73W-00D MP-F73W-01D
DISK/TREND GROUP	15	15	15	15	15
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.4	F: .7/1.4	F: .7/1.4/2.88	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/18,432	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/17434	8717/17434	8717/34868	8717/17434
Rotational speed (RPM)	300	300	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5/125	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	.5 x 3.78 x 4.96	1.0 x 4.0 x 5.9	1.18 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	4Q90	2Q87	3Q92	1Q91	1Q86
COMMENTS					

MANUFACTURER	SONY	TEAC	TEAC	TEAC	TEAC
DRIVE	PDD-110	FD-155GF	FD-55BR	FD-55FR	FD-55GFR
DISK/TREND GROUP	15	14	14	14	14
MARKET	Captive, OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	2.0"	5.25"	5.25"	5.25"	5.25"
Recording medium	Metal Powder	High Density Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .819	F: .7/1.2	F: .360	F: .7	F: .7/1.2
Capacity per track (Bytes)	F: 16,380	F: 4,608/7,680	F: 4,608	F: 4,608	F: 4,608/7,680
Data surfaces per spindle	1	2	2	2	2
Tracks per surface	50	80/77	40	80	80/77
Track density (TPI)	254	96	48	96	96
Maximum linear density (BPI)	51200	5922/9646	5876	5922	5922/9646
Rotational speed (RPM)	3600	300/360	300	300	300/360
PERFORMANCE					
Actuator type	Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track(msec)	4	3	4/6	3	3
Settling time (msec)	--	15	10/15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	50	50	50
Average rotational delay (msec)	8.3	100/83.3	100	100	100/83.3
Data transfer rate (KBytes/sec)	1787.5	31.25/62.5	31.25	31.25	31.25/62.5
SIZE (Inches: H x W x D)	.79 x 2.5 x 3.5	1.0 x 5.75 x 7.52	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	3Q88	8/91	1987	1987	1987
COMMENTS	Data version of 2" still video disk				Dual speed

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-55GR	FD-55GS	FD-05GF	FD-05HF	FD-05HG
DISK/TREND GROUP	14	14	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 1.2	F: .7/1.2	F: .7/1.2	F: .7/1.4	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 7,680	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	77	80/77	80	80	80
Track density (TPI)	96	96	135	135	135
Maximum linear density (BPI)	9646	5922/9646	8717/14184	8717/17434	8717/17434
Rotational speed (RPM)	360	300/360	300/360	300	300/360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	50	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	100/83.3	100/83.3	100	100/83.3
Data transfer rate (KBytes/sec)	62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.7 x 5.7 x 8.0	.5 x 4.0 x 5.1	.5 x 4.0 x 5.1	.5 x 4.0 x 5.1
FIRST CUSTOMER SHIPMENT	1987	1990	10/91	10/91	10/91
COMMENTS		SCSI interface	Direct drive motor	Direct drive motor	Direct drive motor

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-05PGF	FD-05PHF	FD-05PHG	FD-235F	FD-235GF
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.4	F: .7/1.2/1.4	F: .7	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/9,216	F: 4,608	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184	8717/17434	8717/17434	8717	8717/14528
Rotational speed (RPM)	300/360	300	300/360	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100	100/83.3	100	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25	31.25/62.5
SIZE (Inches: H x W x D)	.61 x 4.18 x 5.75	.61 x 4.18 x 5.75	.61 x 4.18 x 5.75	1.0 x 4.0 x 5.71	1.0 x 4.0 x 5.71
FIRST CUSTOMER SHIPMENT	4/92	4/92	4/92	2Q88	2Q88
COMMENTS	External drive unit	External drive unit	External drive unit		

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-235HF	FD-235HG	FD-235HS	FD-235J	FD-235JS
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.4	F: .7/1.4/2.88	F: .7/1.4/2.88
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/18,432	F: 4,608/18,432
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/17434	8717/17434	8717/34868	8717/34868
Rotational speed (RPM)	300	300/360	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5/125	31.25/62.5/125
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.71	1.0 x 4.0 x 5.71	1.65 x 4.1 x 6.37	1.0 x 4.0 x 5.71	1.65 x 4.1 x 6.37
FIRST CUSTOMER SHIPMENT	2Q88		1990	1Q89	1990
COMMENTS			SCSI interface		SCSI interface

MANUFACTURER	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA	VITORIA TECNOLOGIA
DRIVE	ND-0401	ND-0801	ND-3561	ND-3571	DV 5200
DISK/TREND GROUP	14	14	15	15	14
MARKET	OEM	OEM	OEM	OEM	PCM
MEDIA: Nominal disk diameter	5.25"	5.25"	3.5"	3.5"	5.25"
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .360	F: .7/1.2	F: .7/1.4	F: .7/1.4/2.88	F: .360/1.2
Capacity per track (Bytes)	F: 4,608	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/9,216/ 18,432	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	80/77	80	80	80
Track density (TPI)	48	96	135	135	96
Maximum linear density (BPI)	5876	5922/9870	8717/17434	8717/17434/ 34868	5876/9870
Rotational speed (RPM)	300	360	300	300	300/360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track(msec)	6	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continous Contact	Continous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100	100	100/83.3
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	31.25/62.5	31.25/62.5/125	31.25/62.5
SIZE (Inches: H x W x D)	1.6 x 5.7 x 8.2	1.6 x 5.7 x 8.2	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.625 x 5.75 x 7.6
FIRST CUSTOMER SHIPMENT	4Q89	4Q89	4Q89	1Q92	3/91
COMMENTS					

MANUFACTURER	VITORIA TECNOLOGIA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	DV 3200	YD-180	YD-380B-1710B	YD-380B-1711B	YD-380B-1714B
DISK/TREND GROUP	15	13	14	14	14
MARKET	PCM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	8"	5.25"	5.25"	5.25"
Recording medium	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .6/1.2	F: 1.2	F: .7/1.2	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,096/8,192	F: 7,680	F: 4,608/7,680	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	77	77	80	80/77
Track density (TPI)	135	48	96	96	96
Maximum linear density (BPI)	8717/17434	3408/6816	9646	5922/9870	5922/9646
Rotational speed (RPM)	300	360	360	360	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	50	50	50	50
Average rotational delay (msec)	100	83.3	83.3	83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	62.5	37.5/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	2.25 x 8.55 x 12.6	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	8/91	9/81	4/86	4/86	4/86
COMMENTS					

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	YD-380B-1734H	YD-380B-1734S	YD-380B-1736B	YD-380C-1711C	YD-580B-1354B YD-580B-1355B
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.2	F: .7/1.2	F: .7/1.2	F: .360
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/7,680	F: 4,608
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77	80	80	40
Track density (TPI)	96	96	96	96	48
Maximum linear density (BPI)	5922/9870	5922/9870	5922/9870	5922/9870	5876
Rotational speed (RPM)	600/720	600/720	360	360	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	5
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	50
Average rotational delay (msec)	50/41.6	50/41.6	83.3	83.3	100
Data transfer rate (KBytes/sec)	75/125	75/125	37.5/62.5	37.5/62.5	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	6/90	6/91	2Q87	3/91	4/86
COMMENTS	Double speed drive sold for duplicator	Double speed, simultaneous R/W drive sold for duplicator	Also sold as YD-380B-PC		

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	YD-580B-1376B	YD-801 YD-802	YD-645C YD-646C	YD-646F	YD-665C
DISK/TREND GROUP	14	14	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	3.5"	3.5"	3.5"
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .360	F: 2.4	F: .7	F: .7	F: 1.2
Capacity per track (Bytes)	F: 4,608	F: 20,832	F: 4,608	F: 4,608	F: 7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	80	80	80	77
Track density (TPI)	48	96	135	135	135
Maximum linear density (BPI)	5876	19740	8717	4358/8717	14184
Rotational speed (RPM)	300	180	300	300	360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	5	3	6	6	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	50	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	166.7	100	100	83.3
Data transfer rate (KBytes/sec)	31.25	62.5	31.25	15.63/31.25	62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.0 x 4.0 x 5.9	.68 x 3.78 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	2Q87	1Q87	1986	12/89	1986
COMMENTS	Also sold as YD-580B-PC	Compatible with 1.0 and 1.6 MB formats			

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	YD-685C-1505H	YD-686C	YD-686F	YD-701B YD-702B	YD-701B-6031H
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.2	F: .7/1.2	F: .7/1.4	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80/77	80/77	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184	8717/14184	8717/14184	8717/17434	8717/17434
Rotational speed (RPM)	600/720	300/360	300/360	300	600
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	50/41.6	100/83.3	100/83.3	100	50
Data transfer rate (KBytes/sec)	62.5/125	31.25/62.5	31.25/62.5	31.25/62.5	62.5/125
SIZE (Inches: H x W x D)	.68 x 4.0 x 5.9	1.0 x 4.0 x 5.9	.68 x 3.78 x 5.9	1.0 x 4.0 x 5.9	.68 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	6/90	1Q87	1/90	1Q87	6/90
COMMENTS	Double speed drive sold for duplicator				Double speed drive sold for duplicator

