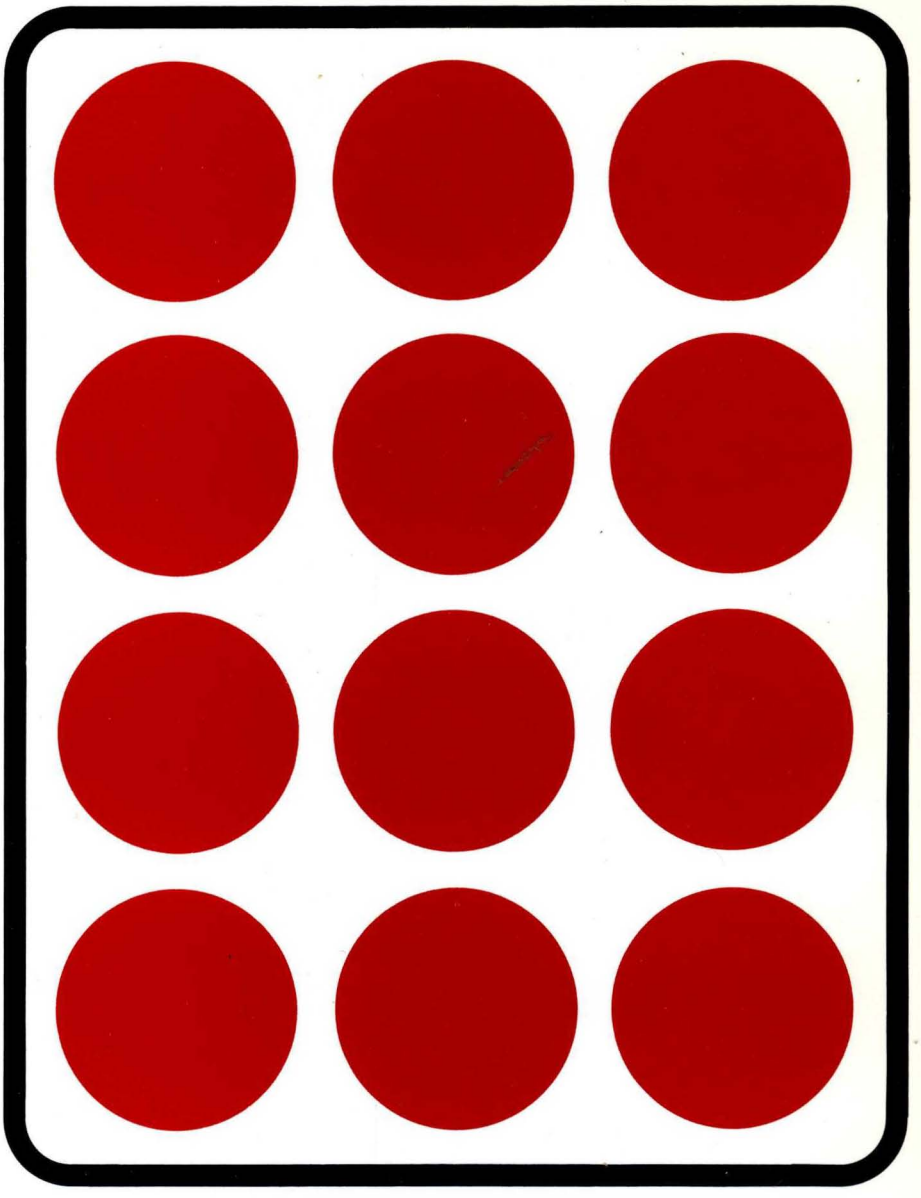
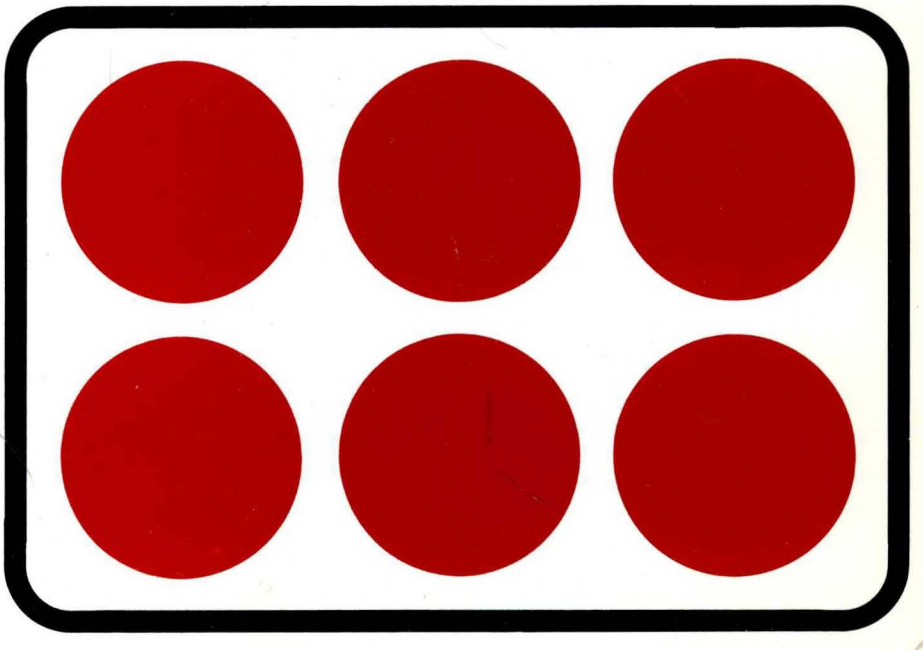


1994 DISK/TREND® REPORT

FLEXIBLE DISK DRIVES



1994 DISK/TREND® REPORT

FLEXIBLE DISK DRIVES

November, 1994

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FOREWORD

The floppy disk drive industry continues to evolve, as older products decline, 3.5" drives achieve ever-higher shipments, prices fall as fast as ever, and drive manufacturing continues to move to a variety of Pacific Rim countries. The DISK/TREND Report is evolving also, as discussed in the introduction to this edition. Next year, we plan to include all of our data on flexible disk drives in the new DISK/TREND Report on removable data storage, which was published for the first time in 1994 -- so this is the last year for the separate edition on flexible disk drives. The 1995 DISK/TREND Report on removable data storage will, of course, also include coverage of PCMCIA flash cards, PCMCIA disk drives, small optical disk drives and rigid disk cartridge drives, as well as the new section on standard floppy disk drives. We think you will find it to be an improvement over the old system.

In its eighteenth year, the DISK/TREND Report has again expanded its list of annual reports. This year the DISK/TREND Report is being published in five volumes. The report on disk drive arrays was released in April for the second year, still the industry's only market study with complete coverage of the emerging disk drive array business. It was followed in July with the 1994 report on optical disk drives, the new report on removable data storage in September, and in October with the report on rigid disk drives.

DISK/TREND ON DISK, statistical and specification tables on floppy disks, is again available to subscribers to the DISK/TREND Report. Instructions for using the disks are included at the end of this report.

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

It's time to make basic changes in the DISK/TREND Report on flexible disk drives

The DISK/TREND Report on flexible disk drives has been published as a separate volume in the DISK/TREND series of annual reports since 1977, but we expect that this will be the final edition in that form. Starting in 1995 we plan to zinclude all coverage on floppy drives in the new DISK/TREND Report on removable data storage, which was published for the first time earlier this year.

The product group section in this report on high capacity floppy drives was duplicated in the 1994 DISK/TREND Report on removable data storage, and a new product group will be created for next year's report on removable data storage which will include the separate data for 8", 5.25" and 3.5" floppy drives. We believe the new product group will improve the usefulness of the information by making it possible to see the data for all types of standard floppy drives in a single presentation.

We value very highly the continuous contact we have had with the manufacturers of floppy drives over the 18 years we have published this report, as well as the system manufacturers, industry suppliers and others who have used the information included in the reports. We would like to assure you that we will continue to cover the product area thoroughly, but in the report covering the broader range of removable data storage products. We think you will find the new report to be even more useful. Please let us know if you have any suggestions for the new arrangement.

We changed a few titles in this year's report

Please note that we revised the product group titles this year for two of the groups. The group previously labeled "Flexible disk drives, microfloppies" has been renamed "Flexible disk drives, 3.5 inch", since the only remaining shipments in the product group are of 3.5" drives. The group labeled "Flexible disk drives, over 5 megabytes" in previous reports has been renamed "High capacity flexible disk drives" in both this report and the separate report on removable data storage.

SUMMARY: FLEXIBLE DISK DRIVES

Industry size

Although the growth in total shipments was less than the industry's exceptionally strong performance in 1992, the overall 1993 total of 66,098,300 floppy drives represented a major increase in shipments, up 11.5% over the previous year. Continued increases in personal computer markets provided the basis for the growth, since floppy drives are universally used with desktop personal computers and with a high proportion of notebook computers. However, total sales revenues for all types of floppy drives were down 1.6% in 1993, depressed by the continual decline in pricing for noncaptive 3.5" drives and the rapidly dropping shipments of 5.25" drives.

The outlook for the next few years is for continuing growth in floppy drive shipments, but at a lower rate. An average annual increase of 3.2% in unit shipments is forecasted for the 1994-97 period, with the 1997 total projected at 75 million drives. 3.5" drives are expected to maintain a 9.1% average annual increase in shipments during the 1994-97 period, but a shipment decline for 5.25" drives during the same period will depress the overall growth rate.

By 1997, shipments of 5.25" drives are expected to be down to 1,760,000 units, only 2.3% of the overall floppy drive total, while 3.5" drive shipments will rise to 72,680,000 units, 96.9% of the overall total. The need to interchange diskettes with older personal computers equipped only with 5.25" drives is now decreasing rapidly, as widespread adoption of newer software and processors forces the retirement of obsolete systems. The last shipments of 8" floppy drives are projected for 1995, and high capacity floppy drives, while increasing in shipment levels as the drives' capacity ranges increase, are expected to provide less than 1% of 1997's total shipments of floppy drives.

The industry's total sales revenues are expected to decline an average of 8.8% in the 1994-97 period, with 1997 revenues estimated at $1.8 billion. Fading sales of 5.25" drives are a major reason for the revenue decline, but falling prices for noncaptive 3.5" drives will also be a major contributor. The price decline is a long-term trend, with the average OEM price for all 3.5" drives at $59 in 1988, dropping to $34 in 1993, and projected at $21 in 1997.

TABLE 1

CONSOLIDATED WORLDWIDE REVENUES

ALL EXISTING FLEXIBLE DISK DRIVE GROUPS

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1993 Revenues		Forecast 1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	50.9	61.9	44.3	51.5	36.0	42.0	28.9	34.0	18.8	21.7
OEM/Integrator	2.2	2.4	2.1	2.5	2.0	2.4	1.4	1.7	.9	1.2
TOTAL U.S. NONCAPTIVE	53.1	64.3	46.4	54.0	38.0	44.4	30.3	35.7	19.7	22.9
TOTAL U.S. REVENUES	53.1	64.3	46.4	54.0	38.0	44.4	30.3	35.7	19.7	22.9
Non-U.S. Manufacturers										
Captive	9.4	317.3	6.6	255.7	5.4	238.9	4.8	220.3	3.8	203.0
PCM/Reseller	264.6	456.7	240.2	416.5	215.5	388.4	181.7	340.0	156.8	307.3
OEM/Integrator	879.6	1,794.0	763.7	1,609.5	697.5	1,490.3	633.1	1,356.1	601.1	1,287.2
TOTAL NON-U.S. REVENUES	1,153.6	2,568.0	1,010.5	2,281.7	918.4	2,117.6	819.6	1,916.4	761.7	1,797.5
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,206.7	2,632.3	1,056.9	2,335.7	956.4	2,162.0	849.9	1,952.1	781.4	1,820.4

Marketing channels

Only 19 manufacturers of flexible disk drives remain in the industry in 1994, down from last year's total of 21. During the twenty year history of the flexible disk drive industry, the peak number of participating manufacturers was 63 companies, a total reached in 1986.

Three Asian manufacturers were dropped from this year's list, each headquartered in a different country. Each of the manufacturers eliminated from this year's list had sales which had declined to a level too low to make efficient production possible, and was therefore unprofitable, in view of the extremely competitive nature of today's floppy drive industry. Insite Peripherals was reclassified as an Asian manufacturer, following its sale to O.R. Computer System Pte. Ltd., of Singapore. Swan Instruments was added to the list of floppy drive manufacturers headquartered in the United States, following its announcement of new high capacity floppy drives.

Although total floppy drive sales revenues produced by captive drive manufactures are expected to continue to decline through 1997, the percentage share held by captive drives will remain about the same. Unit shipments of the mainstream 3.5" drives produced on a captive basis will increase through 1997, but the declining prices for both captive and noncaptive drives will force overall revenue declines at about the same pace for both distribution channels.

Noncaptive marketing channels will continue to dominate both shipments and sales revenues for floppy drives, even in the face of the revenue declines caused by falling prices. Total noncaptive revenues of $2.3 billion in 1993 are expected to decline to $1.6 billion in 1997, holding 83.4% of all floppy drive revenues. In contrast, the total noncaptive unit shipments of 63.3 million drives in 1993 are projected to increase to 72.3 million drives in 1997, 96.4% of worldwide shipments.

An understanding of the relative price levels of captive, PCM/Reseller and OEM/Integrator drives is important in interpreting DISK/TREND revenue statistics. The price used for each drive is the estimated value at the first time it is sold to a nonaffiliated buyer, at captive end user, PCM/Reseller or OEM/Integrator levels. In the flexible disk drive industry captive unit shipments are a relatively small part of the total, and the captive revenue total is smaller than that for other channels.

TABLE 2

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

REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	1993 Revenues $M	1993 Revenues %	1994 Forecast $M	1994 Forecast %	1995 Forecast $M	1995 Forecast %	1996 Forecast $M	1996 Forecast %	1997 Forecast $M	1997 Forecast %
U.S. Manufacturers										
PCM/Reseller	61.9	2.3%	51.5	2.2%	42.0	1.9%	34.0	1.7%	21.7	1.1%
	-8.8%		-16.8%		-18.4%		-19.0%		-36.2%	
OEM/Integrator	2.4	--	2.5	.1%	2.4	.1%	1.7	--	1.2	--
	-11.1%		+4.2%		-4.0%		-29.2%		-29.4%	
Total U.S. Manufacturers	64.3	2.3%	54.0	2.3%	44.4	2.0%	35.7	1.7%	22.9	1.1%
	-8.9%		-16.0%		-17.8%		-19.6%		-35.9%	
Non-U.S. Manufacturers										
Captive	317.3	12.0%	255.7	10.9%	238.9	11.0%	220.3	11.2%	203.0	11.1%
	+18.1%		-19.4%		-6.6%		-7.8%		-7.9%	
PCM/Reseller	456.7	17.3%	416.5	17.8%	388.4	17.9%	340.0	17.4%	307.3	16.8%
	+16.7%		-8.8%		-6.7%		-12.5%		-9.6%	
OEM/Integrator	1,794.0	68.4%	1,609.5	69.0%	1,490.3	69.1%	1,356.1	69.7%	1,287.2	71.0%
	-7.8%		-10.3%		-7.4%		-9.0%		-5.1%	
Total Non-U.S. Manufacturers	2,568.0	97.7%	2,281.7	97.7%	2,117.6	98.0%	1,916.4	98.3%	1,797.5	98.9%
	-1.5%		-11.1%		-7.2%		-9.5%		-6.2%	
Worldwide Recap										
Captive	317.3	12.1%	255.7	10.9%	238.9	11.0%	220.3	11.3%	203.0	11.2%
	+18.1%		-19.4%		-6.6%		-7.8%		-7.9%	
PCM/Reseller	518.6	19.7%	468.0	20.0%	430.4	19.9%	374.0	19.2%	329.0	18.1%
	+12.9%		-9.8%		-8.0%		-13.1%		-12.0%	
OEM/Integrator	1,796.4	68.2%	1,612.0	69.1%	1,492.7	69.1%	1,357.8	69.5%	1,288.4	70.7%
	-7.8%		-10.3%		-7.4%		-9.0%		-5.1%	
Total All Manufacturers	2,632.3	100.0%	2,335.7	100.0%	2,162.0	100.0%	1,952.1	100.0%	1,820.4	100.0%
	-1.7%		-11.3%		-7.4%		-9.7%		-6.7%	

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

Product mix

Following 1992's surge in 3.5" drive shipments, driven by the unexpected strength in personal computer shipments, the continuing momentum in PC markets was adequate to boost 3.5" floppy drive shipments another 22.4% in 1993. Although a slower growth rate is expected for personal computer shipments during the next few years, the combination of lower prices, faster processors and improved software is expected to keep increases in system shipments at a level adequate to maintain continuing growth for 3.5" floppy drives. 51.2 million 3.5" drives were shipped in 1993, and the total is forecasted at 72.7 million drives in 1997. However, the average prices for 3.5" drives are expected to fall as fast as shipments increase, and the total sales revenues for 3.5" floppy drives are expected to drop from $1.9 billion in 1993 to $1.7 billion in 1997.