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	YD-701B-6030S	YD-702F	YD-702G	YD-702J	YD-742
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2/1.4	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.4/2.88
Capacity per track (Bytes)	F: 4,608/7,680/ 9,216	F: 4,608/9,216	F: 4,608/7,680/ 9,216	F: 4,608/7,680 9,216	F: 4,608/18,432
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77/80	80	80/77/80	80/77/80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184/ 17434	8717/17434	8717/14184/ 17434	8717/14184/ 17434	8717/34868
Rotational speed (RPM)	600/720/600	300	300/360/300	300/360/300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	50/41.6/50	100	100/83.3/100	100/83.3/100	100
Data transfer rate (KBytes/sec)	62.5/125/125	31.25/62.5	31.25/62.5/62.5	31.25/62.5/62.5	31.25/62.5/125
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	.68 x 3.78 x 5.9	.59 x 3.78 x 5.1	.41 x 3.78 x 5.1	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	6/91	1/90	7/91	2Q93	1990
COMMENTS	Double speed, simultaneous R/W drive sold for duplicator		Direct drive motor		

MANUFACTURER	Y-E DATA				
DRIVE	YD-750				
DISK/TREND GROUP	16				
MARKET	OEM				
MEDIA: Nominal disk diameter	3.5"				
Recording medium	Metal Powder				
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 20.8				
Capacity per track (Bytes)	F: 27,648				
Data surfaces per spindle	2				
Tracks per surface	380				
Track density (TPI)	677				
Maximum linear density (BPI)	45800				
Rotational speed (RPM)	1080				
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor				
POSITIONING: Track to track(msec)	--				
Settling time (msec)	--				
Head load time(msec)	Continuous Contact				
Average rotational delay (msec)	27.8				
Data transfer rate (KBytes/sec)	625				
SIZE (Inches: H x W x D)	1.625 x 4.0 x 5.9				
FIRST CUSTOMER SHIPMENT	4Q92				
COMMENTS	50 msec average positioning time Read compatible with 1.0 and 2.0 MB				

MANUFACTURER PROFILES

1992 DISK/TREND REPORT

MANUFACTURER PROFILES

All manufacturers now producing flexible magnetic disk drives, or which have indicated specific plans to enter the market, are listed in this section. The heading "1991 FDD sales" refers to the DISK/TREND estimate of flexible disk drive sales only -- no sales of other drive types are included, nor are sales of parts or other disk drive related products such as controllers. "1991 total net sales" covers the fiscal year ending in 1991 for each firm unless noted otherwise, or for the parent company if the disk drive manufacturer is a subsidiary. The fiscal years of listed firms end on December 31, 1991, unless otherwise noted.

Exchange rates

The exchange rates used in converting the financial data of non-U.S. manufacturers to dollars is given below. The average exchange rate for 1991 is used, as reported by the U.S. Federal Reserve Bulletin and rounded to three significant figures, except that the exchange rate for the Brazilian Cruzeiro, which fluctuates widely, has been averaged from several sources.

Country	Currency	Currency units per U.S. dollar
Brazil	Cruzeiro	437.0
Hong Kong	Dollar	7.77
Japan	Yen	135
South Korea	Won	737
Taiwan	Dollar	26.8

Use caution in making year to year comparisons of revenue and income, as they are significantly impacted by exchange rate fluctuations.

U.S Manufacturers

BRIER TECHNOLOGY, INC.
25 Meca Drive
Norcross, GA 30093

Incorporated in April, 1986, Brier was founded by managers from Data Technology and other data storage firms to develop high capacity 3.5 inch floppy disk drives. The initial product was a 21.4 megabyte drive originally scheduled for 1989 shipment. The drive has a "buried" embedded servo, using preformatted diskettes with barium ferrite media. In the Spring of 1988, an interest in Brier was purchased by Intelligent Systems, which also owns Peachtree Software, Princeton Graphics Systems, Quadram, and other PC oriented peripherals companies. Limited shipments began in late 1989 of a 21.4 megabyte drive, which is eventually to be replaced by a 1 inch high version with full read/write downward compatibility with .7 and 1.44 megabyte drives. Brier licensed Irwin Magnetics, now part of Archive, as a second manufacturing source, but this arrangement has not produced results. Brier has pursued primarily the aftermarket, with most drives distributed through Quadram subsystem sales.

INSITE PERIPHERALS, INC.
4433 Fortran Drive
San Jose, CA 95134-2302

Insite's announcement of a 20 megabyte 3.5 inch microfloppy, combining an optical head positioning scheme with magnetic recording, has aroused widespread interest in the industry. Trademarked as the "floptical", the drive uses an LED on the head assembly to follow optically reflective servo tracks on the surface of 3.5 inch barium ferrite media. A 1 inch high version that is downward compatible with standard 3.5 inch .7 and 1.44 megabyte drives in both read and write modes became available in late 1991, the result of Insite's contract manufacturing arrangement with Matsushita Kotobuki Electronics. Insite is attempting to achieve mainstream status for the "floptical" through licensing of established drive and media manufacturers, with Iomega as the first announced licensee, and is aggressively seeking additional strategic relationships. 3M and Hitachi Maxell have been granted licenses as media producers and have made equity investments in Insite.

INTERNATIONAL BUSINESS MACHINES CORPORATION
Route 22
Armonk, NY 10504

1991 total net sales: $64,792,000,000 Net income: ($2,287,000,000)

IBM introduced the original one and two sided 8 inch flexible disk drives, and has used them on a wide variety of business systems, word processing systems,

terminals and specialized equipment. After years of neglecting the minifloppy product area, IBM emerged as the world's largest buyer of OEM floppy drives, when it used two sided 48 TPI 5.25 inch drives for the successful PC program. This choice established the two sided 48 TPI format as a mainstream minifloppy configuration. Later, the IBM blessing was given to 1.2 megabyte 5.25 inch drives, and this configuration became an industry standard. The 1987 introduction of the PS/2 series of personal computers using both .7 and 1.44 megabyte microfloppies reinforced the 3.5 inch trend and gave the 1.44 megabyte format a major boost. IBM made extensive preparations to design and manufacture its own 5.25 inch and microfloppy drives, but abruptly cancelled the program in mid-1985 -- choosing to rely on the low cost floppy drives available from numerous suitable vendors. Internal production of 8 inch floppy drives continued until recently to support older system families.

In 1991, IBM finally announced 2.88 megabyte barium ferrite 3.5 inch drives on one PS/2 system model. IBM's preparations for this move were widely followed and prompted many Japanese floppy drive manufacturers to prepare for production of 2.88 megabyte barium ferrite drives. However, IBM's delay until 1992 in utilizing 2.88 megabyte drives on additional systems, combined with significantly higher price levels for 2.88 megabyte drives, inhibited most other system OEMs in making commitments to use 2.88 megabyte drives. During 1992, IBM has added 2.88 megabyte drives to over 30 new PS/2 models, and gradual acceptance by other system manufacturers is now expected.

IOMEGA CORPORATION
1821 West 4000 South
Roy, UT 84067

1991 FDD sales: $69,500,000
1991 total net sales: $136,566,000 Net income: $12,325,000

Iomega, founded in 1980 by former IBM managers, was successful in establishing production capability for its unique 8 inch drive, which maintained control of head/disk contact with the Bernoulli effect. The product was originally intended as an OEM drive, but Iomega had much better luck with subsystems sold in the personal computer add-on market. The original 8 inch subsystem for the IBM PC market provided most of the company's early revenue growth until surpassed by the 20 megabyte half high 8 inch drives introduced in 1985. However, half high 5.25 inch models in production since 1987 have largely displaced 8 inch drives, and Iomega discontinued 8 inch drives in 1991. The 5.25 inch product line includes drives offering 21.4 megabytes capacity, a 44.5 megabyte model (1989), a 90 megabyte model (1991) and a 150 megabyte model added in late 1992.

Iomega has licensed the Insite Peripherals "floptical" drive and media, and has selected Chinon as a manufacturing partner for the drive. Iomega's "floptical" drive was introduced in late 1992, with immediate production availability. The Iomega version of the drive has been modified somewhat from the Insite design, but supports media interchange with Insite drives.

MILTOPE CORPORATION
1770 Walt Whitman Road
Melville, NY 11747

8 inch flexible disk drives are manufactured internally by Miltope for use in its line of militarized peripherals, which include disk, tape and bubble memory subsystems. Both one and two sided 8 inch drives are produced. Miltope also produces small quantities of militarized rigid disk drives, currently using externally purchased disk mechanisms.

Asian Manufacturers

(All fiscal years end in March, 1991, unless otherwise noted. All companies are in Japan unless otherwise noted.)

ALPS ELECTRIC CO., LTD.
1-7, Yukigaya Ohtsuka-cho
Ohta-ku, Tokyo 145

1991 total net sales: $3,423,874,000 Net income: $61,185,000

Alps Electric is a diversified manufacturer of electronic components and subassemblies for television, audio, instruments and computer applications. Printers, keyboards, mice and disk drives together account for approximately 16% of Alps revenues. Production of captive 5.25 inch floppy drives for use with Alps systems has not been emphasized. The firm's big increase in floppy drive shipments came in 1981, with a rapid buildup of shipments to Apple Computer. Alps began shipping 3.5 inch microfloppy drives in mid-1984. Alps also offers a product line of rigid disk drives.

In the spring of 1987, Alps became the first Japanese company to manufacture floppy drives in the U.S., with 5.25 inch drives made in Garden Grove, California. Alps also manufactures floppy drives in Ireland. In 1989, Alps announced a 2 inch floppy drive for use with video camera systems, but has not announced a similar product for use as a computer peripheral. A 2.88 megabyte 3.5 inch drive became available in mid-1990. A prototype 2.5 inch nonremovable floppy disk drive with a 10 megabyte capacity and average seek time of 50 milliseconds was shown to prospective customers in 1991 but has not been formally announced. A half inch high 3.5" drive began shipments in 1992.