Most participants in the floppy drive industry have been expecting for years to see a decline in 5.25" floppy drive shipments, and the long expected downtrend finally started in 1993. Following the 1992 shipment peak of 17.3 million units, 5.25" drive shipments dropped 14.9% in 1993, to 14.7 million units. 1.8 million drives are projected for 1997, an average annual decline of 39.5% for the 1994-97 period.

The principal reason for the perseverance of the 5.25" floppy format has been the continuing need of business personal computer users to interchange diskettes between new PC models, which almost always are equipped with 3.5" floppy drives, and older personal computers equipped with 5.25" drives. This requirement is now declining rapidly, with the accelerated replacement of older systems by newer personal computers with faster processors and new generations of software, all using 3.5" floppy drives.

High capacity flexible disk drives have experienced difficult times in the last year, with saturating markets for older products, price resistance to newer 3.5" drives, and changing company managements, ownership and manufacturing arrangements. Stability has apparently been reestablished in 1994, and shipments are forecasted to grow to 600,000 drives in 1997. Based on expected growth for 3.5" drives, including a larger degree of OEM adoptions than in the past, the 1997 share of total high capacity flexible disk drive shipments for 3.5" is projected at 86.9%.

Figure 1

CHANGING PRODUCT MIX

Worldwide Flexible Disk Drive Revenue

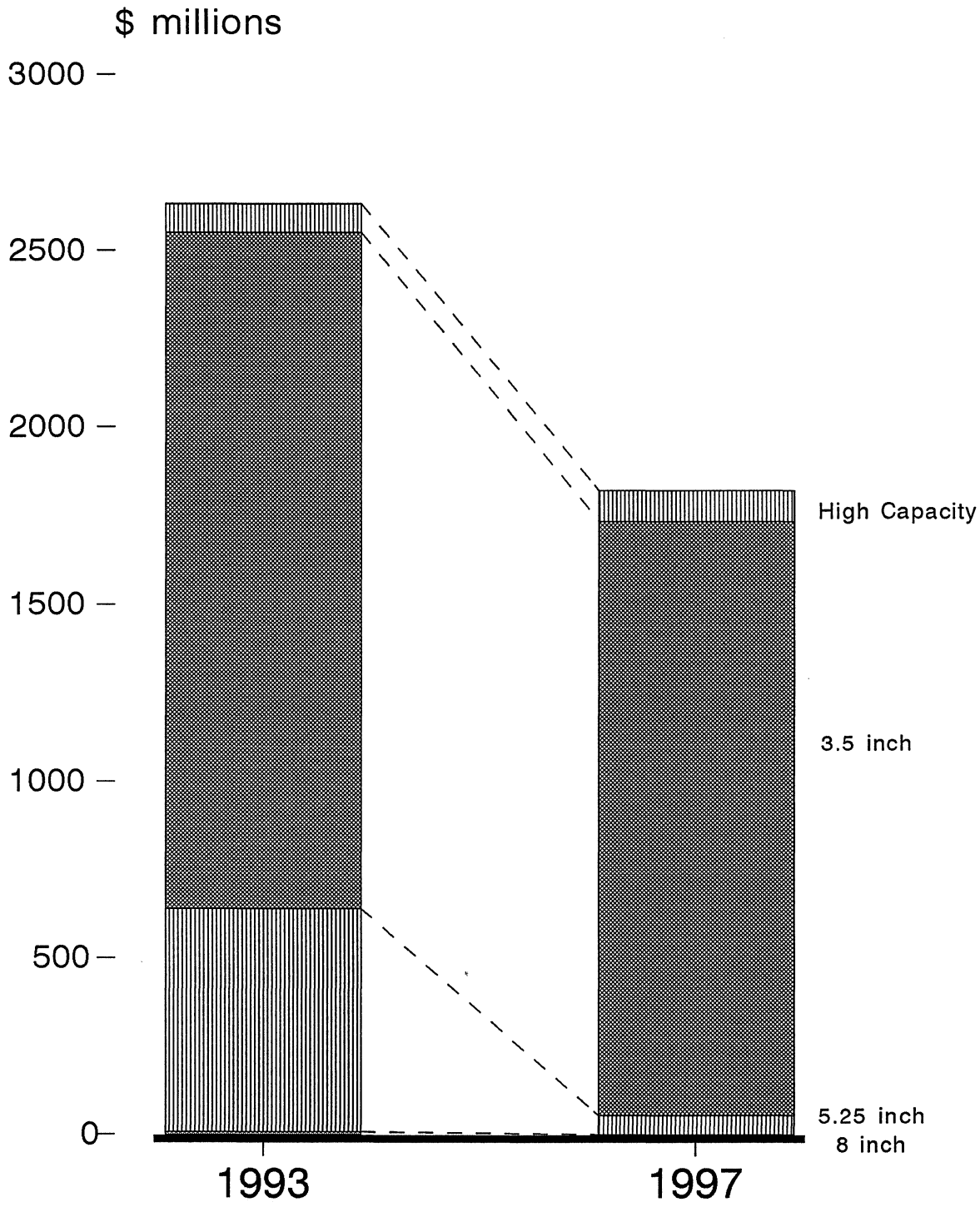


TABLE 3

WORLDWIDE SHIPMENTS

PRODUCT CATEGORY SUMMARY

ALL MANUFACTURERS

Units: Thousands Dollars: $ Million		1993 Shipments	%	1994 Ship	%	1995 Ship	%	Forecast 1996 Ship	%	Forecast 1997 Ship	%
8 INCH DRIVES											
	Units	26.0	-49.6	16.0	-38.4	10.0	-37.5	--	--	--	--
	$M	7.5	-53.7	4.4	-41.3	2.6	-40.9	--	--	--	--
5.25 INCH DRIVES											
	Units	14,711.0	-14.9	11,287.0	-23.2	7,760.0	-31.2	4,270.0	-44.9	1,760.0	-58.7
	$M	630.9	-25.1	415.2	-34.1	267.5	-35.5	138.3	-48.2	54.4	-60.6
3.5 INCH DRIVES											
	Units	51,151.7	+22.4	57,279.0	+11.9	62,490.0	+9.0	67,670.0	+8.2	72,680.0	+7.4
	$M	1,913.0	+9.5	1,841.0	-3.7	1,803.1	-2.0	1,720.3	-4.5	1,679.5	-2.3
HIGH CAPACITY DRIVES											
	Units	209.6	+56.3	243.6	+16.2	399.0	+63.7	525.0	+31.5	600.0	+14.2
	$M	80.9	+14.2	75.1	-7.1	88.8	+18.2	93.5	+5.2	86.5	-7.4
TOTAL ALL DRIVES											
	Units	66,098.3	+11.5	68,825.6	+4.1	70,659.0	+2.6	72,465.0	+2.5	75,040.0	+3.5
	$M	2,632.3	-1.6	2,335.7	-11.2	2,162.0	-7.4	1,952.1	-9.7	1,820.4	-6.7

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

Figure 2

CHANGING PRODUCT MIX

Worldwide Flexible Disk Drive Shipments
All Manufacturers

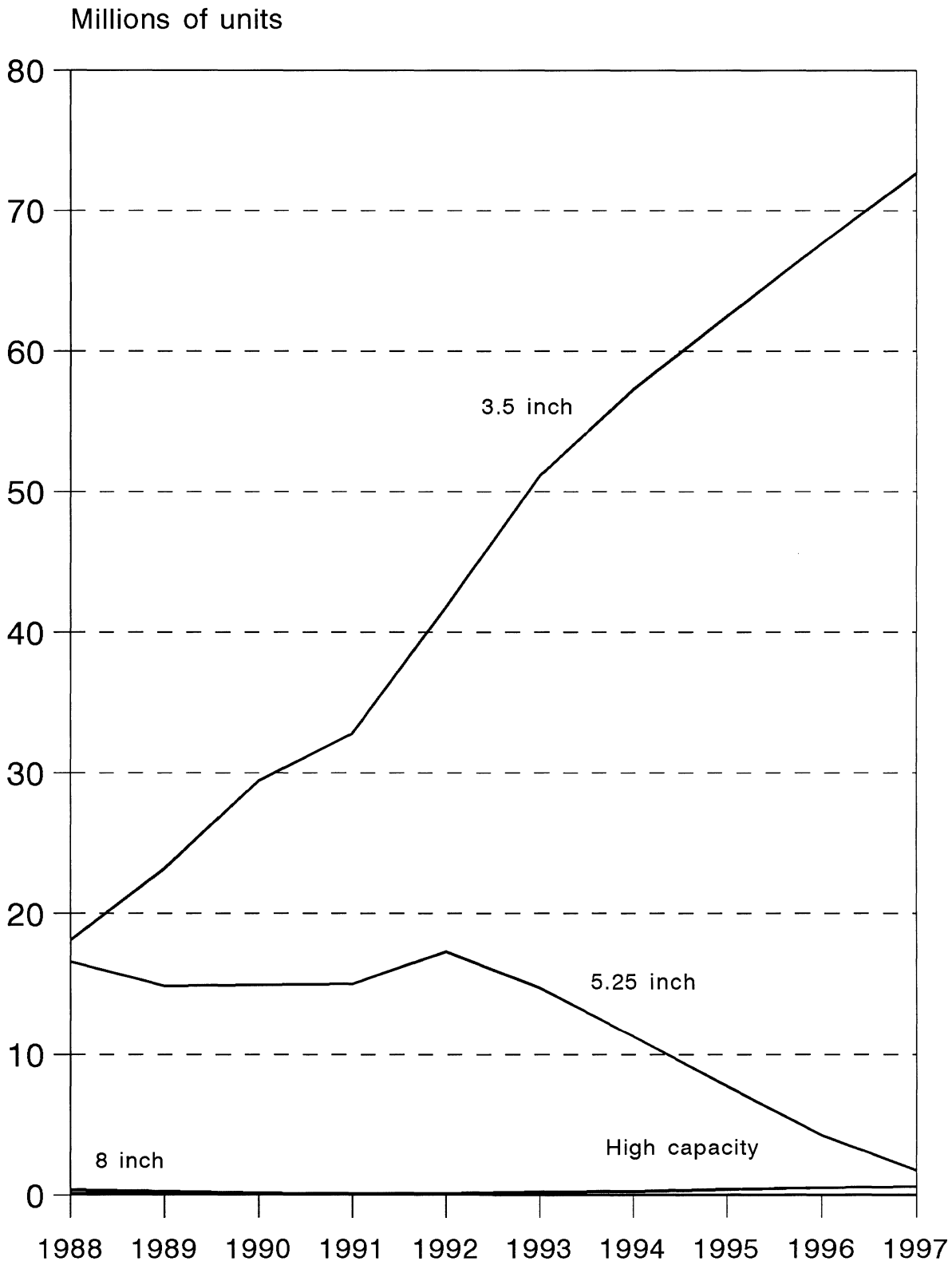


TABLE 4

WORLDWIDE SHIPMENTS

PRODUCT CATEGORY SUMMARY

MANUFACTURERS OF NON-CAPTIVE DRIVES

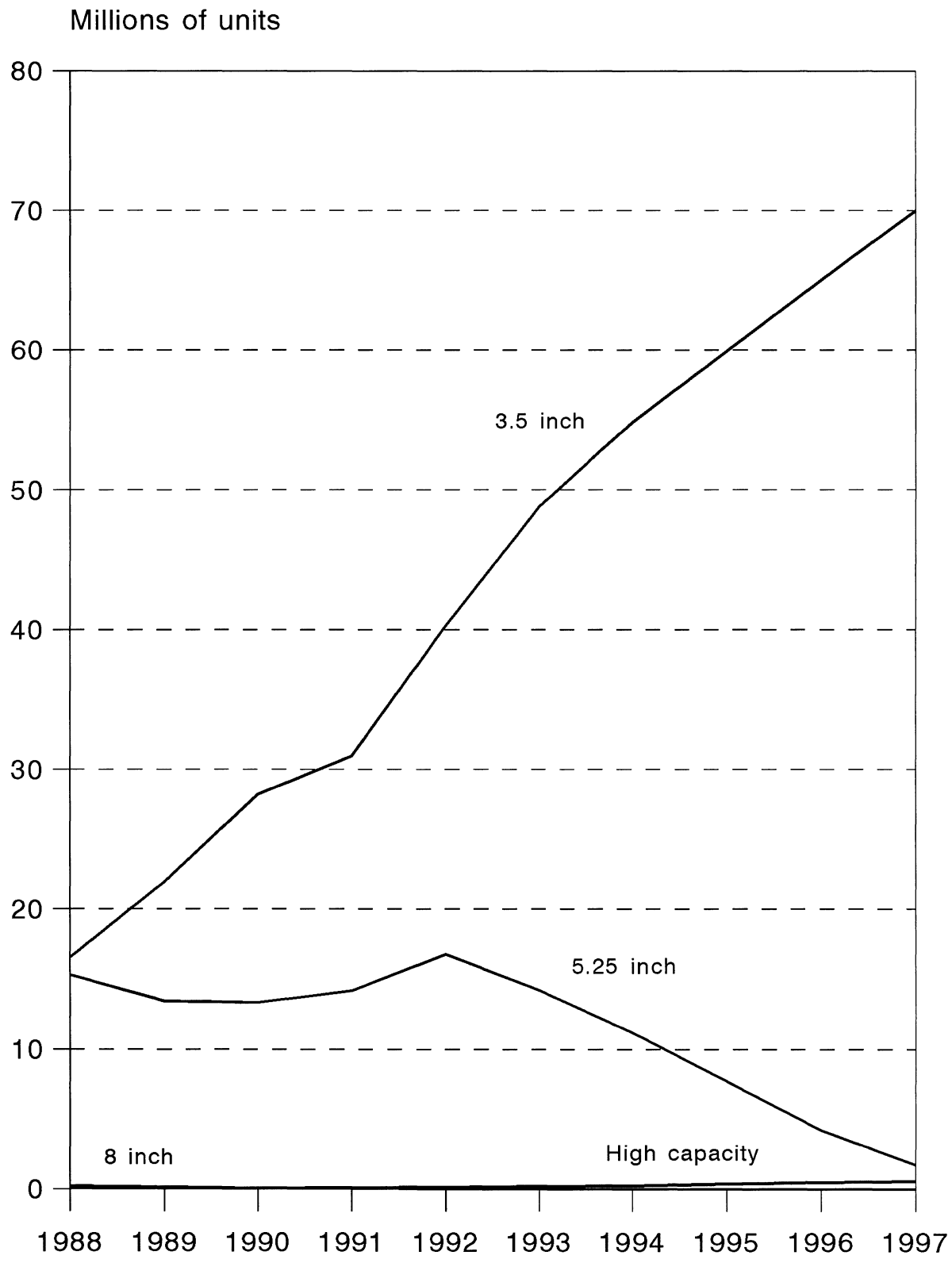
Units: Thousands Dollars: $ Million		1993 Shipments	%	1994 Ship	%	1995 Ship	%	Forecast 1996 Ship	%	1997 Ship	%
8 INCH DRIVES											
	Units	18.0	-47.6	11.0	-38.8	7.0	-36.3	--	--	--	--
	$M	4.1	-51.1	2.4	-41.4	1.5	-37.5	--	--	--	--
5.25 INCH DRIVES											
	Units	14,231.0	-15.2	11,195.0	-21.3	7,715.0	-31.0	4,250.0	-44.9	1,760.0	-58.5
	$M	570.8	-25.5	404.3	-29.1	262.5	-35.0	136.2	-48.1	54.4	-60.0
3.5 INCH DRIVES											
	Units	48,819.7	+21.2	54,827.0	+12.3	59,930.0	+9.3	65,030.0	+8.5	69,990.0	+7.6
	$M	1,659.2	+6.2	1,599.2	-3.6	1,574.3	-1.5	1,508.9	-4.1	1,484.9	-1.5
HIGH CAPACITY DRIVES											
	Units	209.6	+56.4	241.6	+15.2	391.0	+61.8	510.0	+30.4	579.0	+13.5
	$M	80.9	+14.4	74.1	-8.4	84.8	+14.4	86.7	+2.2	78.1	-9.9
TOTAL ALL DRIVES											
	Units	63,278.3	+10.5	66,274.6	+4.7	68,043.0	+2.6	69,790.0	+2.5	72,329.0	+3.6
	$M	2,315.0	-3.8	2,080.0	-10.1	1,923.1	-7.5	1,731.8	-9.9	1,617.4	-6.6

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

Figure 3

CHANGING PRODUCT MIX

Noncaptive Flexible Disk Drive Shipments
All Manufacturers



Application mix

Personal computers have achieved a high penetration of the business market in the industrialized countries and are starting to reach a significant level of usage in consumer markets. Business 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. The business personal computer market consumed 94.3% of all floppy drives shipped in 1993. The portion of floppy drive shipments utilized by business personal computers is expected to decline to 88.8% in 1997, due to an expected higher rate of increase for consumer and hobby computers.

3.5" drives provided 77.4% of all floppy drive shipments in 1993, and they dominated most of the application areas. 48.2 million 3.5" floppy drives were utilized in business personal computer applications in 1993, and the 1997 total is expected to grow to 64.3 million drives. 5.25" drives have also maintained large shipments in business personal computer applications because of the need for media interchange between floppy drive formats. A very high percentage of the 5.25" drives were installed in systems which also use 3.5" drives, to facilitate exchange of diskettes between business users and between home and office computers. However, shipments of 5.25" floppy drives peaked in 1992, and even though 94.5% of 1993's 5.25" drive shipments were used with business personal computers, the 5.25" shipments of 13.9 million drives represented a decline of almost 2 million drives. The number of 5.25" drives used in new business personal computer shipments is expected to drop to 1.7 million in 1997.

The emerging markets for consumer and hobby computers are expected to consume an increasing share of total floppy drive shipments in 1997, growing from 1.5% in 1993 to 8.7% in 1997. Almost all of the 1997 total of 6.6 million drives will be 3.5" models.

The proportion of floppy disk drives used with workstations, both office and nonoffice, continues to slide, as personal computers displace many specialized systems. In 1997 the share of total floppy drive shipments used with workstations is expected to be down to 1.9%. All of the other floppy drive applications are relatively minor, and none is expected to increase its portion of total shipments through 1997.

TABLE 5

FLEXIBLE DISK DRIVE APPLICATIONS SUMMARY

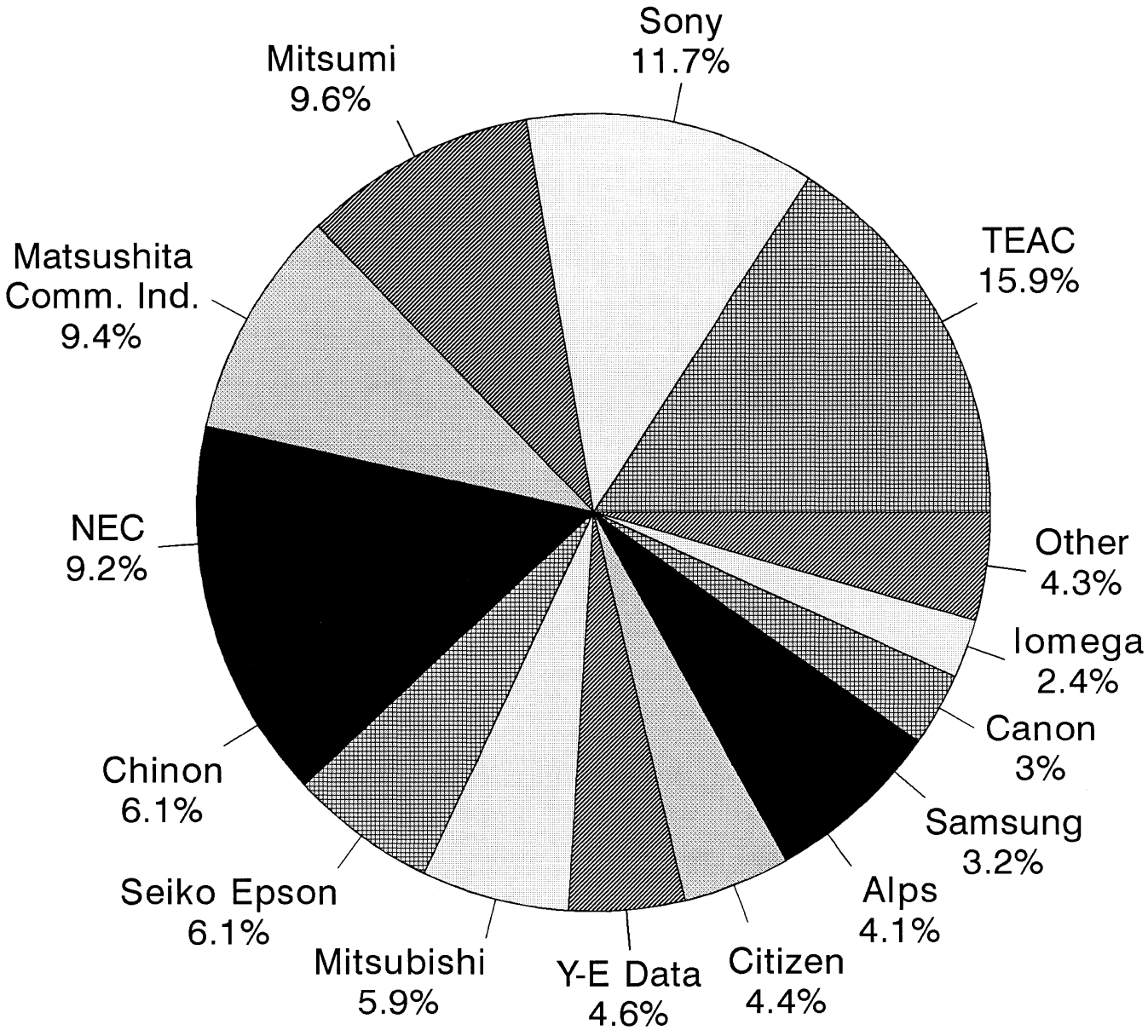
CONSOLIDATED WORLDWIDE SHIPMENTS

	1993 Estimate					1997 Projection				
	All FDD	8" All Types	5.25" All Types	3.5" All Types	High Capacity	All FDD	8" All Types	5.25" All Types	3.5" All Types	High Capacity
VERY HIGH PERFORMANCE Supercomputers and high end imaging										
Units (000)	--	--	--	--	--	--	--	--	--	--
Share %	--	--	--	--	--	--	--	--	--	--
MAINFRAME SYSTEMS General purpose										
Units (000)	14.4	14.4	--	--	--	--	--	--	--	--
Share %	--	55.4%	--	--	--	--	--	--	--	--
NETWORKS/MINI/MULTIUSER Midrange systems and network servers										
Units (000)	461.5	3.4	100.0	358.1	--	294.2	--	3.5	290.7	--
Share %	.7%	13.1%	.7%	.7%	--	.4%	--	.2%	.4%	--
PERSONAL COMPUTERS Business/professional, single user										
Units (000)	62,347.3	5.6	13,903.4	48,236.0	202.3	66,596.0	--	1,707.2	64,321.8	567.0
Share %	94.3%	21.5%	94.5%	94.3%	96.5%	88.8%	--	97.0%	88.5%	94.5%
WORKSTATIONS Engineering/office, single user										
Units (000)	2,105.0	1.6	500.2	1,595.9	7.3	1,445.6	--	31.7	1,380.9	33.0
Share %	3.2%	6.2%	3.4%	3.1%	3.5%	1.9%	--	1.8%	1.9%	5.5%
CONSUMER AND HOBBY COMPUTERS										
Units (000)	974.7	--	207.4	767.3	--	6,553.5	--	12.3	6,541.2	--
Share %	1.5%	--	1.4%	1.5%	--	8.7%	--	.7%	9.0%	--
OTHER APPLICATIONS										
Units (000)	195.4	1.0	--	194.4	--	150.6	--	5.3	145.4	--
Share %	.3%	3.8%	--	.3%	--	.2%	--	.3%	.2%	--
TOTAL, ALL APPLICATIONS										
Units (000)	66,098.3	26.0	14,711.0	51,151.7	209.6	75,040.0	.0	1,760.0	72,680.0	600.0
Share %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	.0%	100.0%	100.0%	100.0%

Figure 4

1993 ESTIMATED MARKET SHARES

Flexible Disk Drive Worldwide Revenue



1993 Revenues: $2,632,300,000

TABLE 6

1993 ESTIMATED MARKET SHARES

WORLDWIDE REVENUES OF ALL FLEXIBLE MAGNETIC DISK DRIVES
(Value of non-U.S. currencies estimated at average 1993 rates)

	CAPTIVE		PCM/RESELLER		OEM/INTEGRATOR		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
Iomega	--	--	61.9	11.9	2.4	.1	64.3	2.4
Other U.S.	--	--	--	--	--	--	--	--
U.S. Total	--	--	61.9	11.9	2.4	.1	64.3	2.4
NON-U.S. MANUFACTURERS								
Alps Electric	--	--	17.0	3.3	91.7	5.1	108.7	4.1
Canon	--	--	--	--	79.7	4.4	79.7	3.0
Chinon	--	--	35.0	6.7	125.0	7.0	160.0	6.1
Citizen	--	--	1.7	.3	114.1	6.4	115.8	4.4
Matsushita Communication Ind.	81.3	25.6	69.9	13.5	96.4	5.4	247.6	9.4
Mitsubishi Electric	3.1	1.0	--	--	152.0	8.5	155.1	5.9
Mitsumi Electric	--	--	20.6	4.0	232.4	12.9	253.0	9.6
NEC	188.2	59.3	--	--	53.8	3.0	242.0	9.2
Samsung Electronics	42.8	13.5	23.5	4.5	19.1	1.1	85.4	3.2
Seiko Epson	--	--	81.2	15.7	79.5	4.4	160.7	6.1
Sony	--	--	33.8	6.5	275.2	15.3	309.0	11.7
TEAC	--	--	79.8	15.4	338.3	18.8	418.1	15.9
Y-E Data	--	--	41.9	8.1	78.7	4.4	120.6	4.6
Other Non-U.S.	1.9	.6	52.3	10.1	58.1	3.2	112.3	4.3
Non-U.S. Total	317.3	100.0	456.7	88.1	1,794.0	99.9	2,568.0	97.6
WORLDWIDE TOTAL	317.3	100.0	518.6	100.0	1,796.4	100.0	2,632.3	100.0

TABLE 7

Codes: C = Captive
P = PCM
O = OEM

CURRENT PRODUCT LINES
MANUFACTURERS OF FLEXIBLE DISK DRIVES

Codes:

Capacity	8"	5.25"	3.5"
<=.5 MB =		.5	.5
.6 MB =	.6		
.7 MB =		.7	.7
1.2 MB =	1.2	1.2	1.2
1.44 MB =			1.4
2.4 MB =		2.4	
2.88 MB =			2.88

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

Formatted capacities shown for all drives

DISK/TREND PRODUCT GROUP:		13	14	15	16
U.S. MANUFACTURERS (2)	TYPE	8 INCH	5.25 INCH	3.5 INCH	HIGH CAPACITY
Iomega	P,O				3:20,5:21/44/90/150/230
Swan Instruments	P,O				3:44/88/170
ASIAN MANUFACTURERS (17)					
Alps Electric	P,O			.7/1.2/1.4/2.88	
Brother	C,O			.5	
Canon	O		.7/1.2	.7/1.2/1.4	
Chinon	P,O		.5/.7/1.2	.5/.7/1.2/1.4/2.88	
Citizen	P,O			.7/1.2/1.4/2.88	
Insite Peripherals	P,O				3:21
Matsushita Communication Indust.	C,P,O		.5/.6/.7/1.2	.7/1.2/1.4/2.88	
Matsushita Electronic Components	O			.7/1.2/1.4	
Mitsubishi Electric	P,O		.7/1.2	.7/1.2/1.4/2.88	
Mitsumi Electric	P,O		.7/1.2	.7/1.2/1.4/2.88	
NEC	C,O	.6/1.2	.7/1.2	.7/1.2/1.4	3:10/21
Safronic	P,O		.5/1.2	.7/1.4	
Samsung Electronics	C,P,O		.7/1.2	.7/1.4	
Seiko Epson	P,O		.7/1.2	.7/1.2/1.4	
Sony	C,P,O			.7/1.2/1.4/2.88	
TEAC	P,O		.5/.7/1.2	.7/1.2/1.4/2.88	
Y-E Data	P,O	.6/1.2	.7/1.2/2.4	.7/1.2/1.4/2.88	

TECHNICAL REVIEW

Competing technologies

With the exception of the high capacity floppy area, 1994 has seen little significant change in floppy drive technology. Notebook computers use large numbers of half inch high 3.5" drives, but one inch high 3.5" drives are still the standard for desktop computers. 2.88 megabyte 3.5" drives, once standard on many PS/2 personal computers, are now only an option on IBM's newer personal computers, and have generated only limited market response outside of IBM. The most interesting developments involve metal powder media, which will be used in new drives capable of storing over 100 megabytes on a 3.5" floppy disk.

While floppy drive development has slowed, other technologies attempting to compete with floppy drives as a universal distribution medium remain too costly, too slow, or are not standardized for universal data interchange. Flexible disk drives have succeeded because they offer low cost, recordability, random access, interchange standards and media removability. The CD-ROM drives now growing in usage for software distribution are limited to the distribution role, due to the lack of recording capability. A critical problem for competitors is that any alternate technology must offer significant improvements at a competitive price, and the OEM price for 3.5" floppy drives is under $25 for large quantities.

Ever-smaller form factors, higher capacities, more effective designs and lower cost manufacturing methods have sustained 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 handheld computers where there is insufficient space or power for floppy drives.

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, interchange with other users, 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" 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. However, with 3.5" floppy drives now almost universally available on systems, the need for 5.25" inch drives is declining.

Today's rigid disk challenge to flexible disk drives is most effectively presented by both disk cartridge drives and 1.8" removable fixed disk drives in PCMCIA format. Most PCMCIA drives are packaged in the 10.5 millimeter high Type III PCMCIA form factor, but 5 millimeter high Type II drives have been announced, with availability in 1995. PCMCIA Type III drives with capacities of several hundred megabytes are available. While fast and convenient, PCMCIA drives are expensive removable units compared to floppy disk media, and a factor only in competition against high capacity floppy drives in some applications.

Small disk cartridge drives, some with capacities as high as 270 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 standard low end flexible drives. 5.25" removable cartridge drives have not been able to compete in package size with low profile floppy drives, although SyQuest's 3.5" and 1.8" cartridge drives are more competitive in this respect, and the OEM price of the 1.8" SyQuest drive competes well against that of high capacity floppy drives. Specialized floppy drives, such as the Iomega Bernoulli disk drives, now with capacities up to 230 megabytes, provide competition for rigid disk drives, supplying performance, removability and high capacity.

* Semiconductor memory: 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 flash memory and about two dollars per megabyte for SRAMs. By comparison, standard low end floppy disk media is expected to cost about twenty 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.

  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 1995.

Flash memory, a form of electrically alterable nonvolatile memory, is a possible alternative to floppy disk drives in cases where high performance, low power drain, or resistance to shock and vibration is more important than low cost. As of mid-1994, flash memory OEM prices are being quoted in the range of $25 to $50 per megabyte, and are projected by semiconductor manufacturers to decrease to the $10 per megabyte range by the end of 1995. 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 multilevel cell (MLC) technology (storing multiple bits per memory cell) announced recently by Intel may boost the future ability of flash memory to compete, if MLC can actually be produced in volume at the anticipated costs.

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 PCMCIA card. Card capacity now ranges from 0.25 to 40 megabytes, and 80 megabyte cards have been announced. 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 300 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. Operation on a single 5 volt power supply is highly desirable, and operation from a 3 volt supply is increasingly important for low power systems with limited battery life. All flash memory is subject to a lifetime limitation ranging from 10,000 to 1,000,000 write/erase cycles per memory cell, 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 has limited markets to niche applications.

  3.5" erasable optical drives, now with a maximum of 230 megabytes per disk cartridge, offer capacities substantially above the ranges likely to be reached by flexible disk drives, so there will be little reason for direct competition. A new generation of 3.5" optical drives expected to be announced in 1995 will have capacities exceeding 600 megabytes. Due to optical disk drive complexity and the thickness of optical disk cartridges, optical drives will have great difficulty in matching the 1/2 inch high floppy drive form factor, although one inch high optical drives are in production.

  Capacity of 5.25" drives is now approaching 1.3 gigabytes per disk side, while 12" drives offer up to 5 gigabytes per side. The drives are used in optical library based storage systems accessing large numbers of optical disks under system control, and are not competitors to floppy disk drives. However, a 12 centimeter (4.72") rewritable phase change drive introduced by Matsushita in late 1994 has prospects for adoption by OEMs and may compete against high capacity flexible disk drives as a combination CD-ROM and rewritable disk device.

  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. For example, the prices of 3.5" M-O drives are still above $500 at the OEM level. However, competition between sub-3.5" optical drives, 4.72" phase change drives and very high-end floppy drives may eventually occur. Sony's audio 2.5" M-O drive has appeared as the MD-DATA drive, in the form of a 140 megabyte computer peripheral. Sony plans a competitive price obtained by leveraging from the anticipated large production volume of audio products.

  Small optical disk drive prices may someday approach high capacity floppy drive prices, as floppy drive capacity increases above 20 mega-

bytes, 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 more powerful personal computers and network servers.

* 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, although a new generation anticipated to be in production in the 1996-1997 time frame is expected to offer over 3 gigabytes of capacity. CD-ROM technology borrows heavily from the designs of the 12 centimeter CD audio players now in volume production, resulting in relatively low CD-ROM drive manufacturing costs (OEM prices are approaching $80), and only moderate 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. 8 centimeter CD-ROM drives were introduced by Sony in 1990, but have not been widely accepted.