ASIA COMMERCIAL CO., LTD.
444-452 Des Voeux Road West
Hong Kong

Asia Commercial, founded in 1968 as a watch manufacturer, was an aftermarket supplier of floppy drives for IBM, Apple, MSX and other microcomputers since 1985. The firm has also manufactured a variety of other computer related products. Shipments of 5.25 inch one sided drives began in 1985, and two sided drives were added in 1986. A 3.5 inch drive was added in 1987. Manufacturing was established in Dongguan, People's Republic of China, managed by Manhattan Electronics, a closely associated firm headquartered in Hong Kong at the same location as Asia Commercial, but the firm elected to leave the flexible disk drive business in 1991 and concentrate on watches.

BROTHER INDUSTRIES
9-35, Horita-dori
Mizuhoku, Nagoya 467

1991 total net sales: $1,703,696,000 (FY ending 11/30/91) Net income: $14,356,000

Brother is Japan's largest manufacturer of sewing machines, knitting machines and typewriters, with rapid growth in recent years in printers and other office equipment. Brother began shipping a 100 kilobyte 3.5 inch microfloppy drive in 1984 and added one inch high .7, 1.2, and 1.44 megabyte versions in 1986. The firm was unable to achieve a high enough production volume to remain competitive in the OEM market, and Brother's floppy disk drive production is now dedicated to use in Brother products, mostly in electronic typewriters.

CANON ELECTRONICS CO., INC.
Subsidiary of Canon, Inc.
1248, Shimokagemori, Chichibu-city
Saitama, 369-18
Japan

1991 total net sales: $13,843,881,000 (FY ending 12/31/91) Net income: $386,333,000

Canon Electronics produces electronic subassemblies for Canon cameras, as well as other electronic components, including magnetic heads, and systems. Floppy disk drives represent 11% of Canon Electronics revenues, up from 10% in 1990. One and two sided 5.25 inch floppy drives have been in production since 1979, originally under a BASF license for one third high drives. Canon also developed its own unique microfloppy using a 97 mm disk, but these drives were dropped, and the firm began shipments of 3.5 inch microfloppies in late 1984. Floppy drives are produced for both captive applications and for sale to the OEM market, both domestic and export. One inch high 3.5 inch drives began production in mid-1986, and in 1988 Canon commenced production of 1.44 megabyte 3.5 inch drives. 19.5 millimeter high 3.5 inch drives were introduced in late 1989, followed by 15 millimeter high versions in 1991.

CHINON INDUSTRIES, INC.
21-17 Takashima 1-chome
Suwa-City, Nagano 392
Japan

1991 FDD sales: $184,700,000
1991 total net sales: $442,919,000 Net income: $615,000

Chinon, founded in 1948, is a manufacturer of electronics, cameras and photographic equipment, with worldwide distribution. Eastman Kodak is a minor-

ity shareholder in the firm, holding 12.3% ownership. The company produces scanners, CD-ROM drives and printers as well as floppy disk drives, many of which are made on a contract manufacturing basis for other firms. In 1984, data products accounted for less than 10% of company revenues, but grew to over 56% in 1991, with a major proportion contributed by floppy drive shipments.

The firm introduced its flexible disk drive product line in 1984, currently consisting of half high 5.25 inch drives and 3.5 inch microfloppies. Chinon announced a Sony-type 2 inch 3,600 RPM floppy disk drive in 1991. A 2.88 megabyte 3.5 inch drive was introduced in 1990. Chinon and Iomega have an agreement for Chinon to produce the "floptical" disk drive that Iomega licensed from Insite Peripherals, with production starting in the second half of 1992.

In mid-1992, Chinon established Chinon Asia Private Ltd., a Singapore company that will manufacture flexible disk drives. Production is scheduled to start in late 1992.

CITIZEN WATCH CO., LTD.
2-1-1, Nishi-Shinjuku
Shinjuku-ku, Tokyo 160
Japan

1991 FDD sales: $125,900,000
1991 total net sales: $3,030,793,000 Net Income: $126,881,000

Citizen is steadily expanding its diversification into additional products, from its basic position of strength as Japan's second largest watch manufacturer. Watches are now down to 50% of sales, machine tools hold 13% and electronic equipment the balance. In addition to printers, displays, and small computers, Citizen introduced 3.5 inch microfloppies in 1984, offering the first one inch high floppy drive, and began an aggressive sales program in the U.S. and Europe, aimed at the OEM market.

In 1989, Citizen again led the industry in drive packaging, this time with the first introduction of 19 millimeter high 3.5 inch floppy disk drives, followed in 1990 with drives only 15 millimeters high. A 20.6 megabyte (formatted) floppy drive using metal powder media was announced in late 1989, with specification changes considered likely to conform to the JEIDA specification for high capacity floppy drives, when final. In late 1991, the firm began shipping 2.88 megabyte 3.5 inch drives and in late 1992 announced the thinnest 3.5 inch floppy drive to date, only 11 millimeters in height.

EASTERN PERIPHERALS PVT. LTD.
72, S. D. F. III
Seepz, Andheri (E)
Bombay, 400 096
India

Eastern Peripherals was originally established in 1979 to make 5.25 inch floppy disk drives and components for Tandon Corporation, and is owned by members of the Tandon family. With Tandon Corporation's departure from the disk drive business in 1987, Eastern Peripherals continued as an OEM floppy drive manufacturer, using models developed by Tandon, and also produces heads, stepping motors, and other electronic products. The firm expects to phase into production of 3.5 inch floppy drives.

ERGO ELECTRONICS CO., LTD.
388 Castle Peak Road
Tsuen Wan, New Territories
Hong Kong

Ergo was founded in 1978 as the Evergo Corporation and changed its name in 1985 to reflect new management. The firm assembles personal computers and also manufactures 5.25 inch floppy disk drives for the Apple compatible market, with drives for the IBM personal computer market added in 1986. 3.5 inch drives were announced in late 1989, with the mechanisms assembled under contract in the People's Republic of China.

HITACHI, LTD.
6-2, Otemachi 2-chome
Chiyoda-ku, Tokyo 100
Japan

1991 total net sales: $57,310,822,000 Net income: $1,705,074,000

Hitachi is Japan's largest electric and electronics manufacturer, with about 46% of its total sales generated by the computer and communications industry. Hitachi has been making 8 inch floppy drives since 1976 for both captive and OEM applications. In 1982, the firm entered the 5.25 inch market, and also joined in the 3 inch microfloppy standard with Matsushita Electric Industrial, but has since dropped production of 3 inch floppy drives. In early 1986, the firm began shipping a 1.2 megabyte 3.5 inch drive, but manufacturing ceased in 1987. Hitachi took an early leadership role in introducing high capacity flexible disk drives designed to use high density particulate media developed by Maxell, including a 6.15 megabyte 8 inch drive and a 4.15 megabyte 5.25 inch drive, but production remained small. The firm has also made technology announcements concerning vertical recording. However, in recent years floppy drive activity has dwindled and production is now mostly directed at filling internal needs.

HYUNDAI ELECTRONICS INDUSTRIES CO., LTD.
San 136-1, Ami-ri, Bubal-myun
Ichon-kun, Kyoungki-do
South Korea

Hyundai's first attempt to enter the disk drive business was a disastrous joint venture with Tandon, which was abandoned in early 1987 after serious friction between the joint venturers. Hyundai later concluded an agreement with Fujitsu to take over the 3.5 inch microfloppy program which Fujitsu was preparing for market introduction at the time it acquired control of Copal, which then was chosen as the Fujitsu floppy drive manufacturing arm. Using the Fujitsu products as a starting point, Hyundai established its own microfloppy drive manufacturing program at the large electronics complex at Ichon, but production levels have been low, for captive use only.

JAPAN PERIPHERAL NETWORK CORPORATION. (See Safronic Corporation)

MANTEC TECHNOLOGY, LTD.
Flat A, 18/F., Chai Wan Industrial Center
20 Lee Chung Street
Chai Wan
Hong Kong

Mantec was founded in 1985 as a producer of floppy disk drives and modems. The drives produced are two sided 5.25 inch 360 kilobyte models and a one sided drive which is Apple compatible. Drive production is currently done at low levels in the PRC.

MATSUSHITA COMMUNICATION INDUSTRIAL CO., LTD.
4-3-1 Tsunashima-Higashi
Kohoku-ku, Yokohama 223
Japan

1991 FDD sales: $230,500,000
1991 total net sales: $2,387,200,000 Net income: $2,331,000

Matsushita Communication Industrial is a member of the Matsushita Electric Industrial group, a worldwide giant in appliances and electronics. During the early growth of the floppy drive industry, MCI manufactured most of the Shugart Associates floppy drive line under license for the Japanese OEM market. MCI later added floppy drives of its own design, including half high 5.25 inch and 3.5 inch microfloppy drives. The firm made half high 5.25 inch drives on a contract manufacturing basis for Shugart and in 1985 acquired marketing rights in the United States, which has resulted in significant sales by the firm's U.S. Panasonic subsidiary. MCI established a joint venture with a manufacturer in the Philip-

pines, Precision Electronics Corporation, to manufacture floppy disk drives and other computer components. Nearly all flexible disk drive production is now located in the Philippines.