  Read-only optical drives are essentially part of a data distribution system and are being used with small systems to provide personal access to large amounts of information and for software distribution. They are expected to have no impact on the floppy drive's role in providing backup and interchange capabilities for small systems but will have a noticeable impact on the use of diskettes for distribution of software for personal computers and other small systems. Even though CD-ROM drives now appear in large numbers as system peripheral devices, floppy disk drives continue to be required for distribution of the majority of purchased software. However, software products requiring 20 megabytes or more will be increasingly distributed on CD-ROM as the population of CD-ROM drives grows, because replication costs for CD-ROM of less than one dollar compare well with floppy media and duplication costs where multiple disks are required.

* Tape drives: 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.

  Rigid disk drive capacities used with typical desktop personal computer systems are now above 200 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 in which the typical file is also small,

such as with word processing systems and home computers. But if files are typically large, if a data base 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. The 20 megabyte 3.5" high floppies developed by Insite Peripherals, NEC and others have so far been able to develop only niche markets because of costs several times higher than standard floppy drives. Due to the completely different capacity ranges offered by floppy drives and tape drives, the two types of recording devices are normally used for completely different applications.

* Data communications: The growing shipments of notebook computers have created a new challenge for floppy drives. Many drive manufacturers, starting with TEAC, now offer 3.5" floppy drives only 12.7 millimeters high, with growing sales in the notebook computer market, but the continuing movement to even smaller portable systems is prompting many notebook computer manufacturers to eliminate floppy drives completely in order to conserve space and weight. It is not yet clear how many users of the new "subnotebook" computers, typically less than four pounds, will insist on having the convenience of a floppy drive for interchange with other personal computers, or will be willing to forego having a floppy or PCMCIA storage device, and use other methods of transferring files such as networks, direct cable connection to desktop PCs, infrared communications and wireless links.

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" drive, leadership shifted to Shugart Associates and its successors in the 5.25" segment of the market. By the late 1970s, Shugart Associates had shrunk IBM's original technology down to the 5.25" format, executing one of the most influential repackaging jobs of all time. However, the computer industry wanted still smaller floppy drives for the emerging personal computer market, and several drives in the 3 to 4 inch range appeared in the early 1980s. After a few years of jockeying for position, the Sony 3.5" format achieved a consensus, and by 1989 industry shipments of 3.5" drives exceeded 5.25" 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" drive, the Sony 3.5" 1.44 megabyte microfloppy, and, most recently, the 2.88 megabyte 3.5" 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" and the 3.5" (including the 1.44 megabyte version) formats through product introductions. The 2.88 megabyte version first appeared in an IBM system in 1991 and while standard in numerous IBM PS/2 system models, its status has been lowered to that of an option on IBM's PC series introduced in 1994, and has not won wide acceptance from other manufacturers.

The thrust of floppy drive innovation has currently shifted to two areas: Decreasing height and increasing capacity. The vertical form factor for many 3.5" drives has decreased to 12.7 millimeters, with models from Citizen down to 11 millimeters, spurred by the requirements of notebook computer manufacturers. 3.5" drives with capacities over 20 megabytes are available and are currently being used with both personal computers and workstations. A second generation "floptical" device with 100 megabytes capacity is a future possibility. Swan Instruments has discussed a 3.5" flexible disk drive with one fixed and one removable disk, both flexible. In the Swan drive design, a fixed flexible disk contains 170 megabytes, and the removable disk has up to 88 megabytes.

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 beyond 100 megabytes.

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

* Form factor: The 1/2 inch high 3.5" floppy drives now in production permit designers of notebook computers to reduce weight and system package size, and to match the heights of new 2.5" and 1.8" rigid disk drives. The 1/2 inch high profile floppy drives will be widely used in notebook computers and have also found usage in subsystems which combine a 3.5" drive with a 5.25" drive in a single unit designed to be used in a 1.625" high slot in desktop systems.

  Drives ranging from 15 to 19 millimeter height are currently offered as "3/4 inch" drives. After initial enthusiasm, the computer industry's reaction to 3/4 inch floppy drives cooled off, with recent growth in shipments going to one inch high drives -- or to 1/2 inch high drives when necessary due to packaging requirements. It currently appears that one inch high drives will remain the desktop computer standard.

* 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" drives, 96 TPI with 5.25" drives, and 135 TPI with 3.5" 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" and early 5.25" diskettes, while 600 Oersted cobalt modified oxide coatings are currently in use on most high density 5.25" and microfloppy diskettes. Cobalt modified oxide coatings typically achieve 8,000 to 10,000 FCI for 5.25" drives and 17,434 FCI for the 1.44 megabyte 3.5" drives in common use.

The 20 megabyte drives now available employ higher performance coatings using barium ferrite and metal powder. The 2.88 megabyte 3.5" floppy drive introduced by Toshiba and others records at 34,868 FCI and NEC's 21.4 megabyte drive records at 52,539 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 at least 100 megabytes per diskette. Japanese producers tend to favor metal powder coatings because of their inherently higher performance, previous experience with metal powder in entertainment products, and a strong industry position in metal powder media. Fuji Photo Film has announced a 3.5" metal powder diskette capable of storing over 100 megabytes. A 100 megabyte 3.5" drive is planned for delivery in early 1995 by Iomega.

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 was intended that drives would have downward read/write compatibility with .7 and 1.44 megabyte drives. This tentative standard was held up in procedural steps until the participating manufacturers were satisfied of the existence of a market of adequate size, but it now appears that few of the participating companies will introduce drives at the 20 megabyte level.

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 to over 50,000 FCI now and can be extended further. 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.

* Perpendicular recording: Perpendicular recording offers great potential for increased recording densities on flexible disk drives. The very high data transfer rates which result from perpendicular recording with rigid disk drives -- faster than most channels and controllers are now ready to handle -- has inhibited usage of perpendicular recording with rigid disk drives. However, the contact recording 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 many of the small Winchester disk drives now in wide use.

  Toshiba pioneered perpendicular recording for floppy drives with the development of barium ferrite recording technology, and after several years of tentative market exploration introduced a 2.88 megabyte drive in 1988. Toshiba's design maintained the industry standard open loop 135 TPI density, and the program was joined by numerous other floppy drive

and media producers. All of these 2.88 megabyte drives claim full interchange compatibility with .7 and 1.44 megabyte media.

* 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" 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 for several years 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 2,353 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 unsuccessful 3.5" drive used preformatted disks and offered a formatted capacity of 21.4 megabytes and 35 millisecond average head positioning time. A track density of 777 TPI was used. Insite Peripherals and Iomega achieved a track density of 1,245 TPI on their "floptical" drives using optical tracking of a servo pattern imprinted on the disk surface by a laser or impressed in a special fixture.

* 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" 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 use multigap heads to achieve downward compatibility. The newer 20 megabyte drives currently offer compatibility with .7 and 1.44 megabyte 3.5" 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's drive wrote a servo track on the media at a frequency much lower than the data recording frequency, then used 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" drives were announced by two firms, but acceptance was limited and the products were commercial failures. Matsushita Communication Industrial's design approach mapped a standard 3.5" 1 megabyte drive format onto 2" media and won a major OEM contract for a notebook computer, but the unconventional, noninterchangeable media failed to win broad acceptance.

  Sony produced drives and media based upon a video drive used in the Mavica camera. While the Sony specifications were 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 impeded acceptance. Lack of media interchange capability with 3.5" floppy drives, now the dominant standard for office computers, also restrained the industry's enthusiasm.

  While no 2.5" drives have yet appeared, the success of the rigid disk drive 2.5" and smaller formats may 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 and the need for higher capacities is suppressing the appearance of smaller diameter flexible disk drives.

* 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 1,7 RLL code (Insite Peripherals) and 1,8 RLL code (Iomega Bernoulli drives). As flexible disk drive capacities climb, their internal electronic capabilities will increasingly resemble those of rigid disk drives -- with the appropriate design and manufacturing cost consequences.

  Error correction appears 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 Seiko Epson 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 by any disk drive manufacturer, except sales 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 Citizen 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:

* Iomega is considered a U.S. manufacturer, even though some of its disk drives may be 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 1994 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:

Very high performance systems: Disk drives attached directly to the processor or to a terminal associated with a supercomputer or a high end imaging system.

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

Networks/mini/multiuser computers: Drives attached to network file servers, minicomputers, video-on-demand servers and other midrange multiuser systems. Examples: IBM System AS/400, Hewlett-Packard 3000, Compaq Systempro, Data General CLARiiON series.

Personal computers: Drives used with a desktop or portable personal computer intended primarily for nonconsumer applications. Examples: IBM PC series, Apple Macintosh, Compaq DeskPro, Toshiba Satellite series.

Workstations: Attached to single user high end workstations used for engineering, graphics, order processing/shipping, document storage and imaging, point-of-sale, medical, CAM/CAD/CAE, law enforcement, factory production control, military, and other applications.

Consumer and hobby computers: Used in general purpose or dedicated applications systems sold primarily to consumers for nonbusiness purposes. Examples: All computers intended for home use and all computer games. Multimedia systems for home use, such as the Tandy Sensation, are also included in this category.

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

FLEXIBLE DISK DRIVES, 8 INCH

1994 DISK/TREND REPORT

FLEXIBLE DISK DRIVES, 8 INCH

Coverage

Examples of flexible disk drives in this group include:

NEC	FD 1165
Y-E Data	YD-180

The first flexible disk drives were all 8" 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" models, the number of remaining manufacturers has shrunk to the short list above.

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

Market status

During the last decade, there has been an unending decline in shipments of 8" floppy drives. Worldwide shipments for 8" one sided drives peaked in 1981, at 746,600 units, and two sided drives peaked two years later, with 1,275,900 units. 1993 shipments were only half of the previous year total, at 26,000 drives, and the total for 1994 is expected to drop to 16,000 units.

During the 1970's, 8" floppy drives filled a growing need in the computer industry for a low cost removable data storage medium with random access capability. After the current media interchange standard became established, with the 1973 introduction of IBM's 3740 data entry system, the floppy drive market increased rapidly.

Floppy drives have been used in many applications, but the early stimulus for 8" floppy drive sales came from mushrooming demand for small business systems and dedicated word processing systems, followed by personal computers at the end of the 1970s. The advent of the personal computer, however, was actually the event which doomed the 8" floppy drive. Responding to requests for a physically smaller floppy drive to be used with desktop personal computers,

Shugart Associates introduced the 5.25" floppy drive in 1976, and the 8" floppy drive soon became a rarity in the emerging personal computer market.

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

Y-E Data has dominated noncaptive shipments in this product group during recent years, and held 94.4% of the 1993 total.

Marketing trends

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" formats, offering capacities equaling those of 8" drives at much lower prices, (2) Reliability problems most manufacturers experienced with 8", two sided drives in the late 1970s, which kept many OEMs from committing to the format, and (3) Lack of further development of the 8" drive format by IBM, which inhibited manufacturers of OEM drives from investing in higher density versions.

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 now expected in 1995.

In Japan's domestic market, demand for 8" 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"

floppy drive developed under the sponsorship of Nippon Telephone & Telegraph made it possible to do so. The subsequent availability of 3.5" drives in this capacity range have intensified the problem for 8" 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" floppy 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" floppy drives until the end of the 1970s, 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. System manufacturers will continue to move to smaller drives, causing a continuing reduction in worldwide shipments of 8" drives, with the last shipments in 1995.

TABLE 8

FLEXIBLE DISK DRIVES, 8 INCH

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1993 Revenues		Forecast 1994		1995		1996		1997	
	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	--	3.4	--	2.0	--	1.1	--	--	--	--
PCM/Reseller	--	.2	--	.2	--	.2	--	--	--	--
OEM/Integrator	1.1	3.9	.9	2.2	.4	1.3	--	--	--	--
TOTAL NON-U.S. REVENUES	1.1	7.5	.9	4.4	.4	2.6	--	--	--	--
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1.1	7.5	.9	4.4	.4	2.6	--	--	--	--
OEM Average Price ($000)		.229		.220		.216		--		--

TABLE 9

FLEXIBLE DISK DRIVES, 8 INCH

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1993 Shipments		Forecast 1994		1995		1996		1997	
	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	--	8.0	--	5.0	--	3.0	--	--	--	--
PCM/Reseller	--	1.0	--	1.0	--	1.0	--	--	--	--
OEM/Integrator	5.0	17.0	4.0	10.0	2.0	6.0	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	5.0	26.0	4.0	16.0	2.0	10.0	--	--	--	--
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	5.0	26.0	4.0	16.0	2.0	10.0	--	--	--	--
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	10.4	4.1	10.4	4.1	10.4	4.1	10.4	4.1	10.4
WORLDWIDE TOTAL	5.3	12.2	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

	1993		Forecast							
	--Shipments--		-----1994----		-----1995----		-----1996----		-----1997----	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	--		--		--		--		--	
Non-Captive Total	--		--		--		--		--	
Total U.S.	--		--		--		--		--	
NON-U.S. MANUFACTURERS										
Captive Total	8.0		5.0		3.0		--		--	
Half High	8.0	100.0%	5.0	100.0%	3.0	100.0%	--	--	--	--
Non-Captive Total	18.0		11.0		7.0		--		--	
Half High	18.0	100.0%	11.0	100.0%	7.0	100.0%	--	--	--	--
Total Non-U.S.	26.0		16.0		10.0		--		--	
Half High	26.0	100.0%	16.0	100.0%	10.0	100.0%	--	--	--	--
WORLDWIDE RECAP										
Total Worldwide Shipments	26.0		16.0		10.0		--		--	
	-49.6%		-38.4%		-37.5%		--		--	
Half High	26.0	100.0%	16.0	100.0%	10.0	100.0%	--	--	--	--
	-49.6%		-38.4%		-37.5%		--		--	

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	1993 Estimate Units (000)	1993 Estimate %	1997 Projection Units (000)	1997 Projection %
VERY HIGH PERFORMANCE				
Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS				
General purpose	14.4	55.4	--	--
NETWORKS/MINI/MULTIUSER				
Midrange systems and network servers	3.4	13.1	--	--
PERSONAL COMPUTERS				
Business and professional, single user	5.6	21.5	--	--
WORKSTATIONS				
Engineering and office, single user	1.6	6.2	--	--
CONSUMER, GAME AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	1.0	3.8	--	--
Total	26.0	100.0	--	--

TABLE 12

FLEXIBLE DISK DRIVES, 8 INCH

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1993 Net Shipments			
	To United States Destinations		Worldwide	
Drive Manufacturers	Units (000)	%	Units (000)	%
Y-E Data	5.0	100.0	17.0	94.4
Other U.S.	--	--	--	--
Other Non-U.S.	--	--	1.0	5.6
TOTAL	5.0	100.0	18.0	100.0

FLEXIBLE DISK DRIVES, 5.25 INCH

1994 DISK/TREND REPORT

FLEXIBLE DISK DRIVES, 5.25 INCH

Coverage

Examples of flexible disk drives in this group include:

Two sides: 48 tracks per inch, .360 megabyte

Chinon	FZ-502
TEAC	FD-55BR

Two sides: 96 tracks per inch, .7 megabyte

TEAC	FD-55FR

Two sides: 96 tracks per inch, 1.2 megabytes

Canon	MD-5501
Chinon	FR-506
Matsushita Communication Ind.	JU-475
Mitsubishi Electric	MF504C
Mitsumi Electric	D 509V3
NEC	FD 1157D, FD 1158C*
Safronic	DS-53AC
Samsung Electronics	SFD-560D
Seiko Epson	SD-680L, SD-780*
TEAC	FD-55GFR, FD-155GF*
Y-E Data	YD-380B

Two sides: 96 tracks per inch, 2.4 megabytes

Y-E Data	YD-801

*1 inch high

The basic standards for physical size and recording format for this product group were created by the 1976 introduction by Shugart Associates of the SA 400, the original minifloppy. Early growth in small microcomputer systems inspired several innovative one sided 5.25" drives, some of which achieved success until the industry's movement to two sided versions.

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

Two sided 5.25" 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" 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" format, which now accounts for most of the industry's shipments of 5.25" floppy drives.

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" microfloppies, and Y-E Data's drive is the only 5.25" floppy drive with a capacity of more than 1.2 megabytes still in production.

Market status

After an extended ten year period of peak shipments, it finally seems certain that the overall shipment level of 5.25" floppy drives has entered a period of continuing decline. The need of many businesses to interchange data between various generations of personal computers kept the 5.25" floppy at a high production level for a longer period than anyone expected, but the continuous evolution of PC software and processors has accelerated the movement to new systems, all of which use 3.5" floppy drives, making 5.25" floppies unnecessary at a growing number of user sites.

1992 was the peak shipment year for 5.25" floppy drives, with 17.3 million units, driven by the personal computer industry's strong shipments. The downward slope started in 1993, with a decline of 14.9%, to 14.7 million drives. The DISK/TREND forecast for 1994 is 11.3 million drives, down 23.3%, resulting in the lowest level of 5.25" floppy drive shipments since 1983. Sales revenues are declining even faster, as price levels continue to erode. 1992 worldwide reve-

nues were $843 million, but the estimate for 1994 is less than half that amount, $415.2 million.

The 1.2 megabyte two sided 5.25" floppy drives which now dominate shipments in this product group were used with IBM's PC AT personal computers, which were introduced in 1984, and with the clones offered by numerous manufacturers. In 1987 IBM moved on to the PS/2 personal computer family, using 3.5" microfloppies. But despite abandonment by IBM, the PC AT standard continued its momentum and contributed to continuing sales of 1.2 megabyte two sided 5.25" drives with numerous AT clones, especially in the United States. 5.25" floppy drives with capacities below 1.2 megabytes are expected to be out of production after 1994.

Underlying the remaining momentum of 5.25" drive shipments is the desire by many buyers of new personal computer models to maintain the ability to interchange diskettes with older PCs. This demand has caused a high proportion of new PC models to be shipped with both 5.25" and 3.5" floppy drives. However, with the growing dominance of Microsoft's Windows and related applications programs, increasing quantities of the older PC AT systems are being retired, since they lack the main memory or hard disk capacity required for the newer software. Since the retired PCs generally utilized 5.25" floppy drives, and the replacement PCs have 3.5" floppy drives, the requirement that PCs for business applications have 5.25" floppy drives for interchange purposes has diminished.

The drop in 5.25" floppy drive shipments would probably be even greater except for the impact in recent years of the 5.25"/3.5" combination drive packaging. This packaging technique provides both 5.25" and 3.5" floppy formats in a single unit which maintains the standard "half high" package height of 41.3 millimeters. Early producers of combination drives were TEAC, Seiko Epson and Canon, using various combinations of 1/3 high and one inch high 5.25" drives, packaged with 1/2 inch or other thin 3.5" drives. The combination drives can reduce installation costs for system manufacturers and conserve space needed for other peripherals, such as CD-ROM drives. However, the price for a combination drive assembly is approximately twice the cost of a single drive. Therefore, while continuing shipments of combination drives are expected, shipments for the entire product group will decline.

Personal computer applications dominate the usage of 5.25" floppy drives, with 94.5% of 1993's shipments, with minor usage attributed to consumer and hobby computers, workstations and networks/minicomputer/multiuser systems. As 5.25" floppy drive unit shipments decline during the next few years, the percentage destined for personal computer applications is expected to increase slightly, to 97.0%.

TEAC has held the leadership in noncaptive shipments of 5.25" floppy drives since 1989, and the company's dominance continued in 1993. TEAC's share increased to 32.3% of the worldwide 1993 total, representing 4.6 million drives. Mitsumi Electric remained in second position with 13.7%, and Chinon advanced to third with 12.5%.

Marketing trends

The expected declines in shipments and sales revenues for this product group are now well under way, and the decline in both measurements is forecasted to accelerate. The most significant negative factors for 5.25" floppy drive shipments will be the preference for 3.5" floppies by most personal computer 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" drives. As more users reach the stage when all of the PCs in their companies are able to utilize 3.5" diskettes, fewer will feel the need to buy new PCs which also contain a 5.25" floppy drive.

The movement to more versatile software will continue to force the retirement of older personal computers using 5.25" floppy drives, and the shipment of new 5.25" drives is now expected to drop rapidly. DISK/TREND forecasts predict worldwide shipments of only 1.7 million drives in 1997, representing an average annual decline of 44.9% in the 1995-97 period. 1997 worldwide sales revenues for the product group are forecasted at $54.4 million, less than one tenth of the 1993 total.

Technical trends

It is considered unlikely that drive manufacturers will devote their resources to further product development for 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" high 1.6 megabyte 5.25" drive. Three companies had previously introduced "one third high" 5.25" drives in the early 1980s, but the demand at that time was limited and all but one of those models eventually disappeared from the market.

However, the TEAC 1" high drive has found a more interesting reception, since the firm is offering it in a combination unit with a .5" high 3.5" drive. TEAC's 5.25"/3.5" combination can be mounted in a personal computer's half high 5.25" slot, providing a significant improvement in interchange flexibility for AT clones. Other floppy drive manufacturers have copied the idea, and combination 5.25"/3.5" units are available from multiple sources.

It now appears that drive manufacturers will devote no further effort to development of capacity increases for 5.25" floppy drives. After several programs during the 1980s using embedded servo techniques, the only remaining higher capacity 5.25" 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 1.2 megabyte diskettes, although a special diskette is required for usage at 2.4 megabytes.

Forecasting assumptions

1. The existing momentum of the PC AT format will decline rapidly, but the large installed base of PC AT and compatible systems will provide a declining residual market for 1.2 megabyte 5.25" 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, utilizing offshore production.

TABLE 13

FLEXIBLE DISK DRIVES, 5.25 INCH

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1993 Revenues		Forecast 1994		1995		1996		1997	
	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	3.8	60.1	2.4	10.9	1.1	5.0	.5	2.1	--	--
PCM/Reseller	100.2	148.9	79.8	110.0	56.3	75.8	31.7	41.6	14.3	18.5
OEM/Integrator	245.4	421.9	171.5	294.3	109.7	186.7	55.3	94.6	21.1	35.9
TOTAL NON-U.S. REVENUES	349.4	630.9	253.7	415.2	167.1	267.5	87.5	138.3	35.4	54.4
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	349.4	630.9	253.7	415.2	167.1	267.5	87.5	138.3	35.4	54.4
OEM Average Price ($000)		.040		.036		.034		.032		.030

TABLE 14

FLEXIBLE DISK DRIVES, 5.25 INCH

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1993		Forecast							
	Shipments		1994		1995		1996		1997	
	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	30.0	480.0	20.0	92.0	10.0	45.0	5.0	20.0	--	--
PCM/Reseller	2,508.0	3,746.0	2,210.0	3,050.0	1,655.0	2,230.0	990.0	1,300.0	460.0	595.0
OEM/Integrator	6,056.0	10,485.0	4,740.0	8,145.0	3,220.0	5,485.0	1,725.0	2,950.0	685.0	1,165.0
TOTAL NON-U.S. SHIPMENTS	8,594.0	14,711.0	6,970.0	11,287.0	4,885.0	7,760.0	2,720.0	4,270.0	1,145.0	1,760.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	8,594.0	14,711.0	6,970.0	11,287.0	4,885.0	7,760.0	2,720.0	4,270.0	1,145.0	1,760.0
Cumulative Shipments (Units in millions)										
IBM	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
Non-IBM	84.6	171.8	91.6	183.1	96.5	190.9	99.2	195.1	100.3	196.9
WORLDWIDE TOTAL	85.1	172.3	92.0	183.6	96.9	191.3	99.6	195.6	100.8	197.4

TABLE 15

FLEXIBLE DISK DRIVES, 5.25 INCH

WORLDWIDE SHIPMENTS (000)

TRACK DENSITY ANALYSIS

	1993 --Shipments--		Forecast 1994		1995		1996		1997	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	--		--		--		--		--	
Non-Captive Total	--		--		--		--		--	
Total U.S.	--		--		--		--		--	
NON-U.S. MANUFACTURERS										
Captive Total	480.0		92.0		45.0		20.0		--	
96 TPI 1.2 MB	480.0	100.0%	92.0	100.0%	45.0	100.0%	20.0	100.0%	--	--
Non-Captive Total	14,231.0		11,195.0		7,715.0		4,250.0		1,760.0	
48 TPI	178.0	1.3%	50.0	.4%	--	--	--	--	--	--
96 TPI .7 MB	5.0	--	--	--	--	--	--	--	--	--
96 TPI 1.2 MB	14,048.0	98.7%	11,145.0	99.6%	7,715.0	100.0%	4,250.0	100.0%	1,760.0	100.0%
Total Non-U.S.	14,711.0		11,287.0		7,760.0		4,270.0		1,760.0	
48 TPI	178.0	1.2%	50.0	.4%	--	--	--	--	--	--
96 TPI .7 MB	5.0	--	--	--	--	--	--	--	--	--
96 TPI 1.2 MB	14,528.0	98.8%	11,237.0	99.6%	7,760.0	100.0%	4,270.0	100.0%	1,760.0	100.0%
WORLDWIDE RECAP										
Total Worldwide Shipments	14,711.0		11,287.0		7,760.0		4,270.0		1,760.0	
	-14.9%		-23.2%		-31.2%		-44.9%		-58.7%	
48 TPI	178.0	1.2%	50.0	.4%	--	--	--	--	--	--
	-58.6%		-71.9%		--		--		--	
96 TPI .7 MB	5.0	--	--	--	--	--	--	--	--	--
	-85.7%		--		--		--		--	
96 TPI 1.2 MB	14,528.0	98.8%	11,237.0	99.6%	7,760.0	100.0%	4,270.0	100.0%	1,760.0	100.0%
	-13.6%		-22.6%		-30.9%		-44.9%		-58.7%	

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	1993 Estimate Units (000)	1993 Estimate %	1997 Projection Units (000)	1997 Projection %
VERY HIGH PERFORMANCE				
Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS				
General purpose	--	--	--	--
NETWORKS/MINI/MULTIUSER				
Midrange systems and network servers	100.0	.7	3.5	.2
PERSONAL COMPUTERS				
Business and professional, single user	13,903.4	94.5	1,707.2	97.0
WORKSTATIONS				
Engineering and office, single user	500.2	3.4	31.7	1.8
CONSUMER, GAME AND HOBBY COMPUTERS	207.4	1.4	12.3	.7
OTHER APPLICATIONS	--	--	5.3	.3
Total	14,711.0	100.0	1,760.0	100.0

TABLE 17

FLEXIBLE DISK DRIVES, 5.25 INCH

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1993 Net Shipments			
	To United States Destinations		Worldwide	
Drive Manufacturers	Units (000)	%	Units (000)	%
TEAC	2,502.0	29.2	4,599.0	32.3
Mitsumi Electric	1,415.0	16.5	1,950.0	13.7
Chinon	1,165.0	13.6	1,773.0	12.5
Matsushita Communication Ind.	460.0	5.4	1,443.0	10.1
Seiko Epson	705.0	8.2	990.0	7.0
Canon	775.0	9.0	955.0	6.7
Mitsubishi Electric	437.0	5.1	601.0	4.2
Y-E Data	349.0	4.1	559.0	3.9
Other U.S.	--	--	--	--
Other Non-U.S.	756.0	8.9	1,361.0	9.6
TOTAL	8,564.0	100.0	14,231.0	100.0

FLEXIBLE DISK DRIVES, 3.5 INCH

1994 DISK/TREND REPORT

FLEXIBLE DISK DRIVES, 3.5 INCH

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

Chinon	F-354
Citizen	OSDC, W1DC*
Matsushita Electronic Comp.	EME-213
Mitsumi Electric	D357T3
TEAC	FD-235F

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

Alps Electric	DFR 643, DF323H*
Canon	MD 3511, MD 3551
Citizen	OSDB, W1DB*
Matsushita Electronic Comp.	EME-262
Mitsubishi Electric	MF354F
Mitsumi Electric	D 358P3, D358F2*
NEC	FD 1137C
TEAC	FD-235GF, FD-05GFL*
Y-E Data	YD-686C

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

Alps Electric	DFR 723, DF 324H*
Canon	MD 3651, MD 3641
Chinon	FZ-357, FP-357*
Citizen	OSDA, W1DA*
Matsushita Communication Ind.	JU-257A, JU-227A*
Matsushita Electronic Comp.	EME-278
Mitsubishi Electric	MF355F
Mitsumi Electric	D 359P3, D 359F2*, D 359G*
NEC	FD 1138T, FD 1139H*
Safronic	DS-34AC
Samsung Electronics	SFD-321D
Seiko Epson	SMD-340
Sony	MP-F17W, MP-F320*
TEAC	FD-235HF, FD-05HF*
Y-E Data	YD-701B, YD-702J*

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

Alps Electric	DFR 823, DF328N*
Chinon	FZ-358
Citizen	OSDG, OSDF
Matsushita Communication Ind.	JU-259A
Mitsubishi Electric	MF 356F
Mitsumi Electric	D352E
Sony	MP-F40W
TEAC	FD-235J, FD-05J*
Y-E Data	YD-742

*12.7 millimeters height, or less

All microfloppy drives with formatted capacities less than 5 megabytes and disk diameters of 3.5" or less are included in this product group. The only type of microfloppy currently remaining in the product group is the 3.5" format, which has evolved into the industry standard. All of the other microfloppy formats in the 2" to 4" diameter range which were introduced during the last 11 years have been phased out.

All 3.5" 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" diskettes, and also use 40 or 80 tracks per side to maintain file compatibility with 5.25" diskettes.

1.2 and 1.44 megabyte 3.5" drives were announced in 1985, and are intended for use with the high density media originally proposed by Sony, which operates at up to 17,434 BPI, and uses 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. 1.2 megabyte 3.5" drives are compatible with NEC drives used with personal computers in the domestic Japanese market. 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" drives have also made the transition from the earlier 41.3 millimeter high drives ("half high", in 5.25" 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. Citizen did not match the 12.7 millimeter height, but lowered the height on its newest models to 10.9 millimeters. The availability of thin 3.5" floppy drives has made it possible for manufacturers to offer the drives in combination packages with other products, initially with 5.25" floppy drives. In 1994, TEAC announced a 3.5" floppy/CD-ROM drive combination with 41.3 millimeter height, and 3.5" floppy/PCMCIA card slot combinations with 25.4 millimeter heights were announced by Y-E Data and Mitsumi Electric.

The 3" microfloppy format which was produced in quantity for several years has lost all of its original adherents including the last holdout, Matsushita Electronic Components, and is now out of production. 2" drives, in a data recording version of a video camera floppy, were produced during recent years by Sony, but found a limited market. Initial shipments of 2" drives with notebook computers encountered resistance from buyers who did not want to bother with interchange problems, and there were not enough applications in home computers, electronic typewriters and games to maintain growth for the 2" format. While there may eventually be a future for a 2" or smaller floppy format, most of the drive manufacturers do not appear to be interested.

Market status

Worldwide 3.5" floppy drive shipments have continued a pattern of growth, benefiting from strong personal computer shipments, which in turn are driven by lower PC hardware prices and the continuing improvements in software. The 1992 surge in the personal computer market boosted 3.5" floppy drive shipments by 27.3%, and there was enough continuing momentum in 1993 to push 3.5" drive shipments up another 22.4%. Growth in system shipments has settled down to a more typical rate in 1994, and 3.5" drive shipments are forecasted to increase 11.9%. 51.2 million 3.5" floppy drives were shipped in 1993, and the 1994 worldwide total is forecasted at 57.3 million drives.

Despite the continually climbing shipment levels, sales revenues for 3.5" floppy drives have not enjoyed increases comparable to the growth in unit shipments, due to nonstop declines in average unit selling prices. The 1993 worldwide revenue total for the product group was $1,913,000,000, representing an increase less than half as large as the growth in unit shipments. In 1994 prices are falling faster than the increase in shipments, and the sales revenue total for the year is expected to decline 3.7%, to $1,841,000,000.

Several factors have contributed to the overall decline in average prices for 3.5" floppy drives, despite the continuous upgrading of the industry's overall product mix to higher capacity drives and the increased value of the Japanese Yen. The average OEM price for all 3.5" drives was $59 in 1988, $51 in 1989, $46 in 1990, $42 in 1991, $38 in 1992, and $34 in 1993. In 1994 a further drop in the overall OEM average price for 3.5" drives to $29 is forecasted. Underlying the continuing declines in average price by the major Japanese floppy drive manufacturers are continuing pressure from system manufacturers for the lowest possible price, extensive product redesign for cost reduction, and the movement of more than half of Japanese floppy drive manufacturing to offshore sites with lower costs.

Shipments of 3.5" drives with capacities of .7 megabyte or less have continued to decline and represented only 3.3% of the 1993 total. The 1.44 megabyte models which originated in 1985 and are 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. 1993 shipments of 1.2/1.44 megabyte drives provided 93.6% of the total of all 3.5" floppy drive formats, and the 1994 share for these drives is expected to reach 96.6% of the worldwide total.

IBM's long-expected adoption of the 2.88 megabyte microfloppy format finally occurred in 1991. Most floppy drive manufacturers had expected 2.88 megabyte drives to become an important part of the industry, but shipments in 1993 grew to only 1.6 million drives, just 3.1% of the overall 3.5" floppy drive total. Many system manufacturers delayed adoption due to the relatively high price for

2.88 megabyte drives. 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 failed to adopt it. The major negative influence holding down wider usage has been the drives' higher selling price, combined with low awareness of the drives' advantages among computer users. Since personal computer system manufacturers have not noticed significant demand for 2.88 megabyte drives, few have included them in systems, and those that have offered 2.88 megabyte drives have classified them as options, not standard equipment. 1994 shipments are expected to decline to 1.4 million drives, only 2.3% of the overall 3.5" floppy drive total.