The firm introduced a .7 megabyte 2 inch floppy drive that was adopted by Zenith in 1989 for use in a notebook computer but was otherwise shunned by the computer industry. In 1987, MCI became one of several firms that licensed the barium ferrite technology used in the Toshiba 2.88 megabyte 3.5 inch floppy drive, but shipped its first 2.88 megabyte drive in 1990. MCI has also announced high capacity 3.5 inch drives and 17 millimeter high 3.5 inch drives with .7, 1.44, and 2.88 megabyte capacities, but most of the product line is still 1 inch high drives. A 28 megabyte 3.5 inch drive, downward compatible with the .7 and 1.44 megabyte formats, was introduced in 1991 and subsequently modified to be compatible with expected JEIDA specifications for high capacity drives.

MATSUSHITA ELECTRONIC COMPONENTS CO., LTD.
Subsidiary of Matsushita Electric Industrial Co., Ltd.
1006, Kadoma, Kadoma City
Osaka 571
Japan

1991 FDD sales: $50,500,000
1991 total net sales: $2,866,778,000 Net income: $193,000

Matsushita's Panasonic, National, Technics and Quasar brand names are among the most widely known in the world for appliances, consumer electronics and communications equipment. Matsushita Electronic Components Co. (MACO) joined with Hitachi in attempting to establish a 3 inch microfloppy standard, which had widest acceptance in the European market, but discontinued in 1991. Production of one inch high 3.5 inch microfloppies began in 1987 and a 15 millimeter high version was added in 1991.

MITSUBISHI ELECTRIC CORPORATION
2-3, Marunouchi 2-chome
Chiyoda-ku, Tokyo 100
Japan

1991 FDD sales: $111,200,000
1991 total net sales: $24,564,763,000 Net income: $590,815,000

Mitsubishi Electric is a leader in the Japanese domestic small business systems market, and one of the country's leading electronic and electrical products manufacturers. 8 inch drives, used with the firm's Melcom systems and sold in the domestic market for several years, are now out of production. A family of half high 5.25 inch floppy drives was introduced in 1982, with capacities up to 1.6 megabytes. Mitsubishi also started shipping a 3.5 inch microfloppy drive in 1983 and introduced a 1.44 megabyte version as early as 1985.

After production of flexible disk drives was moved to expanded facilities at Mitsubishi's Koriyama Works, Melco Manufacturing (Thailand), a joint venture for the manufacture of floppy disk drives was established in Thailand with Kang Yong Electric Manufacturing Co. The joint venture is largely owned by Mitsubishi. Production of one inch high 3.5 inch drives at Koriyama began in 1987, and Mitsubishi became a major supplier of flexible disk drives to IBM. In 1991, the firm introduced a 2.88 megabyte 3.5 inch drive and a 14.8 millimeter high 3.5 inch 1.44 megabyte drive.

MITSUMI ELECTRIC CO., LTD.
8-8-2, Kokuryo-cho
Chofu-City, Tokyo 182
Japan

1991 FDD sales: $120,200,000
1991 total net sales: $1,174,874,000 (FY ending 1/31/91) Net income: $11,341,000

Mitsumi is a leading manufacturer of electronic subassemblies and components, including magnetic heads. Floppy disk drives represent about 10% of sales, up from 8% in 1990. The firm established a joint venture facility with Commodore, named Newtronics, to produce 5.25 inch and 3.5 inch floppy drives, and acquired complete ownership of Newtronics in 1986.

In 1984, Mitsumi introduced a very low cost 2.8 inch drive using a special Maxell disk under the name "Quick Disk", which uses a single spiral track with 64,000 kilobytes capacity. It is used primarily in low-end home systems, including games. One inch high 3.5 inch drives went into production in 1987, followed by 3/4 inch high drives in 1989. A 12.7 millimeter high 1.44 megabyte 3.5 inch drive was announced in late 1991. Mitsumi has established a manufacturing facility in Malaysia for floppy disk drives and began manufacturing at Cebu Mitsumi in the Philippines in early 1992.

NEC CORPORATION
5-33-1 Shiba
Minato-ku, Tokyo 108
Japan

1991 FDD sales: $363,600,000
1991 total net sales: $27,398,504,000 Net income: $402,837,000

About 52% of NEC's revenues are generated by computer mainframes, small business systems, minicomputers and desktop systems -- and the firm remains the clear leader in the growing Japan domestic personal computer market. Since 1978 the company has manufactured two sided 8 inch floppy drives, and was one of the earliest firms to offer half high 8 inch drives, with shipments start-

ing in late 1981. 3.5 inch microfloppy drives and half high 5.25 inch drives were introduced in 1984. The majority of NEC's floppy drive shipments have been for captive applications, making the company the world leader in total DISK/TREND revenues for flexible disk drives.

NEC moved into the high capacity floppy drive market with the 1988 introduction of a 3.5 inch 9.4 megabyte drive for sale with its microcomputer systems. A 10 megabyte version with downward compatibility to .7 and 1.44 megabyte drives was introduced in 1990. NEC is very active on the JEIDA committee working to standardize high capacity 3.5 inch floppy disk drives. In 1989, NEC announced that it was establishing a subsidiary in Hong Kong to oversee procurement and manufacturing in southeast Asia, including production of floppy disk drives in the Philippines.

ORIENTAL PRECISION COMPANY, LTD.
Tae Wha Building, 11th Floor
194-27 Insa-dong, Chongno-gu
Seoul
South Korea

OPC, established in 1953, was a diversified producer of electronic products and systems including terminals, telecommunication products, small computers and radio products. Computer equipment accounted for about one fifth of annual sales. The firm manufactured a line of 5.25 inch floppy drives under license from Teac, and also did contract manufacturing of small rigid disk drives. In 1991, OPC was purchased by Jade Insurance, part of the Korea Chemical Group, and the company subsequently terminated operations later in 1991.

ROCTEC ELECTRONICS LTD.
Subsidiary of Roctec Enterprises
Union Industrial Building
18 Lee Chung Street
Chai Wan
Hong Kong

Roctec Electronics was established in 1986 when a group of engineers approached the parent organization and proposed establishing floppy drive manufacturing. Shipments of 5.25 inch drives, mostly two sided, began in 1987. Recent production has declined and ceased entirely in 1991. Drives are currently sourced from Japan and the People's Republic of China. Roctec now emphasizes externally mounted diskette add-on products for various personal computers including Apple, Commodore, Compaq, IBM, and Toshiba.

SAFRONIC CORPORATION
7-5-17 Nakazato
Tendo-shi, Yamagata 994

Safronic, founded in October, 1988, originally was called Digital Systems, Inc., and later adopted the name of its major distributor, Japan Peripherals Network (JPN). In 1991, the firm adopted its present name, with JPN remaining a separate organization distributing peripherals, mostly floppy disk drives made by Safronic. Safronic now manufactures half high 5.25 inch drives and 1.44 megabyte 3.5 inch drives. Sales are mostly through distribution.

SAMSUNG ELECTRONICS CO., LTD.
Subsidiary of the Samsung Group
Taipyung-ro, Chung-ku
Seoul
South Korea

1991 total net sales: $7,092,442,300 Net income: $93,118,000

Samsung Electronics is the leading manufacturer of consumer electronics and appliances in Korea. About 16% of sales are computer or communications products. In 1988, the firm merged with Samsung Semiconductor and Telecommunications, with Samsung Electronics the surviving organization. Samsung got started in floppy drive production in 1983 when Shugart granted a license to manufacture and market the Shugart 5.25 inch floppy drives in South Korea, but consumer electronics and appliances are the firm's major sources of income. Samsung is currently making half high 5.25 inch drives with capacities up to 1.2 megabytes, and production of 3.5 inch 1.44 megabyte one inch high drives began in 1989. 2.88 megabyte 3.5 inch drives were introduced in 1992.

SANKYO SEIKI MFG. CO., LTD.
17-2, 1-chome, Shinbashi
Minato-ku, Tokyo 105
Japan

1991 total net sales: $864,800,000 Net income: $17,444,000

Sankyo Seiki is a leading manufacturer of musical movements, industrial robots and a wide variety of small electromechanical components used in cameras, video recorders, timers and other products. The firm received a major investment in 1988 from Nippon Steel as part of that firm's diversification program into technology industries. In 1981, the firm began shipping a spiral track flexible disk drive for word processing, program loading and special industrial applications, and in mid-1984 added 3.5 inch microfloppies. The current 3.5 inch line consists only of 1 inch high models. Production of spiral track drives ended in 1987, and 1992 is expected to be the final production year for other types.

SEIKO EPSON CORPORATION
3-5, Owa 3-chome, Suwa-shi
Nagano, 392
Japan

1991 FDD sales: $161,200,000

Seiko Epson is owned by the privately held Suwa Seikosha/Epson group held by members of the Hattori family, who also control Japan's Seiko companies active in watches and electronics. Epson is best known for matrix printers, now used worldwide with personal computers. Epson also manufactures line printers, LCDs, watch components, and portable computers.

The first Epson floppy drive was a captive 5.25 inch one third high unit first shipped in 1982 and used with the Epson portable computer. Starting in October, 1983, Epson added an OEM floppy drive product line of 5.25 and 3.5 inch models, including 3.5 inch drives with very low power requirements. At the 1985 Fall Comdex, Seiko Epson showed a 2.5 inch floppy disk drive prototype for which no manufacturing program has ever been announced. As of 1992, the product line included half high 5.25 inch drives and 25.4 millimeter, 18 and 15 millimeter high 3.5 inch drives.