The manufacturers of 3.5" floppy drives have experimented with numerous packaging heights during the 12 year history of the format. 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. Intense competition has come from drives with smaller heights -- initially 19 millimeters, then 17 millimeters, 15 millimeters, then in late 1991 12.7 millimeters, and more recently down to 11 millimeters.

Drives less than 1 inch high provided 17.1% of total 1993 3.5" floppy drive shipments, but it now appears that the continuing increases in total market share for 3.5" drives less than 1 inch height will be slower than originally expected, due to prices typically higher than those of 1 inch high drives. The decline in shipments of drives in the 15-19 millimeter height range is now starting to be offset by the growth in shipments for drives with heights of 12.7 millimeters or less, driven by demand for notebook computers and combination packages which combine 12.7 millimeter 3.5" and thin 5.25" drives in a "half high" form factor.

Shipments of all floppy drives with disks 3.5 inches or less in diameter have traditionally been grouped together in this product group, but the group currently includes only 3.5" floppy drives. Shipments of 3" floppy 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" drives never significantly penetrated the United States market, and after an early lead were overtaken in the Japan domestic market by 3.5" drives. The subgroup for less than 3.5" drives has also included 2" floppy drives in recent years, most recently available only in the Sony format.

However, 2" floppy drives did not attract a wide following due to lack of interchange capability with other microfloppy formats, and 1993 was the last production year for 2" floppy drives.

Personal computer applications dominate the shipments of 3.5" floppy drives, utilizing 94.3% of the worldwide total in 1993. However, personal computer applications are expected to take a smaller share of 1997's total shipments, declining to 86.5%, as consumer and hobby applications increase from 1.5% in 1993 to 9% in 1997.

The worldwide leadership in 1993 noncaptive 3.5" floppy drive shipments remained with Sony, which increased its share to 17.2%, with 8.4 million drives. TEAC again held second place, with 14.8%, and Mitsumi Electric remained in third position, with 12.6%.

Marketing trends

As 5.25" floppy drives decline in shipments during the next few years, 3.5" drives are expected to increase from 77.4% of all floppy drive shipments in 1993 to 96.9% of the total in 1997. 3.5" floppy drives have become the dominant removable recording device used with small computer systems and are expected to continue in that role for many years.

However, the average annual increase in unit shipments for 3.5" floppy drives is forecasted at only 8.2% for the 1995-97 period, below the generally expected rate of increase in personal computer shipments, due to the trend to more notebook computers without internal floppy drives and increasing competition from PCMCIA flash cards and PCMCIA disk drives. Although the increasing population of CD-ROM drives in the personal computer and workstation markets will absorb a portion of the software distribution role traditionally held by floppies, CD-ROM penetration of these markets is not expected to have a significant impact on shipments of floppy drives, which provide a unique low cost interchange medium.

Total sales revenues for 3.5" floppy drives are expected to decline each year through 1997, despite increasing unit shipments, due to continuing reductions in noncaptive price levels, especially for 1.44 megabyte models. The overall aver-

age unit price for 3.5" floppy drives is forecasted to be only $26 in 1995, dropping to $21 in 1997. As a result, the industry's total revenues for 3.5" drives are projected at $1,679,500,000 in 1997, an average annual decline of 2.9%.

The future for drives with heights less than one inch is a mixed picture. Overall shipments of drives in the 15-19 millimeter height range are now declining, and this trend is expected to continue. Shipments of drives in the 11-12.7 millimeter height range have steadily increased, with more gains expected. Growth in total shipments of drives less than one inch high is expected to average 13.7% in the 1995-97 period, boosting annual shipments to over 14 million drives in 1997.

Underlying the increased demand for drives with heights of 12.7 millimeters or less is the continuing expansion of the notebook computer market, which now employs floppies limited to this height range. However, notebook computers are being packaged in ever-smaller form factors, and there is a gradually increasing tendency to eliminate the floppy drive in some of the smaller implementations, relying for interchange on network connections or on externally attached floppy drives. The other current major usage of 12.7 millimeter 3.5" floppy drives is in combination packages with thin 5.25" drives offering a total of 41.3 millimeters, or "half high". The drive combination packages are currently growing in shipments in both OEM/Integrator and PCM/Reseller channels, but the major decline in 5.25" drive shipments expected during the next few years will limit this market. New combinations of 12.7 millimeter 3.5" floppy drives with either CD-ROM drives or with PCMCIA card slots have been introduced in 1994, but the size of the potential markets for these products is not yet known. Perhaps the most significant limitation on wider usage of 12.7 millimeter floppy drives is the higher typical prices for these models. 12.7 millimeter OEM drives are priced an average of $12 higher than one inch high models in 1994, and the differential is expected to remain as high as $6 in 1997. As a result of these limits on the potential market growth for thin drives, 1 inch high 3.5" drives are expected to remain dominant, with 80.6% of the 1997 market.

The 1.44 megabyte capacity has also become the industry standard, and is expected to retain that position. Drives with .7 megabyte capacity or less will continue to decline in shipments, down to an expected .1% share of the 1997 worldwide total in 1997. The once-promising outlook for 2.88 megabyte drives

has now changed to a pessimistic expectation for the future, leaving most growth in unit shipments to be enjoyed by the 1.44 megabyte standard.

Despite IBM's initial surge of PS/2 systems using 2.88 megabyte drives, the company stayed with the more competitive 1.44 megabyte drives for ValuePoint and PS/1 personal computers. In the general overhaul of its personal computer product lineup which IBM undertook in 1994, the PS/2 models were dropped, and 2.88 megabyte floppy drives are now available only as options on most of the company's new PC models. Other personal computer manufacturers continue to show no signs of extensive utilization of 2.88 megabyte drives in their systems. 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. Because of intense price competition in the personal computer industry, aggressive cost reduction programs are under way and few system manufacturers have been willing to add significantly to their product costs.

The pricing differential for 2.88 megabyte drives was about $23 higher than 1.44 megabyte drives in 1992, and the differential in 1994 has dropped to only about $11, as the special heads required decline in cost and production procedures are normalized. Nevertheless, the typical 1997 OEM prices for 2.88 megabyte floppy drives are expected to still be about $8 higher than prices for 1.44 megabyte drives. Lacking any sign of strong consumer demand, it is clear that personal computer manufacturers cannot afford to pay a significantly higher price for special floppy drives, considering the extremely competitive environment in which they operate. Without the sales impetus of a major personal computer manufacturer using 2.88 drives as standard feature, usage will remain spotty. It is now expected that shipments of 2.88 megabyte drives will decline to only 120,000 units in 1997, a mere .1% of the overall 3.5" worldwide total.

Technical trends

The highest development priority for manufacturers of 3.5" drives in recent years has been cost reduction. Intense activity has resulted in lower costs through reduction of electronic and mechanical parts counts, and through substitution of alternate materials. However, the same level of improvement has been more difficult with 2.88 megabyte drives and with very thin drive assemblies.

The only significant potential problem for the floppy drive industry in establishing large-scale production of 2.88 megabyte drives was availability of the multifunction head required to provide downward compatibility with .7 and 1.44 megabyte drives. But with multiple head sources established, the continuing challenge is cost reduction.

The next challenges for most manufacturers of 3.5" drives were 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. Nevertheless, the changes have been achievable, once production of smaller motors and other key components became available. The thinner drive configurations have made possible the initial announcements in 1994 of combination packages of 3.5" floppy drive/CD-ROM drive and 3.5" floppy drive/PCMCIA card slot combinations, which will present another round of cost reduction challenges

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" drives with heights less than 1 inch will not exceed 20% of the microfloppy shipment total for 1997, and 1.44 megabyte drives will maintain shipment dominance through 1997.

2. No major personal computer manufacturer will utilize 2.88 megabyte drives as a general standard for its product lines, except for specialized models.

3. A positive growth rate for personal computers will continue through 1997.

4. The dollar/yen exchange rate will stay in the current range, and prices for noncaptive 3.5" drives will continue to decline at the forecasted rate.

TABLE 18

FLEXIBLE DISK DRIVES, 3.5 INCH

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1993 Revenues		Forecast							
			1994		1995		1996		1997	
	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	5.6	253.8	4.2	241.8	4.3	228.8	4.3	211.4	3.8	194.6
PCM/Reseller	158.1	297.7	153.4	294.9	147.2	294.4	135.7	276.9	128.2	267.1
OEM/Integrator	628.6	1,361.5	585.7	1,304.3	569.2	1,279.9	553.8	1,232.0	553.0	1,217.8
TOTAL NON-U.S. REVENUES	792.3	1,913.0	743.3	1,841.0	720.7	1,803.1	693.8	1,720.3	685.0	1,679.5
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	792.3	1,913.0	743.3	1,841.0	720.7	1,803.1	693.8	1,720.3	685.0	1,679.5
OEM Average Price ($000)		.034		.029		.026		.023		.021

TABLE 19

FLEXIBLE DISK DRIVES, 3.5 INCH

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1993		Forecast							
	Shipments		1994		1995		1996		1997	
	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	45.0	2,332.0	40.0	2,452.0	45.0	2,560.0	50.0	2,640.0	50.0	2,690.0
PCM/Reseller	4,786.0	9,056.0	5,432.0	10,616.0	5,655.0	11,310.0	5,900.0	12,040.0	6,105.0	12,720.0
OEM/Integrator	18,125.9	39,763.7	19,775.0	44,211.0	21,635.0	48,620.0	23,855.0	52,990.0	26,040.0	57,270.0
TOTAL NON-U.S. SHIPMENTS	22,956.9	51,151.7	25,247.0	57,279.0	27,335.0	62,490.0	29,805.0	67,670.0	32,195.0	72,680.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	22,956.9	51,151.7	25,247.0	57,279.0	27,335.0	62,490.0	29,805.0	67,670.0	32,195.0	72,680.0
Cumulative Shipments (Units in millions)										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	95.5	220.7	120.7	278.0	148.0	340.5	177.8	408.2	210.0	480.9
WORLDWIDE TOTAL	95.5	220.7	120.7	278.0	148.0	340.5	177.8	408.2	210.0	480.9

TABLE 20

FLEXIBLE DISK DRIVES, 3.5 INCH

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1993 Revenues		Forecast			
	3.5" SS	3.5" DS	1994 3.5" DS	1995 3.5" DS	1996 3.5" DS	1997 3.5" DS
U.S. MANUFACTURERS						
TOTAL U.S. REVENUES	--	--	--	--	--	--
NON-U.S. MANUFACTURERS						
Captive	1.4	252.4	241.8	228.8	211.4	194.6
PCM/Reseller	--	297.7	294.9	294.4	276.9	267.1
OEM/Integrator	--	1,361.5	1,304.3	1,279.9	1,232.0	1,217.8
TOTAL NON-U.S. REVENUES	1.4	1,911.6	1,841.0	1,803.1	1,720.3	1,679.5
WORLDWIDE RECAP						
Captive	1.4	252.4	241.8	228.8	211.4	194.6
	--	+38.2%	-4.2%	-5.4%	-7.6%	-7.9%
PCM/Reseller	--	297.7	294.9	294.4	276.9	267.1
	--	+31.0%	-.9%	-.2%	-5.9%	-3.5%
OEM/Integrator	--	1,361.5	1,304.3	1,279.9	1,232.0	1,217.8
	--	+2.0%	-4.2%	-1.9%	-3.7%	-1.2%
Total Revenues	1.4	1,911.6	1,841.0	1,803.1	1,720.3	1,679.5
	--	+9.6%	-3.7%	-2.1%	-4.6%	-2.4%
ANNUAL SHARE, BY DIAMETER	.1%	99.9%	100.0%	100.0%	100.0%	100.0%

TABLE 21

FLEXIBLE DISK DRIVES, 3.5 INCH

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1993 Shipments		Forecast			
	3.5" SS	3.5" DS	1994 3.5" DS	1995 3.5" DS	1996 3.5" DS	1997 3.5" DS
U.S. MANUFACTURERS						
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--
NON-U.S. MANUFACTURERS						
Captive	8.0	2,324.0	2,452.0	2,560.0	2,640.0	2,690.0
PCM/Reseller	--	9,056.0	10,616.0	11,310.0	12,040.0	12,720.0
OEM/Integrator	--	39,763.7	44,211.0	48,620.0	52,990.0	57,270.0
TOTAL NON-U.S. SHIPMENTS	8.0	51,143.7	57,279.0	62,490.0	67,670.0	72,680.0
WORLDWIDE RECAP						
Captive	8.0	2,324.0	2,452.0	2,560.0	2,640.0	2,690.0
	--	+54.8%	+5.5%	+4.4%	+3.1%	+1.9%
PCM/Reseller	--	9,056.0	10,616.0	11,310.0	12,040.0	12,720.0
	--	+52.4%	+17.2%	+6.5%	+6.5%	+5.6%
OEM/Integrator	--	39,763.7	44,211.0	48,620.0	52,990.0	57,270.0
	--	+15.8%	+11.2%	+10.0%	+9.0%	+8.1%
Total Shipments	8.0	51,143.7	57,279.0	62,490.0	67,670.0	72,680.0
	--	+22.4%	+12.0%	+9.1%	+8.3%	+7.4%
ANNUAL SHARE, BY DIAMETER	--	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 22

FLEXIBLE DISK DRIVES, 3.5 INCH

WORLDWIDE SHIPMENTS (000)

DRIVE HEIGHT ANALYSIS

	1993 --Shipments--		Forecast 1994		1995		1996		1997	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	--		--		--		--		--	
Non-Captive Total	--		--		--		--		--	
Total U.S.	--		--		--		--		--	
NON-U.S. MANUFACTURERS										
Captive Total	2,332.0		2,452.0		2,560.0		2,640.0		2,690.0	
Less than 1 inch	1,494.0	64.2%	1,562.0	63.8%	1,610.0	63.0%	1,630.0	61.8%	1,640.0	61.1%
1 inch	830.0	35.6%	890.0	36.2%	950.0	37.0%	1,010.0	38.2%	1,050.0	38.9%
More than 1 inch	8.0	.2%	--	--	--	--	--	--	--	--
Non-Captive Total	48,819.7		54,827.0		59,930.0		65,030.0		69,990.0	
Less than 1 inch	7,263.0	14.9%	7,995.0	14.6%	9,050.0	15.1%	10,540.0	16.2%	12,430.0	17.8%
1 inch	39,677.7	81.4%	46,832.0	85.4%	50,880.0	84.9%	54,490.0	83.8%	57,560.0	82.2%
More than 1 inch	1,879.0	3.7%	--	--	--	--	--	--	--	--
Total Non-U.S.	51,151.7		57,279.0		62,490.0		67,670.0		72,680.0	
Less than 1 inch	8,757.0	17.1%	9,557.0	16.7%	10,660.0	17.1%	12,170.0	18.0%	14,070.0	19.4%
1 inch	40,507.7	79.3%	47,722.0	83.3%	51,830.0	82.9%	55,500.0	82.0%	58,610.0	80.6%
More than 1 inch	1,887.0	3.6%	--	--	--	--	--	--	--	--
WORLDWIDE RECAP										
Total Worldwide Shipments	51,151.7		57,279.0		62,490.0		67,670.0		72,680.0	
	+22.4%		+11.9%		+9.1%		+8.2%		+7.4%	
Less than 1 inch	8,757.0	17.1%	9,557.0	16.7%	10,660.0	17.1%	12,170.0	18.0%	14,070.0	19.4%
	+9.5%		+9.1%		+11.5%		+14.1%		+15.6%	
1 inch	40,507.7	79.3%	47,722.0	83.3%	51,830.0	82.9%	55,500.0	82.0%	58,610.0	80.6%
	+31.3%		+17.8%		+8.6%		+7.0%		+5.6%	
More than 1 inch	1,887.0	3.6%	--	--	--	--	--	--	--	--
	-35.9%		--		--		--		--	

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

TABLE 23

FLEXIBLE DISK DRIVES, 3.5 INCH

WORLDWIDE SHIPMENTS (000)

DRIVE CAPACITY ANALYSIS

	1993 --Shipments--		Forecast 1994		1995		1996		1997	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	--		--		--		--		--	
Non-Captive Total	--		--		--		--		--	
Total U.S.	--		--		--		--		--	
NON-U.S. MANUFACTURERS										
Captive Total	2,332.0		2,452.0		2,560.0		2,640.0		2,690.0	
.7 Megabyte or Less	8.0	.3%	--	--	--	--	--	--	--	--
1.2/1.44 Megabytes	2,324.0	99.7%	2,452.0	100.0%	2,560.0	100.0%	2,640.0	100.0%	2,690.0	100.0%
Non-Captive Total	48,819.7		54,827.0		59,930.0		65,030.0		69,990.0	
.7 Megabyte or Less	1,689.5	3.5%	661.0	1.2%	295.0	.5%	130.0	.2%	70.0	.1%
1.2/1.44 Megabytes	45,491.2	93.3%	52,799.0	96.4%	58,965.0	98.5%	64,585.0	99.4%	69,800.0	99.8%
2.88 Megabytes	1,639.0	3.2%	1,367.0	2.4%	670.0	1.0%	315.0	.4%	120.0	.1%
Total Non-U.S.	51,151.7		57,279.0		62,490.0		67,670.0		72,680.0	
.7 Megabyte or Less	1,697.5	3.3%	661.0	1.2%	295.0	.5%	130.0	.2%	70.0	.1%
1.2/1.44 Megabytes	47,815.2	93.6%	55,251.0	96.6%	61,525.0	98.6%	67,225.0	99.4%	72,490.0	99.8%
2.88 Megabytes	1,639.0	3.1%	1,367.0	2.2%	670.0	.9%	315.0	.4%	120.0	.1%
WORLDWIDE RECAP										
Total Worldwide Shipments	51,151.7		57,279.0		62,490.0		67,670.0		72,680.0	
	+22.4%		+11.9%		+9.1%		+8.2%		+7.4%	
.7 Megabyte or Less	1,697.5	3.3%	661.0	1.2%	295.0	.5%	130.0	.2%	70.0	.1%
	-37.8%		-61.0%		-55.3%		-55.9%		-46.1%	
1.2/1.44 Megabytes	47,815.2	93.6%	55,251.0	96.6%	61,525.0	98.6%	67,225.0	99.4%	72,490.0	99.8%
	+26.2%		+15.5%		+11.3%		+9.2%		+7.8%	
2.88 Megabytes	1,639.0	3.1%	1,367.0	2.2%	670.0	.9%	315.0	.4%	120.0	.1%
	+40.0%		-16.6%		-50.9%		-52.9%		-61.9%	

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

TABLE 24

FLEXIBLE DISK DRIVES, 3.5 INCH

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1993 Estimate Units (000)	1993 Estimate %	1997 Projection Units (000)	1997 Projection %
VERY HIGH PERFORMANCE				
Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS				
General purpose	--	--	--	--
NETWORKS/MINI/MULTIUSER				
Midrange systems and network servers	358.1	.7	290.7	.4
PERSONAL COMPUTERS				
Business and professional, single user	48,236.0	94.3	64,321.8	88.5
WORKSTATIONS				
Engineering and office, single user	1,595.9	3.1	1,380.9	1.9
CONSUMER, GAME AND HOBBY COMPUTERS	767.3	1.5	6,541.2	9.0
OTHER APPLICATIONS	194.4	.4	145.4	.2
Total	51,151.7	100.0	72,680.0	100.0

TABLE 25

FLEXIBLE DISK DRIVES, 3.5 INCH

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1993 Net Shipments			
	To United States Destinations		Worldwide	
Drive Manufacturers	Units (000)	%	Units (000)	%
Sony	4,675.9	20.4	8,370.7	17.2
TEAC	3,550.0	15.5	7,243.0	14.8
Mitsumi Electric	3,215.0	14.0	6,165.0	12.6
Seiko Epson	1,955.0	8.5	3,620.0	7.4
Mitsubishi Electric	2,074.0	9.1	3,293.0	6.7
Matsushita Communication Ind.	850.0	3.7	3,278.0	6.7
Citizen	1,205.0	5.3	3,201.0	6.6
Alps Electric	1,675.0	7.3	2,970.0	6.1
Chinon	1,832.0	8.0	2,740.0	5.6
Y-E Data	500.0	2.2	2,633.0	5.4
NEC	275.0	1.2	1,401.0	2.9
Matsushita Electronic Ind.	--	--	1,020.0	2.1
Canon	385.0	1.7	945.0	1.9
Samsung Electronics	125.0	.5	895.0	1.8
Other U.S.	--	--	--	--
Other Non-U.S.	595.0	2.6	1,045.0	2.2
TOTAL	22,911.9	100.0	48,819.7	100.0

HIGH CAPACITY FLEXIBLE DISK DRIVES

1994 DISK/TREND REPORT

HIGH CAPACITY FLEXIBLE DISK DRIVES

Coverage

Examples of flexible disk drives in this group include:

5.25" flexible disk drives

Iomega	Bernoulli 20, 44, 90, 150, 230

3.5" flexible disk drives

Insite Peripherals	I325VM
Iomega	Zip drive
NEC	FD 2135
Swan Instruments	FRD-3128

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 general 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 3.5" drives.

Iomega's 5.25" 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" 10 megabyte Alpha-10 in September, 1982, followed by other 8" models, all of which have since been discontinued. A 5 megabyte full size 5.25" drive was introduced in 1983, followed by a 21 megabyte half high model in 1986, a 44 megabyte version in 1989, a 90 megabyte model in 1991, a 150 megabyte model in 1992, and the 230 megabyte model in the Fall of 1994.

Floptical drives: 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" diskettes to achieve high track density (1,245 TPI), resulting in a capacity of 21 megabytes, in a 1 inch high drive with downward read/write compatibility for .7 and 1.44 megabyte diskettes.

Since 1992, Insite has been delivering a version of the drive which is manufactured for Insite on a contract basis by Matsushita-Kotobuki Electronics. Insite also licensed the floptical technology to Iomega, which introduced drives compatible with Insite's in 1992, using Chinon as a contract manufacturing source, but Iomega has been phasing out of the floptical drive market in 1994. In November, 1993, O.R. Computer System Pte. Ltd., a major Singapore distributor of personal computers and peripherals, acquired control of Insite Peripherals.

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" drive in 1984, followed in 1985 by a 4.15 megabyte 5.25" drive. Both of these drives were used only in limited applications, and only in Japan, and were phased out in 1992.

During the last several years there have been several announced high capacity 3.5" floppy drive programs. Brier Technology's 21 megabyte 3.5" drives used a unique "dual level" or "buried" recording system in which embedded servo information occupied the same position as data tracks, without reducing track capacity. The first version of the 21 megabyte Brier drive was delivered in early 1990, but after changes in ownership, and limited shipments of the drive in the personal computer add-on market, the Brier drive was phased out in 1992.

NEC delivered its 9.4 megabyte drive in August, 1988, for the domestic Japanese market, and later superseded it with a 10.18 megabyte model, followed by the current 21.4 megabyte drive, which incorporates read and write compatibility with .7 and 1.44 megabyte diskettes. All of these NEC drives have used embedded servos, with metal powder media. All of the other high capacity 3.5" floppy drive programs by several Japanese manufacturers have been dropped, including announced drives by Matsushita Communication Industrial, Citizen, Y-E Data and others. During the last few years, Japan Electronic Industry Development Association (JEIDA) 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 was in a holding pattern during most of 1992/93, while the manufacturers involved pursued a "wait and see" policy, while assessing the market reception to the "floptical" drives offered by Insite and Iomega. At this time, NEC is the only company participating in the Japanese standards program that is still active with a production drive.

In late 1994, Iomega announced the "Zip drive", a newly designed 3.5" floppy drive utilizing either 25 or 100 megabyte disk cartridges, in an attempt to broaden its penetration of the personal computer market through low prices and software designed to help users organize their data. Iomega expects to have the drive in retail stores in early 1995, with a typical retail price of about $200 for the drive, $20 for the 100 megabyte disk and $10 for the 25 megabyte disk.

Market status

Despite increasing shipments of 3.5" floppy drives in this group during 1994, total sales revenues are expected to decline from 1993's $80.9 million to $75.1 million in 1994, due to a slight current drop in shipments of Iomega 5.25" drives. 1993's total shipments of all floppy drives with capacities over 5 megabytes were 209,600 units, with an increase to 243,600 drives forecasted for 1994.

Iomega's Bernoulli principle drives: Although Iomega's original 8" drives have long since peaked and went out of production three years ago, shipments of the firm's 5.25" Bernoulli drives continued to grow each year until 1993. All of the 5.25" 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 disk drives, 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.

Iomega's Bernoulli drive shipments are currently all 5.25" models, totaling 106,200 in 1993. Iomega has continually upgraded the range of capacities available in the 5.25" drive series, and the higher capacity models now dominate current shipments. Nevertheless, unit shipments for 1994 are estimated to decline to 103,000, as newer magneto-optical 3.5" drives and SyQuest's 270 megabyte 3.5" rigid disk cartridge drive provide difficult competition.

Other flexible disk drives: Time has passed by the several 5.25" high capacity floppy drive programs previously introduced, and 3.5" drives currently provide the product group's long-term growth potential.

After numerous delays, 3.5" 20 megabyte "floptical" drives became available in volume from Insite in the first half of 1992 and from Iomega late in that year. Total 3.5" drive shipments were only 25,600 units in 1992, but the combined marketing activity of Insite and Iomega boosted 1993 shipments to 103,400 drives. Although initial sales were concentrated in PCM/Reseller markets, adoptions by specialized system manufacturers have provided a major part of the current growth for floptical drives. Contract manufacturing is now concentrated at Matsushita-Kotobuki Electronics, for O.R. Computer's Insite Peripherals, the only remaining principal in the floptical program.

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. The floptical standard has been adopted by two system manufacturers for technical workstation applications. 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. The major challenge to 3.5" drive manufacturers will be to find ways to reduce prices as much and as fast as possible. It is clear that most of the mainstream personal computer market is not available to the existing 20 megabyte floppy drives through OEMs, due to prices several times higher than those of standard floppy drives --

leaving only specialized and high-end applications. Most of the current sales have been made in the aftermarket for add-on units.

Marketing trends

The DISK/TREND Report forecast of shipments and revenue for the high capacity flexible disk drive product group have again been lowered, in view of the continuing difficulty drive manufacturers have experienced in reducing prices low enough to stimulate a major penetration of the personal computer market. Total shipments are forecasted to reach 600,000 drives in 1997, of which 86.9% are expected to be 3.5" models.

The majority of sales for high capacity 3.5" floppy drives are still 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 significant latent demand believed to exist for improved system backup devices, continuing PCM/Reseller growth is expected for this product group now that adequate production is available, at least for "floptical" drives.

OEM/Integrator shipments, at least for technical workstations, are now starting, but the OEM market will probably be limited to workstations, high-end personal computers and specialized applications, due to the relatively high price of 3.5" drives in this product group compared to conventional 3.5" floppy drives. Although continuing sales activity aimed at the OEM market is expected to increase OEM shipments to a majority of the total 3.5" drive shipments starting next year, the expected market penetration will be limited by the exceptionally strong market position of standard 1.44 megabyte 3.5" floppy drives, available to major system manufacturers next year at less than $25 per drive.

In the meantime, 5.25" Bernoulli drives are forecasted to grow in shipments in 1995 to 111,000 units, on the strength of continuing product improvements. Iomega's 150 megabyte drives introduced in late 1992 have been well received and have provided significant competition to alternative products offered by other manufacturers. Iomega adopted an aggressive price strategy in 1993, which is helping the firm to maintain its current market position, but the peak for 5.25" drives is expected in 1995, with lower shipments in succeeding years.

Although 3.5" 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 a credible drive manufacturing organization and major media manufacturers, with plans under way to increase the capacity available in the format to at least 100 megabytes.

The leading Japanese floppy drive manufacturers are still patiently observing the difficult early years of the "floptical" program, including the establishment of large-scale production through Matsushita-Kotobuki Electronics, the startup of the Iomega program using Chinon for manufacturing, Iomega's phaseout of the program, the very slow response by system manufacturers and Insite Peripheral's purchase by O.R. Computer. So far, the response is mixed. Most drive manufacturers are still watching the situation, and waiting for an indication of the availability of a high volume market. Except for NEC, it appears that the majority will attend an occasional JEIDA standards committee meeting on high capacity floppies, but avoid any commitment to production until there is a clear indication of availability of a major market.

The new Iomega Zip drive may provide the first test of the market's appetite for 3.5" drives in the 100 megabyte range. It's price level will be significantly lower than removable media disk drives previously offered at that capacity range, and it will be supported by an aggressive marketing program through established marketing channels. If successful, it could establish a new movement to a high capacity floppy media interchange standard, which could provide a major boost for the high capacity floppy drive business.

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 useful with interchange of graphics and other applications, and they must provide aggressive price competition to tape drives, removable cartridge rigid disk drives and erasable optical disk drives.

Since the 3.5" 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, to the 100 megabyte range promised for 1995 and beyond -- and to achieve the design simplification required for low manufacturing cost.

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. Japanese drive manufacturers cooperating with the JEIDA standards activity have hoped to achieve a simpler design using metal powder media, with a lower manufacturing cost. None of the above product designs provide for media interchange except among drives of the same type, plus 1 and 2 megabyte 3.5" drives.

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. High volume production of 3.5" high capacity floppy drives will continue to be available in the 1995-97 period.

2. Due to relatively high prices compared to 1.44 megabyte floppy drives, OEM adoptions of 3.5" high capacity floppy drives will be confined to technical workstations, high-end personal computers and specialized applications during the 1995-97 period.

3. Shipments of 5.25" Bernoulli drives will peak in 1995.

TABLE 26

HIGH CAPACITY FLEXIBLE DISK DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1993 Revenues		Forecast 1994		1995		1996		1997	
	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	50.9	61.9	44.3	51.5	36.0	42.0	28.9	34.0	18.8	21.7
OEM/Integrator	2.2	2.4	2.1	2.5	2.0	2.4	1.4	1.7	.9	1.2
TOTAL U.S. NONCAPTIVE	53.1	64.3	46.4	54.0	38.0	44.4	30.3	35.7	19.7	22.9
TOTAL U.S. REVENUES	53.1	64.3	46.4	54.0	38.0	44.4	30.3	35.7	19.7	22.9
Non-U.S. Manufacturers										
Captive	--	--	--	1.0	--	4.0	--	6.8	--	8.4
PCM/Reseller	6.3	9.9	7.0	11.4	12.0	18.0	14.3	21.5	14.3	21.7
OEM/Integrator	4.5	6.7	5.6	8.7	18.2	22.4	24.0	29.5	27.0	33.5
TOTAL NON-U.S. REVENUES	10.8	16.6	12.6	21.1	30.2	44.4	38.3	57.8	41.3	63.6
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	63.9	80.9	59.0	75.1	68.2	88.8	68.6	93.5	61.0	86.5
OEM Average Price ($000)		.214		.181		.149		.127		.110

TABLE 27

HIGH CAPACITY FLEXIBLE DISK DRIVES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1993		Forecast							
	Shipments		1994		1995		1996		1997	
	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	93.6	115.2	98.0	115.0	90.0	105.0	85.0	100.0	65.0	75.0
OEM/Integrator	5.5	6.0	5.0	6.0	5.0	6.0	4.0	5.0	3.0	4.0
TOTAL U.S. NONCAPTIVE	99.1	121.2	103.0	121.0	95.0	111.0	89.0	105.0	68.0	79.0
TOTAL U.S. SHIPMENTS	99.1	121.2	103.0	121.0	95.0	111.0	89.0	105.0	68.0	79.0
Non-U.S. Manufacturers										
Captive	--	--	--	2.0	--	8.0	--	15.0	--	21.0
PCM/Reseller	33.0	52.0	40.0	65.0	80.0	120.0	110.0	165.0	125.0	190.0
OEM/Integrator	24.4	36.4	35.6	55.6	130.0	160.0	195.0	240.0	250.0	310.0
TOTAL NON-U.S. SHIPMENTS	57.4	88.4	75.6	122.6	210.0	288.0	305.0	420.0	375.0	521.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	156.5	209.6	178.6	243.6	305.0	399.0	394.0	525.0	443.0	600.0
Cumulative Shipments (Units in thousands)										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	885.0	1,131.9	1,063.6	1,375.5	1,368.6	1,774.5	1,762.6	2,299.5	2,205.6	2,899.5
WORLDWIDE TOTAL	885.0	1,131.9	1,063.6	1,375.5	1,368.6	1,774.5	1,762.6	2,299.5	2,205.6	2,899.5

TABLE 28

HIGH CAPACITY FLEXIBLE DISK DRIVES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1993 Revenues		Forecast							
			1994		1995		1996		1997	
	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"
U.S. MANUFACTURERS										
PCM/Reseller	4.2	57.7	5.4	46.1	--	42.0	--	34.0	--	21.7
OEM/Integrator	.2	2.2	--	2.5	--	2.4	--	1.7	--	1.2
TOTAL U.S. REVENUES	4.4	59.9	5.4	48.6	--	44.4	--	35.7	--	22.9
NON-U.S. MANUFACTURERS										
Captive	--	--	1.0	--	4.0	--	6.8	--	8.4	--
PCM/Reseller	9.9	--	11.4	--	18.0	--	21.5	--	21.7	--
OEM/Integrator	6.7	--	8.7	--	22.4	--	29.5	--	33.5	--
TOTAL NON-U.S. REVENUES	16.6	--	21.1	--	44.4	--	57.8	--	63.6	--
WORLDWIDE RECAP										
Captive	--	--	1.0	--	4.0	--	6.8	--	8.4	--
	--	--	--	--	+300.0%	--	+70.0%	--	+23.5%	--
PCM/Reseller	14.1	57.7	16.8	46.1	18.0	42.0	21.5	34.0	21.7	21.7
	+131.1%	-6.6%	+19.1%	-20.1%	+7.1%	-8.9%	+19.4%	-19.0%	+.9%	-36.2%
OEM/Integrator	6.9	2.2	8.7	2.5	22.4	2.4	29.5	1.7	33.5	1.2
	--	-18.5%	+26.1%	+13.6%	+157.5%	-4.0%	+31.7%	-29.2%	+13.6%	-29.4%
Total Revenues	21.0	59.9	26.5	48.6	44.4	44.4	57.8	35.7	63.6	22.9
	+238.7%	-7.1%	+26.2%	-18.9%	+67.5%	-8.6%	+30.2%	-19.6%	+10.0%	-35.9%
ANNUAL SHARE, BY DIAMETER	26.0%	74.0%	35.4%	64.6%	50.1%	49.9%	61.9%	38.1%	73.6%	26.4%