SONY CORPORATION
6-7-35, Kita-Shinagawa
Shinagawa-ku, Tokyo 141
Japan

1991 FDD sales: $329,100,000
1991 total net sales: $27,339,081,000 Net income: $866,111,000

Sony, founded in 1946, is best known as a consumer electronics producer, but in recent years has made it clear that expansion in communications and computer products markets is a major company objective. About 21% of sales are nonconsumer products. Included are word processing and personal computer equipment -- both of which use the Sony 3.5 inch microfloppy which has been shipping since late 1981.

After initially taking a somewhat stiff posture on granting licenses, Sony demonstrated flexibility in working with the U.S. manufacturers concerned with establishing common standards. The result was agreement on the 3.5 inch media standard by Sony and several U.S. drive and media manufacturers -- and a growing number of Japanese firms rushing to make 3.5 inch microfloppy drives. After a big early boost when Hewlett-Packard selected Sony's drive for a variety of personal computers, there was a two year period of attack from contentious sponsors of rival standards, but the industry consensus on the Sony 3.5 inch drive has been in place since the mid-1980's. Sony's microfloppy drive and media shipments grew strongly after Apple chose the drive for its Macintosh system and other systems manufacturers signed on.

Sony proposed to the industry a 1.44 megabyte, 3.5 inch diskette in 1985, which has become a de facto industry standard, with a little help from IBM. In 1987, Sony responded to the growing industry support for one inch high 3.5 inch drives by introducing its own model. A 2.88 megabyte 3.5 inch floppy disk drive was introduced in 1991. The firm has been pioneering the submicrofloppy field with a very high bandwidth .7 megabyte 2 inch floppy based upon a design used in the Mavica video camera storage device. Sony is also an active producer of CD-ROM, erasable and write-once optical disk drives, but has been frustrated in attempting to establish a presence in the rigid disk drive market.

TEAC CORPORATION
3-7-3, Naka-cho
Musashino, Tokyo 180
Japan

1991 FDD sales: $350,600,000
1991 total net sales: $943,370,000 Net income: $32,800,000

Teac is a leading manufacturer of consumer and professional audio recorders, but digital recording equipment is a major portion of the firm's product mix, now accounting for about 74% of total revenues. Shipments of 5.25 inch floppies for the OEM market started in 1978, and rapid growth made Teac the leader in worldwide noncaptive floppy drive revenues during the last few years. Major products today are half high 5.25 inch drives and microfloppy drives. In 1985, Teac announced its line of 3.5 inch drives, including a 1.44 megabyte model and subsequently added one inch high models. The firm joined Toshiba in 1987 in announcing 2.88 megabyte 3.5 inch floppy drives using barium ferrite media. 19 millimeter high 3.5 inch drives were introduced in 1989, and a 2.88 megabyte model was introduced in 1990. In 1991, Teac introduced the industry's first 12.7 millimeter high 3.5 inch floppy disk drive, moving to the front in the race to downsize microfloppy drives. Teac has made manufacturing and licensing arrangements with a number of firms in Japan, Korea, and other countries.

Much of TEAC's current production has been moved to Malaysia, where the majority of the units shipped are 5.25 inch drives. The company has also established a drive component manufacturing operation in Singapore.

TOSHIBA CORPORATION
1-1-1, Shibaura
Minato-ku, Tokyo 105
Japan

1991 FDD sales: $49,000,000
1991 total net sales: $1,006,689,000 Net income: $21,437,000

Toshiba is one of Japan's major diversified electric and electronics manufacturers, with products ranging from heavy electric machinery to home appliances

and communications equipment. Toshiba has a major share of the Japanese minicomputer and small business system markets. 8 inch floppy drives for both captive and OEM markets were produced starting in 1977. Half high two sided 5.25 inch drives were added in 1982, with the more recent addition of microfloppy drives. Although now de-emphasizing internal production of standard floppy drives, Toshiba has actively promoted advanced technology, including optical drives. High capacity barium ferrite media has been developed by the firm for 2.88 megabyte 3.5 inch floppies, with production of drives and media starting in 1988. Several other firms have licensed the drive and media. Toshiba has put some development effort into 3.5 inch drives with 15-20 megabyte capacity, and displayed a 16 megabyte 3.5 inch drive using barium ferrite media at the Japan Business Show in May, 1989. Volume production of 2.88 megabyte drives began in early 1992.

Y-E DATA, INC.
60, 1-1, Higashi-Ikebukuro 3-chome
Toshima-ku, Tokyo 170
Japan

1991 FDD sales: $157,600,000
1991 total net sales: $257,911,000 Net income: $1,348,000

Y-E Data is a spin-off of Yaskawa Electric, a diversified manufacturer of heavy electric, factory automation and data processing equipment. Data processing products are the responsibility of Y-E Data, which first manufactured 8 inch one sided floppy drives in 1974 under an Orbis license. Disk drives represent about two thirds of current sales. Manufacturing is split between Japan, Thailand and a facility in the U.K.

Y-E Data became an early leader in the Japanese OEM markets for both 8 and 5.25 inch two sided drives. Y-E Data also cooperated with NTT on the standard for 1.2 megabyte 5.25 inch drives and has been shipping its version since early 1982. Microfloppy drives were added in 1984. Y-E Data's biggest sale of all came in 1984, with IBM's selection of the firm's 1.2 megabyte 5.25 inch drive for use with the PC AT. In 1986, one inch high 3.5 inch drives were added to the product line. A 2.88 megabyte 3.5 inch microfloppy drive using cobalt modified oxide media was introduced in 1988 in an unsuccessful attempt to develop an industry standard, and a standard 2.88 megabyte 3.5 inch drive was first shipped in 1990. A preliminary announcement of a 27.8 megabyte drive using metal particle media was made in 1989, with specifications revised in 1991. 17 millimeter high .7 and 1.44 megabyte 3.5 inch drives were announced in 1990, followed by a 15 millimeter high version introduced in 1991.

In addition to its drive manufacturing activities, Y-E Data supplies drive kits to manufacturers in India, mainland China and other Asian countries.

European Manufacturers

DZU
6000 Stara Zagora
Bulgaria

DZU is the current name for the Bulgarian organization known for many years as ISOT, following a series of reorganizations in 1989 of the governmental structure which manages Bulgarian technology industries. DZU has produced flexible and rigid disk drives, as well as most of the components needed for disk drive fabrication, plus many other electrical and electronic devices. Isotimpex is the foreign trade organization for Bulgarian computer equipment and other electronic products. Over the years, the main market for disk drives manufactured by DZU were the former Eastern Bloc countries, with some magnetic media products also exported to Western countries. Rigid disk drives, in several older IBM configurations, have been produced since the 1960s, later joined by 8 inch and 5.25 inch floppy drives. As a result of the economic upheaval in the former Eastern Bloc countries, DZU production has been greatly reduced and extensive reorganization of the facilities which produced floppy drives has been under way.

ELCOMATIC LTD.
Subsidiary of British & Commonwealth Shipping Co., Ltd.
Kirktonfield Road
Nielston, Glasgow
Scotland

In July, 1981, Elcomatic acquired the 8 inch flexible disk product line of MFE. These drives had been manufactured mostly in a two sided version at plants in Salem, Massachusetts, and in Livingston, Scotland. Elcomatic moved manufacturing to a Glasgow plant and for ten years produced 8 inch two sided floppy drives for the European market. Production ceased in 1991, due to declining markets for 8 inch floppy drives.

ISOT (See DZU)

PERIPHERAL DATA SYSTEMS
Asenovgradsko Shose
Plovdiv
Bulgaria

Peripheral Data Systems (formerly known as Instrumentation and Automation) had the charter from the Bulgarian government for product development

and to establish high volume manufacturing facilities for peripherals used in personal computers, in order to facilitate usage of personal computers throughout the country. With assistance from ISOT, plus acquisition of tooling from outside countries, the organization started production of 5.25 inch flexible disk drives in 1985. However, with the extensive political and economic changes which have occurred in all former Eastern Bloc countries, floppy drive production by this organization has dropped to a low level.

South American Manufacturers

COBRA COMPUTADORES E SISTEMAS BRASILEIROS S.A.
Avenida Commandante Guaranys, 447
Jacarepagua
22700 Rio de Janeiro/RJ
Brazil

Cobra, founded in 1974, is Brazil's largest computer company. Its products include minicomputers, microcomputers, terminals and other computer peripherals. The company has made a variety of floppy and rigid disk drives, usually under license from U.S. manufacturers. Cobra's floppy disk manufacturing was limited to an 8 inch one sided drive originally designed by Caldisk. Production levels were always modest, with the drives being used in Cobra's own system products. Production ended in 1991.

ELEBRA INFORMATICA S.A.
Rua Maestro Joaquim Capocchi, 165
Jurubatuba
04696 Sao Paulo/SP
Brazil

Elebra was founded in 1979, and is believed to be the most significant specialized manufacturer of computer peripherals in South America. Its product lines have included floppy disk drives, rigid disk drives, printers and tape drives. Floppy disk production, including one and two sided 5.25 inch drives, both 48 and 96 TPI versions, ended in 1991.

FLEXDISC TECNOLOGIA S.A.
Rua Francisco Tramontano, 100
05686 Sao Paulo/SP
Brazil

Originally known as Electrodigi S.A. Electronica Digital, Flexdisc has had several name changes. Its most recent name was adopted in mid-1986. Floppy disk drives have been produced by Flexdisc since 1979, originally under a Shugart Associates license. Additional products also included rigid disk drives, controllers, and other peripheral products. The floppy disk product line began with 8 inch drives, but later included one and two sided 5.25 inch floppy drives. Flexdisc was one of the early casualties of the opening of the Brazilian computer market and shut down operations in 1991.

ITAUTEC INFORMATICA S.A.
Rua Odorico Mendes, 540
03106 Mooca
Sao Paulo SP
Brazil

Itautec is part of the Itau group, Brazil's second largest bank. Itautec was formed in 1979 to automate the banking systems of its parent organization and went into the computer systems business in 1984. The firm began production of floppy disk drives in 1986 and rigid disk drives, made under license from BASF, in 1988. The most recent floppy disk drive line consisted of 360 KB and 1.2 megabyte half high models, but was terminated in 1991 when the firm elected to use lower cost imported drives in its systems.

MULTIDIGIT TECNOLOGIA S.A.
BR 290, Km 75
Distrito Industrial de Gravatai
94000 Gravatai/RS
Brazil

Multidigit was founded in 1979 with a cadre of Brazilian university students, and so qualifies as a genuinely homegrown company. Products include floppy and rigid drives, controllers, and tape drives. The floppy drives are half high 5.25 inch models using both 48 and 96 TPI and have been produced since 1985 and 1986, respectively. Production has declined under the pressure of the opened Brazilian computer market, but a few models remain in production.

PROLOGICA INDUSTRIA E COMERCIO DE MICROCOMPUTADORES LTDA.
Rua Fidencio Ramos, 302
04551 Villa Olimpia
Sao Paulo SP
Brazil

Prologica began as a retail store for electronic components, but soon moved into sales of kits for radios and, eventually, sales of microcomputer kits. The company decided to produce floppy drives in 1982 and actually started production of an IBM compatible 500 kilobyte drive in 1983. This was superseded in 1985 by a half high version. In 1984, the firm established a related company, Microperifericos, to manufacture drives for OEM customers and to do contract manufacturing, but ceased flexible disk drive production in 1991.

VITORIA TECNOLOGIA S/A
Rua Joao Batista Parra, 100
Vitoria/Centro Industrial da Grande Vitoria
CIVIT II Serra Espirito Santo
BRAZIL

Vitoria Tecnologia has purchased the inventory and much of the production equipment of Tecmate, a Taiwan company that formerly produced floppy disk drives. The floppy disk drive product line, consisting of 5.25" drives compatible with Apple, IBM and MSX type systems, was announced in 1990. The firm has since elected to assemble drives using major components obtained from other sources.

DISK/TREND ON DISK

1992 DISK/TREND REPORT

DISK/TREND ON DISK

Introduction

DISK/TREND ON DISK is a licensed set of floppy disks containing the statistical tables and specification tables from the annual DISK/TREND Reports. The disk files have been prepared in a format usable on IBM or IBM-compatible computers running under the MS-DOS or PC-DOS operating system. A system with a hard disk is highly recommended, but a system with two floppy disks can be used if necessary. All DISK/TREND ON DISK files contain data only -- manipulation of data is the user's responsibility. Because some of the files can be very large, system memory of 640K or more is recommended.

Two types of diskette files are supplied for each DISK/TREND disk drive report. The first type contains the statistical tables in ASCII format. File names are keyed to the table numbers in the report for easy identification. The second type contains the specification section in a Lotus 1-2-3 data base format. Multiple disks of each type are provided where the files are too numerous or too large to fit on a single floppy disk. The color of the label of the floppy disk is similar to the color used on the cover of the corresponding report for ease in identification.

Because the statistical tables are provided in ASCII format, they can be used with any spreadsheet program that can import ASCII text files. However, the specification tables have been prepared specifically in Lotus 1-2-3 format to allow them to be searchable using Lotus 1-2-3 data base commands. If you are using a spreadsheet program other than Lotus 1-2-3 that can translate Lotus WK1 formatted files to its own format, it may be able to import the specification tables without difficulty.

A file translation program, AutoImport, is available from DISK/TREND to assist in converting the data supplied to the formats of several popular spreadsheet programs. One copy of AutoImport is provided automatically at no extra charge to DISK/TREND subscribers who have purchased an original copy of DISK/TREND ON DISK but is provided only in the first year DISK/TREND ON DISK is purchased. Updates to AutoImport may be provided in following years at DISK/TREND's discretion. Extra copies of AutoImport may be purchased at any time. If you have not purchased DISK/TREND ON DISK, but would find AutoIm-

port useful with other file translation tasks, it may be purchased independently from DISK/TREND or White Crane Systems, Inc.

The authors of this manual assume that you are familiar with personal computers, Lotus 1-2-3 or other spreadsheets, and MS-DOS, and do not cover their operation in this manual. This manual deals specifically with how to load and use the files supplied on the floppy disks.

Note: Please read the license on the following page.

DISK/TREND ON DISK

Information License

DISK/TREND supplies diskettes containing selected information from the 1992 DISK/TREND Report as a separately purchased option to subscribers to the corresponding 1992 DISK/TREND Report volume.

YOU MAY:

1. Install and use the information on a single computer system, provided that you or the organization by which you are employed has purchased at least one copy of the DISK/TREND report volume associated with the information.

2. Make backup copies of the information for your own use. Such backup copies may be used only on the computer on which the information is installed. You must reproduce the copyright notice on any copies.

3. Reproduce the information, but not the associated programs or documentation, contained in the Product for use within internal documents distributed within the organization by which you are employed.

YOU MAY NOT:

1. Install, or allow the use of, the information on more than a single computer system.

2. Transfer the information through or within a computer network.

3. Distribute the information or any portion thereof in any form outside the organization by which you are employed or modify the information for purposes of distribution.

4. Transfer this license to another party.

AUTOIMPORT

Use of AutoImport is subject to license terms and conditions of White Crane Systems, Inc.

Trademarks

IBM is a trademark of International Business Machines Corporation.
Lotus and Lotus 1-2-3 are trademarks of Lotus Development Corporation.
MS-DOS is a trademark of Microsoft Corporation.
AutoImport is a trademark of White Crane Systems, Inc.

1992 DISK/TREND REPORT

Getting started

The first thing you should do is to make working copies of the original DISK/TREND diskettes. Place the originals in a safe location and use only the working copies for day-to-day operations. This procedure will help to protect your data from inadvertent destruction or loss due to a malfunction of the computer or its operator. We also recommend that you place a write protect tab on the working copies (after you create them) for the same reason. Use the hard disk or another floppy disk copy for day-to-day manipulations of the files.

The statistical tables are provided in ASCII text format. This allows you to use any word processor to edit the file prior to importing it into Lotus 1-2-3. Appropriate editing removes any material you don't wish to work with and allows you to add figures or text to the data tables. You may also embed the data in internal documents or reports you are preparing for use within your company.

To convert the statistical tables to a spreadsheet you may use the AutoImport utility software, which is probably quicker and easier than the typical text file import and conversion procedure provided with spreadsheet programs. One copy of AutoImport is provided automatically at no extra charge to each DISK/TREND subscriber who has purchased an original copy of DISK/TREND ON DISK and is provided in the first year DISK/TREND ON DISK is purchased. Updates to AutoImport may be provided in following years at DISK/TREND's discretion. Extra copies of AutoImport may be purchased at any time.

DISK/TREND ON DISK is normally shipped on 1.2 megabyte 5.25" floppy disks, but is also available on 1.44 megabyte 3.5" disks if requested.

STATISTICAL TABLES

Loading and Installation

1. Place the floppy disk marked "Tables" in a floppy disk drive able to read your size disks. This is usually drive A, but if you are using a dual floppy only system, use drive B and put the Lotus 1-2-3 system disk in drive A. Use the DOS 'DIR' command to examine the file directory on the "Tables" disk. If there are any special instructions, they will be in a file named READ.ME. To see these instructions, at the DOS prompt type:

   TYPE A:READ.ME (Use the appropriate drive letter if not A)

   If you wish to print the instructions, turn on your printer and type:

   TYPE A:READ.ME>PRN

2. Do this step if you have a hard disk. Log into the hard disk directory in which Lotus 1-2-3 normally stores worksheet files. Using the DOS 'COPY' command, copy all the statistical table files to the hard disk. This can be done in one step using the copy command as follows:

   COPY A:?T*.*

   Several utility files should also be copied. The command is:

   COPY A:*.PRN (if you are using the Lotus 1-2-3 data parsing commands)
   COPY A:*.MSK (if you are using AutoImport)

   The utility files named FORMLIN?.PRN are specifically for usage with Lotus 1-2-3 data parsing if you prefer not to use AutoImport for file translation.

   Installing AutoImport: If you have a hard disk, create a directory named AIMP (You could use other names if you prefer). Now place AutoImport disk 1 in drive A and type: A:INSTALL C:\AIMP and then ENTER. Follow any instructions appearing on the screen until installation is complete. To make AutoImport accessible from any directory, place C:\AIMP in your AUTOEXEC.BAT file's 'PATH' statement. See your MS-DOS instruction manual for information about this step.

   If you are using a floppy-only system, copy the AutoImport disks and use only the copies in following steps. In a floppy-only system, AutoImport disk 1 should be in drive A when AutoImport is in use for file translation.

3. If you are using AutoImport (highly recommended) for translation of files to spreadsheet format, do the translation at this point. See the following section on using AutoImport for details.

4. Now you are ready to start your spreadsheet. If you are using a two floppy system, place the DISK/TREND disk in drive B and the spreadsheet system disk in drive A. If you are using a rigid disk system, place a copy of the spreadsheet system disk in floppy drive A if required by the security provisions of your spreadsheet program. Now start your spreadsheet as usual. After obtaining the blank spreadsheet image on the screen, use the appropriate file retrieval command to select a file. An example of a Lotus 1-2-3 command is:

   /FR<filename>

   The file names are in the format XTYY.WK1, where:

   X= Type of data
   F (Flexible disk drive data)
   R (Rigid disk drive data)
   O (Optical disk drive data)

   YY= Table number, as shown in the appropriate report volume

   Examples:
   File RT10.WK1 is Rigid Disk Drive Report Table 10
   File FT2.WK1 is Flexible Disk Drive Report Table 2
   File OT1.WK1 is Optical Disk Drive Report Table 1

   The file selected will be loaded as a worksheet. If this is the first time the file has been loaded, you may want to create your own formulas linking the cells of the spreadsheet. See your spreadsheet reference manual for details on numerical manipulations and graphics.

If you don't use AutoImport

If you don't use AutoImport but still want to translate ASCII files to your spreadsheet format, you will have to use spreadsheet tools such as the Lotus 1-2-3 Data Parse commands. They allow the user to convert a table which has been imported in the form of a block of text to a form in which the individual numbers and labels can be manipulated as spreadsheet elements or used to prepare graphics. Let's take Lotus 1-2-3 as an example. Before proceeding, it would be useful to read the Lotus reference manual on this subject if you are not a regular user of the Data Parse commands.

The trickiest and most time-consuming part of using the Data Parse commands is setting up the format line. Several utility files have been provided on

the tables disk to make this process easier. These are used with various table formats encountered in the DISK/TREND Reports and correspond with the precomputed masks provided for use with AutoImport:

o FORMLINA.PRN	Used with Tables 1 and 2 and the Revenue and Unit Shipment tables found in the product group sections of all DISK/TREND reports.
o FORMLINB.PRN	Used with Tables 3 and 4.
o FORMLINF.PRN	Used with Tables 5 through 12.
o FORMLIND.PRN	Used with Application tables.
o FORMLINE.PRN	Used with Drive Height, Drive Capacity and Track Density tables in Flexible Disk Drive Report.

There are no FORMLIN format files for disk diameter tables or market share tables, as these are variable in format. You will have to construct the format line directly, but after you have seen how it is done for the other tables, this should not be too big a job.

After you have used spreadsheet tools to translate a file, you will understand why we recommend AutoImport for this function.

Using AutoImport

Using AutoImport is a two-step process. Step one is creation of a translation mask for each format used in files to be converted. The typical DISK/TREND Report uses 5 to 7 standard mask designs (which have been precomputed and included on your Statistical Tables disk) plus additional masks that are dependent upon table content, as some table types have variable numbers of columns. You will have to create your own masks for such tables, but this can be done easily as shown below.

Step two is the translation process. Once the mask has been created, it can be used with any table matching the mask format. See the tables below which relate table types to specific masks.

MASK TABLE

Mask File Name	Rigid Report	Flexible Report	Optical Report
MASKA	<-------- Table 1--------->		Tables 1,2
	<------------ Product Group Revenue ---------->		
	<------------ Product Group Shipment ---------->		
MASKB	<-------- Table 2 -------->		Tables 3,4
MASKC	Tables 3,4,6,9, 10,11	Tables 3,4	Tables 5 to 12
MASKD	<----- All Product Group Application Tables ------->		
MASKE	N/A	Drive Height, Track Density, Drive Capacity	Write-Once/ Erasable Analysis
MASKF	N/A	Applications Summary	N/A
MASKG	*	Product Group Market Share	*
MASKH	Tables 7,8	N/A	N/A
MASKI	Product Group Price/Megabyte	N/A	N/A

N/A = Not applicable to this report

* Variable format depending upon number of disk diameters in the product group.

TABLE NUMBER TO MASK CROSS-REFERENCE

Table Number	1992 Rigid Report	1992 Flexible Report	1992 Optical Report
1	MASKA	MASKA	MASKA
2	MASKB	MASKB	MASKA
3	MASKC	MASKC	MASKB
4	MASKC	MASKC	MASKB
5	--	--	MASKC
6	MASKC	--	MASKC
7	MASKH	MASKF	MASKC
8	MASKH	MASKA	MASKC
9	MASKC	MASKA	MASKC
10	MASKC	MASKE	MASKC
11	MASKC	MASKD	MASKC
12	--	MASKG	MASKC
13	--	MASKA	--
14	MASKA	MASKA	--
15	MASKA	MASKE	--
16	--	MASKE	--
17	--	MASKD	MASKA
18	MASKD	MASKG	MASKA
19	MASKI	MASKA	--
20	--	MASKA	--
21	MASKA	--	MASKD
22	MASKA	--	--
23	--	MASKE	MASKA
24	--	MASKE	MASKA
25	MASKD	MASKD	--
26	MASKI	MASKG	--
27	--	MASKA	--
28	MASKA	MASKA	--
29	MASKA	--	MASKE
30	--	--	MASKD
31	--	MASKD	--
32	MASKD	MASKG	MASKA
33	MASKI		MASKA
34	--		MASKD
35	MASKA		MASKA
36	MASKA		MASKA
37	--		MASKA
38	--		MASKA
39	MASKD		--
40	MASKI		--
41	--		MASKE
42	MASKA		MASKA
43	MASKA		MASKA
44	--		--
45	--		--
46	MASKD		MASKE
47	MASKI		MASKA

Cross reference (continued)

Mask File Name	1992 Rigid Report	1992 Flexible Report	1992 Optical Report
48	--		MASKA
49	MASKA		--
50	MASKA		--
51	--		MASKE
52	--		
53	MASKD		
54	MASKI		
55	--		
56	MASKA		
57	MASKA		
58	--		
59	--		
60	MASKD		
61	MASKI		
62	--		
63	MASKA		
64	MASKA		
65	--		
66	--		
67	MASKD		
68	MASKI		
69	--		
70	MASKA		
71	MASKA		
72	--		
73	--		
74	--		
75	MASKD		
76	MASKI		
77	--		

-- indicates that the format of this table is variable. Create a mask using AutoImport if a spreadsheet is needed.

Translation using precomputed masks

1. First, copy the files you wish to translate to the AIMP directory from DISK/TREND ON DISK floppy disk. Go to the AIMP directory, insert the floppy disk in drive A and type the following commands:

   COPY A:?T*.*
   COPY A:*.MSK

   These commands copy the data files and mask files you need.

   If you are using a two floppy disk system, copy the files you want to translate to a second floppy disk along with the mask files. Make sure that no more than half of the floppy disk is filled, because you will need space for the converted files.

2. Now start AutoImport. When the opening screen appears, select the "TRANSLATE" menu item using the arrow keys or just type "T". (The AutoImport menu system works just like the menus in Lotus 1-2-3.)

3. When the next screen appears, enter the name of the mask to use on the top line where the highlighted space is. If a standard mask is being used, see the mask table above to choose the mask file name to enter. If you used a mask previously, the system defaults to the last mask named. Press "ENTER".

4. Select the output file name. Type /OFT (Output:File:Type-in)

   Enter the name of the file. The file name form recommended is ?Tnn, where ? is the type of report (R, F, or O), T is just that, and nn is the DISK/TREND Report table number matching the file being translated. You should not enter the file name extension as the system adds it automatically for you. Press "ENTER".

   Examples: RT4 FT12 OT14

5. Enter the input file name using the same file naming convention as above. Type /IT (Input:Type-in)

   Enter the name of the file, including the extension, which will be of the form yy? where yy is the year of the report and ? is the report type as above.

   Examples: RT4.92R FT12.92F OT14.92O

6. The default spreadsheet type to which the translation is made is Lotus 1-2-3 version 2.x. If you wish to translate to a different spreadsheet format you may choose it by typing /TS (Task:Spreadsheet)and then selecting your preference from the menu of choices displayed.

7. You are ready to translate. Type "G" for "GO" or select "GO" using the arrow keys. You will see the file being translated scroll by as the translation proceeds.

8. If you want to do more translations, repeat from step 3.

9. When you are done translating, leave AutoImport by typing /Q (Quit) to return to the AutoImport main menu and then /E (Exit) to leave AutoImport and return to DOS. It will save you some keystrokes if you copy your new spreadsheet files to your spreadsheet directory. If you are using a two floppy system, just remove the AutoImport disk from drive A and substitute your spreadsheet disk.

Mask Generation

1. Start AutoImport as above. When the opening screen appears, select "Mask" using the arrow keys or type "M".

2. Name the file you will use as the template to create the mask. The file name will be of the form ?Tnn.yy?, where ? is the type of report (R, F, or O), nn is the table number and yy is the report year.

   Example: FT10.92F

   To name the file, type /FIT (File:Input:Type-in). When the highlighted blank space appears, fill it in with the file name and press 'Enter'. The contents of the file will now appear on the screen.

3. Next define the header lines. These are lines that are translated to the spreadsheet as a single cell of text. Place the cursor at the top of the header area, normally at the left top of the report table. Now type /LH (Line:Header). Using the down arrow key, expand the highlighted area until it extends to just above the first row of numerical data. Press 'Enter'. If there are any footnotes at the bottom, the lines in which they appear can be treated the same way by locating the header at the left margin of the first footnote line, typing /LH, extending the highlight area over the note and pressing 'Enter'.

4. Next, locate the longest left margin label (excluding the header lines) in the table. Position the cursor so that it is at the left margin of the line containing the longest label. Type /AY (Auto:Yes). This step actually creates the mask. Check to be sure all figures have been delineated properly. If not, see below.

   In a few cases, the automatic feature may be confused by a table layout and all values will not be picked for conversion. In these unusual cases, you may be able to get the overlooked values included by repeating this step on another line.

   Another unusual case can occur in which the right-hand part of a label is somehow included in a value occurring in the next column to the right. Deal with this rare case as follows:

   o Place cursor in left margin of offending line. Type /CW to adjust width and then use arrow keys to move right column margin clear of the column of values.

   o Set cursor on last position of column to the right of the left margin labels. Type /DCO to delete this one column from the mask.

   o Now place the cursor in the first space to the right of the left margin

label column. Type /C and then adjust the column width to encompass all places in the values column you have been working with. This will restore the mask column, also.

5. Save the mask in a mask file. Type /FMS (File:Mask:Save). Fill in the name of the mask file.

   Example: FT10MSK

6. Save the output file. Type /FOT (File:Output:Type-in). Now enter the file name.

   Example: FT10. You don't need to enter the file extender.

7. To make more masks, repeat from step 2. To quit the mask function, type /Q (quit). This returns you to the AutoImport main menu. To leave AutoImport, type /E.

Other AutoImport Functions

AutoImport can do much more than the functions described above, which are those concerned with a basic understanding of how to create spreadsheets from DISK/TREND ON DISK files. See the separate AutoImport manual provided for details of these other functions.

SPECIFICATION TABLES

Loading

1. Place the floppy disk marked "Specifications" in a floppy disk drive able to read your size disks. This is usually drive A, but if you are using a dual floppy only system, use drive B and put the spreadsheet system disk in drive A. Use the DOS "DIR" command to examine the file directory on the "Tables" disk. If there are any special instructions, they will be in a file named READ.ME. To see these instructions, at the DOS prompt type:

   TYPE A:READ.ME (Use the appropriate drive letter if not A)

   If you wish to print the instructions, turn on your printer and type:

   TYPE A:READ.ME>PRN

2. Do this step if you have a hard disk. Log into the hard disk directory in which your spreadsheet normally stores worksheet files. Using the DOS "COPY" command, copy all the specification table files to the hard disk. This can be done in one step using the copy command as follows:

   COPY A:?S*.*

3. Now you are ready to start Lotus 1-2-3 or other spreadsheet. If you are using a two floppy system, place the DISK/TREND disk in drive B and the Lotus spreadsheet system disk in drive A. If you are using a rigid disk system, place the spreadsheet system disk in floppy drive A. If your spreadsheet is not Lotus 1-2-3, you will have to translate the data from Lotus 1-2-3 to your format. Almost all spreadsheet packages of recent vintage are able to do this translation. After translation, if needed, start your spreadsheet as usual. After obtaining the blank spreadsheet image on the screen, use the spreadsheet File Retrieve command to select a file. The equivalent Lotus 1-2-3 command is:

   /FR<filename>

   The file names are in the format XSYZZ.WK1 or XSYZZ.WKS, depending upon which version of Lotus 1-2-3 you are using. X,Y, and Z are:

   X= F (Flexible disk drive data)
   O (Optical disk drive data)
   R (Rigid disk drive data)

Y= Table number. Usually, there is only one table, but if the specification file is so large as to need multiple disks to hold it, there may be several.

ZZ= Year of report.

Example: FS192 Flexible disk specification table

Note that the specification tables load directly as a data base. You can use the data base functions of Lotus 1-2-3 to sort, count or otherwise manipulate the data for purposes of special analysis. Other spreadsheets may have similar capabilities.

Using the specification data base

Introduction: If you have not used the Lotus 1-2-3 /DATA QUERY commands, it will be helpful for you to review the sections of the Lotus 1-2-3 reference manual that pertain to their use before proceeding further.

The specification data base fits into a worksheet format of 25 to 30 columns, depending upon whether rigid, optical or floppy drives are involved, and a row count of up to 500 rows. Each row represents a specific record, and is equivalent to a single column in the Specifications section of the DISK/TREND report. Each column represents a specific specification parameter, and is equivalent to one row of the DISK/TREND report.

The data base has been set up for data extraction using Lotus 1-2-3 commands. The Input, Output and Criterion ranges have been predefined, but you, the user, will have to decide how you want the extracted data manipulated and place the appropriate Lotus functions, such as @COUNT, in the appropriate cells. Some rows between the bottom of the input range and the top of the output range have been left empty so that you can do this easily. When the data base is first loaded, you will see the top of the input range, showing the first column (manufacturer name) for the first several manufacturers. Use the arrow keys to find other manufacturers or specific product specifications. If you are not using Lotus 1-2-3, use the equivalent procedure for your spreadsheet.

Operating tips

Expanding the input or output ranges: The predefined output range is of a nominal size, and a search with broad parameters may result in overflowing the output range. In such a case, merely extend the output range (add more rows) using the Lotus 1-2-3 /DQEO command. Similarly, it is possible to extend the input range to add more products, but be sure you move the output range so that there is no overlap.

Memory overflow: If you should receive a memory overflow message while manipulating the specification data, it is usually because:

- o There are other "pop-up" programs resident in the memory of your computer. These should be removed.
- o You have selected too large an output range. Use a smaller output range or delete some of the columns that contain data not relevant to your analysis. If you delete data, be sure that if you save your spreadsheet you use a different file name, otherwise you will overwrite the original file with the modified spreadsheet.
- o If you receive a memory overflow message while loading the data base, the data base is too large for your computer's available memory. You probably will have to remove other resident programs and reload Lotus 1-2-3 and the data base. If your computer doesn't have 640K memory, you will probably get this message.

Saving time

The specification data base is large and takes significant time to recompute or perform other operations. If you are interested in drives that belong to only a few product groups, it will probably save you time in the long run if you extract only those groups you are interested in into a new worksheet and use that for the analysis. Use spreadsheet FILE EXTRACT and FILE COMBINE commands for this purpose.

Another way to save time is to use the SORT capabilities of your spreadsheet to organize the data the way you find it most useful. The most commonly done sorts are by manufacturer name and by DISK/TREND product group, but it would also be possible to sort by average seek time, price, and so on.

Make sure that when you save a worksheet using the FILE SAVE command

that you save it in a new file name. If you save it in the file name from which it was loaded, the original copy will be overwritten. If a file is overwritten unintentionally, it can take a long time to recreate.

If you are interested in only a subset of product groups, use the FILE EXTRACT and FILE COMBINE commands to move these records to another file and then use the second file for analysis. The smaller file will take less time to process.

Technical support

Just about all of your questions regarding the use of DISK/TREND ON DISK should be answered in this manual or in the Lotus 1-2-3 reference manual. However, if you need to contact us to resolve any points of confusion, report errors, or otherwise receive comfort:

Call us at: **415-961-6209**

Ask for Technical Support for DISK/TREND ON DISK

In order to make this process efficient, when you call--

1. Tell us what is on the diskette label.

2. Have your computer up and displaying the data or operation that is the subject of your call.

3. Have this manual and the Lotus 1-2-3 reference manual handy.

If you have questions about AutoImport as it is used with DISK/TREND ON DISK, contact DISK/TREND at the number above. Questions about other functions of AutoImport should be referred to White Crane Systems.

Apple Macintosh compatibility: While DISK/TREND on DISK has been prepared for use on IBM PC compatible computers, users have reported that they are able to translate files into Macintosh format using Apple Computer software. The specific software reported used is Apple File Exchange.

Special data

The specification data base contains one category of information not present in the hard copy report. This is the country code field, representing the continental region in which the headquarters of the drive producer is located. A key is located at the top of the adjacent column to the right.

In order to make it easier to do sorting or extraction analysis on the data, the contents of certain fields have been modified and are not exactly the same as in the printed report tables. The affected fields have been converted to purely numeric fields as described below. Where multiple values existed, the value representing the highest level of performance or capability has been retained.

Comments and asterisks in the affected fields have been eliminated. A '0' means that no data was available. Asterisks are retained in the comment field so that you will have an indication that one or more characteristics of the drive was referenced to a comment. Check the printed report table for details.

The affected fields are:

Group	Numeric conversion: Now you can extract a range of groups.
TPI	A single numeric value, 0 if data not available. If a drive has several configurations, the highest TPI is used.
RPM	Numeric conversion: You can now extract a range of values.
Track to track positioning time	Will be a single numeric value, 0 if data not available. If a disk drive model is specified as having more than one positioning time, the shortest will be used. Settling time is always included.

A country code field has been added in the last column of the data base.
The code explanation is:

1 = U.S. manufacturer
2 = Asian manufacturer
3 = European manufacturer
4 = South American or other manufacturer

Codes are based upon the location of the manufacturer's headquarters. First ship date has been modified so that the last two characters will always represent the year of shipment. An entry of ??89 in the criterion field for the First Ship Date column will cause all drives first shipped in 1989 to be extracted.