TABLE 29

HIGH CAPACITY FLEXIBLE DISK DRIVES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1993 Shipments		Forecast							
			1994		1995		1996		1997	
	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"
U.S. MANUFACTURERS										
PCM/Reseller	14.0	101.2	18.0	97.0	--	105.0	--	100.0	--	75.0
OEM/Integrator	1.0	5.0	--	6.0	--	6.0	--	5.0	--	4.0
TOTAL U.S. SHIPMENTS	15.0	106.2	18.0	103.0	--	111.0	--	105.0	--	79.0
NON-U.S. MANUFACTURERS										
Captive	--	--	2.0	--	8.0	--	15.0	--	21.0	--
PCM/Reseller	52.0	--	65.0	--	120.0	--	165.0	--	190.0	--
OEM/Integrator	36.4	--	55.6	--	160.0	--	240.0	--	310.0	--
TOTAL NON-U.S. SHIPMENTS	88.4	--	122.6	--	288.0	--	420.0	--	521.0	--
WORLDWIDE RECAP										
Captive	--	--	2.0	--	8.0	--	15.0	--	21.0	--
	--	--	--	--	+300.0%	--	+87.5%	--	+40.0%	--
PCM/Reseller	66.0	101.2	83.0	97.0	120.0	105.0	165.0	100.0	190.0	75.0
	+164.0%	-1.7%	+25.8%	-4.2%	+44.6%	+8.2%	+37.5%	-4.8%	+15.2%	-25.0%
OEM/Integrator	37.4	5.0	55.6	6.0	160.0	6.0	240.0	5.0	310.0	4.0
	--	-5.7%	+48.7%	+20.0%	+187.8%	--	+50.0%	-16.7%	+29.2%	-20.0%
Total Shipments	103.4	106.2	140.6	103.0	288.0	111.0	420.0	105.0	521.0	79.0
	+303.9%	-1.9%	+36.0%	-3.0%	+104.8%	+7.8%	+45.8%	-5.4%	+24.0%	-24.8%
ANNUAL SHARE, BY DIAMETER	49.4%	50.6%	57.8%	42.2%	72.3%	27.7%	80.1%	19.9%	86.9%	13.1%

TABLE 30

HIGH CAPACITY FLEXIBLE DISK DRIVES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1993 Estimate Units (000)	1993 Estimate %	1997 Projection Units (000)	1997 Projection %
VERY HIGH PERFORMANCE				
Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS				
General purpose	--	--	--	--
NETWORKS/MINI/MULTIUSER				
Midrange systems and network servers	--	--	--	--
PERSONAL COMPUTERS				
Business and professional, single user	202.3	96.5	567.0	94.5
WORKSTATIONS				
Engineering and office, single user	7.3	3.5	33.0	5.5
CONSUMER, GAME AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	--	--	--	--
Total	209.6	100.0	600.0	100.0

TABLE 31

HIGH CAPACITY FLEXIBLE DISK DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1993 Net Shipments			
	To United States Destinations		Worldwide	
Drive Manufacturers	Units (000)	%	Units (000)	%
Iomega	99.1	63.3	121.2	57.8
Insite Peripherals	57.0	36.4	88.0	42.0
Other U.S.	--	--	--	--
Other Non-U.S.	.4	.3	.4	.2
TOTAL	156.5	100.0	209.6	100.0

FLEXIBLE DISK DRIVE SPECIFICATIONS

1994 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 identification purposes. 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

Formatted capacity is used to determine the appropriate DISK/TREND Report product group for each drive, to be consistent with the disk drive industry's trend to identify all drives by formatted capacities. Prior to 1992, unformatted capacities were used with most drives in this report but the movement to embedded controllers in rigid disk drives and high capacity floppy drives has meant that most drives are now specified in formatted capacities, and most users normally identify floppy drives by formatted capacities.

In the specification, capacities are listed as "U" for unformatted or "F" for formatted. 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.

1994 DISK/TREND product groups for flexible disk drives

Group number	Drives included
13.	Flexible disk drives, 8"
14.	Flexible disk drives, 5.25"
15.	Flexible disk drives, 3.5"
16.	High capacity flexible disk drives

MANUFACTURER	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC
DRIVE	DF 323H	DF 324H	DF 324N	DF 328N	DF 333H
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	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: .7/1.2/1.4/ 2.88	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680/ 9,216	F: 4,608/7,680/ 9,216/18,432	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80/77/80	80/77/80/80	80/77
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184	8717/17434	8717/14184/ 17434	8717/14184/ 17434/34868	8717/14184
Rotational speed (RPM)	360	300	300/360/300	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
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	100/83.3	100/83.3	83.3
Data transfer rate (KBytes/sec)	37.5/62.5	31.25/62.5	31.25/62.5	31.25/62.5/125	37.5/62.5
SIZE (mm: H x W x D)	12.7 x 96 x 126	12.7 x 96 x 126	12.7 x 96 x 126	12.7 x 96 x 126	25.4 x 101.6 x 144.8
FIRST CUSTOMER SHIPMENT	4/92	4/92	5/92	11/92	5/94
COMMENTS	Direct drive	Direct drive	Direct drive	Direct drive	Direct drive

MANUFACTURER	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC
DRIVE	DF 334H	DF 334N	DFR 643	DFR 683	DFR 723
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: .7/1.2/1.4	F: .7/1.2	F: .7/1.2	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/7,680/ 9,216	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	80/77/80	80/77	80/77	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/14184/ 17434	8717/14184	8717/14184	8717/17434
Rotational speed (RPM)	300	300/360/300	360	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	83.3	100/83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	37.5/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 144.8	25.4 x 101.6 x 144.8	25.4 x 101.6 x 144.8	25.4 x 101.6 x 144.8	25.4 x 101.6 x 144.8
FIRST CUSTOMER SHIPMENT	5/94	5/94	5/90	5/90	5/90
COMMENTS	Direct drive	Direct drive	Direct drive	Direct drive	Direct drive

MANUFACTURER	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	BROTHER	BROTHER
DRIVE	DFR 783	DFR 823	DFR 883	FB 015 FB 400	FB 100
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	Captive, OEM	Captive
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	Barium Ferrite	Barium Ferrite	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2/1.4	F: .7/1.4/2.88	F: .7/1.2/1.4/ 2.88	F: .240	F: .1024
Capacity per track (Bytes)	F: 4,608/7,680/ 9,216	F: 4,608/9,216/ 18,432	F: 4,608/7,680/ 9,216/18,432	F:	F: 2,560
Data surfaces per spindle	2	2	2	1	1
Tracks per surface	80/77/80	80	80/77/80/80	78	40
Track density (TPI)	135	135	135	135	67.5
Maximum linear density (BPI)	8717/14184/ 17434	8717/17434/ 34868	8717/14184/ 17434/34868	5180	4064
Rotational speed (RPM)	300/360/300	300	300/360/300/300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	20	60
Settling time (msec)	15	15	15	10	20
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100/83.3	100/83.3	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5/125	31.25/62.5/125	19.50	15.63
SIZE (mm: H x W x D)	25.4 x 101.6 x 144.8	25.4 x 101.6 x 144.8	25.4 x 101.6 x 144.8	25.4 x 103.1 x 169.9	54.9 x 129.5 x 165.1
FIRST CUSTOMER SHIPMENT	5/90	8/90	4/92	10/87	1984
COMMENTS	Direct drive	Direct drive	Direct drive	FB 400 is kit for typewriter GCR encoded	Used in knitting machines

MANUFACTURER	CANON	CANON	CANON	CANON	CANON
DRIVE	MD 5501	MD 3541	MD 3551	MD 3641	MD 3651
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: .7/1.4	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	80	80	80
Track density (TPI)	96	135	135	135	135
Maximum linear density (BPI)	5922/9646	8717/14527	8717/14527	8717/17434	8717/17434
Rotational speed (RPM)	360	360	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	83.3	83.3	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	37.5/62.5	37.5/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	26.9 x 146 x 198.1	19.6 x 101.6 x 129.5	15.5 x 96 x 130	19.6 x 101.6 x 129.5	15.5 x 96 x 130
FIRST CUSTOMER SHIPMENT	7/86	4/90	1991	4/90	1991
COMMENTS				Direct drive motor	

MANUFACTURER	CANON	CHINON	CHINON	CHINON	CHINON
DRIVE	MD 3661	FR-506	FZ-502	FP-357 FP-357X	FZ-354 FZ-354I FZ-354IS
DISK/TREND GROUP	15	14	14	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	5.25"	5.25"	3.5"	3.5"
Recording medium	High Density Oxide Coated	Oxide Coated	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: .180/.360	F: .7/1.4	F: .360/.7
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/7,680	F: 2,304/4,608	F: 4,608/9,216	F: 2,304/4,608
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	40	80	80
Track density (TPI)	135	96	48	135	135
Maximum linear density (BPI)	8717/14527	5922/9870	2938/5876	8717/17434	4359/8717
Rotational speed (RPM)	360	300/360	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	5	3	3
Settling time (msec)	15	15	20	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	100
Data transfer rate (KBytes/sec)	37.5/62.5	37.5/62.5	15.63/31.25	31.25/62.5	15.65/31.25
SIZE (mm: H x W x D)	15.5 x 101.6 x 108	41 x 146 x 193	41 x 146 x 193	12.7 x 96 x 126	25.4 x 101.6 x 130
FIRST CUSTOMER SHIPMENT	5/92	1Q91	3/87	2Q93	1Q90
COMMENTS				FP-357X is external drive FP-357X is 17 mm high	FZ-354I and FZ-354IS in 5.25" frame

MANUFACTURER	CHINON	CHINON	CHINON	CITIZEN	CITIZEN
DRIVE	FZ-356 FZ-356IS	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: .7/1.2/1.4	F: .7/1.4	F: .7/1.4/2.88	F: .7/1.4	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/7,680/ 9,216	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)	8717/14528/ 17434	8717/17434	8717/17434/ 34868	8717/17434	8717/14184
Rotational speed (RPM)	300/360/300	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)	100/83.3/100	100	100	100	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5/62.5	31.25/62.5	31.25/62.5/125	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 130	25.4 x 101.6 x 130	25.4 x 101.6 x 145	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9
FIRST CUSTOMER SHIPMENT	1Q93	1Q90	2Q91	4Q87	4Q87
COMMENTS	FZ-356IS 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 (mm: H x W x D)	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9
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	W1DA W3DA
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: .7/1.2	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 (mm: H x W x D)	15 x 96.5 x 129.5	15 x 96.5 x 129.5	15 x 96.5 x 129.5	15 x 96.5 x 129.5	10.9 x 96.5 x 116.8
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	W3DA is 3 volt model

MANUFACTURER	CITIZEN	CITIZEN	INSITE PERIPHERALS	INSITE PERIPHERALS	INSITE PERIPHERALS
DRIVE	W1DB W3DB	W1DE W3DE	E325VM	ELF-20M External Drive Subsystem	ELF-20P External Drive Subsystem
DISK/TREND GROUP	15	15	16	16	16
MARKET	OEM	OEM	OEM	PCM	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	Barium Ferrite	Barium Ferrite	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.2/1.4	F: 21	F: 21	F: 21
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 13,824	F: 13,824	F: 13,824
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77/80	753	753	753
Track density (TPI)	135	135	1245	1245	1245
Maximum linear density (BPI)	8717/14184	8717/17434	23980 BPI* 17985 FCI	23980 BPI* 17985 FCI	23980 BPI* 17985 FCI
Rotational speed (RPM)	300/360	300/360	720	720	720
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Crs:Step. Motor Fine:Voice Coil	Crs:Step. Motor Fine:Voice Coil	Crs:Step. Motor Fine:Voice Coil
POSITIONING: Track to track(msec)	3	3	1	1	1
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	41.6	41.6	41.6
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	1500	1500	1500
SIZE (mm: H x W x D)	10.9 x 96.5 x 116.8	10.9 x 96.5 x 116.8	25.4 x 101.6 x 149.9	35 x 131 x 203	35 x 131 x 203
FIRST CUSTOMER SHIPMENT	2Q93	2Q93	3/93	12/93	12/93
COMMENTS	W3DB is 3 volt model	W3DE is 3 volt model	*1,7 RLL Code 65 msec average position. time Optical servo track system. SCSI interface. Read/write downward comp. 800 KB/1.4 MB GEC format.	*1,7 RLL Code 65 msec average position. time Macintosh SCSI interface. Read/write downward comp. 800 KB/1.4 MB GEC format.	*1,7 RLL Code 65 msec average position. time Printer parallel port interface. Read/write downward comp. 720 KB/1.2 MB (NEC)/1.44 MB

MANUFACTURER	INSITE PERIPHERALS	IOMEGA	IOMEGA	IOMEGA	IOMEGA
DRIVE	I325VM	Io20S	Bernoulli 20	Bernoulli 44	Bernoulli 90
DISK/TREND GROUP	16	16	16	16	16
MARKET	OEM	OEM	PCM	PCM	OEM, PCM
MEDIA: Nominal disk diameter	3.5"	3.5"	5.25"	5.25"	5.25"
Recording medium	Barium Ferrite	Barium Ferrite	High Density Oxide Coated	Barium Ferrite	Metal Powder
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 21	F: 20.8	F: 21.4	F: 44.5	F: 90
Capacity per track (Bytes)	F: 13,824	F: 13,824	F: 16,128	F: 20,480	F: 29,696
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	753	765	677	1088	1516
Track density (TPI)	1245	1245	570	1095	1605
Maximum linear density (BPI)	23980 BPI* 17985 FCI	23980 BPI* 17985 FCI	23511 BPI* 17633 FCI	28541 BPI* 21405 FCI	37961 BPI* 28470 FCI
Rotational speed (RPM)	720	720	1845.7	2027	2368
PERFORMANCE					
Actuator type	Crs:Step. Motor Fine:Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
POSITIONING: Track to track(msec)	1	15 (including settling)	6.2 (including settling)	3.7	2.4 (including settling)
Settling time (msec)	15	--	--	--	--
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	41.6	41.6	16.25	14.8	12.7
Data transfer rate (KBytes/sec)	1500	200	666	692.5	1173.7
SIZE (mm: H x W x D)	25.4 x 101.6 x 149.9	25.4 x 101.6 x 157.5	41.3 x 146 x 203.2	41.3 x 146 x 203.2	41.3 x 146 x 203.2
FIRST CUSTOMER SHIPMENT	10/93	4Q92	9/87	2/89	7/91
COMMENTS	*1,7 RLL Code 65 msec average position. time Optical servo track system. SCSI interface. Read/write downward comp. 720 KB/1.2 MB (NEC)/1.44 MB.	*1,7 RLL Code 65 msec average position. time Optical servo track system. SCSI interface Downward comp. with .7 & 1.4MB (Read & Write)	*1,8 RLL Code 40 msec average positioning time	*1,8 RLL Code 32 msec average positioning time	*1,7 RLL Code 20 msec average positioning time

MANUFACTURER	IOMEGA	IOMEGA	IOMEGA	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	Bernoulli 150	Bernoulli 230	Zip Drive	JU-475	JU-226A
DISK/TREND GROUP	16	16	16	14	15
MARKET	OEM, PCM	OEM, PCM	PCM	Captive,OEM,PCM	Captive,OEM,PCM
MEDIA: Nominal disk diameter	5.25"	5.25"	3.5"	5.25"	3.5"
Recording medium	Metal Powder	Metal Powder	Metal Powder	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 150.9	F: 230	F: 25/100	F: .360/.7 or F: .6/1.2	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 35,328	F: 47,616	Varies by zone	F: 4,608/7,680	F: 4,608/7,680/ 9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	2594	2885	1808	77/80	80
Track density (TPI)	2117	2353	2118	96	135
Maximum linear density (BPI)	35990 BPI* 26992 FCI	49323 BPI* 36992 FCI	45200 BPI* 33900 FCI*	5922/9646	17434
Rotational speed (RPM)	2368	2439	2968	300/360	300
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	2.5 (including settling)	3.7	4	3	3
Settling time (msec)	--	--	--	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	12.7	12.3	10.1	100/83.3	100
Data transfer rate (KBytes/sec)	5000 synch.** 3000 asynch.**	5000 synch.** 3000 asynch.**	1250**	31.25/62.5	62.5
SIZE (mm: H x W x D)	41.3 x 146 x 203.2	41.3 x 146 x 202.3	36.9 x 134.1 x 181.6	41.3 x 146 x 203.2	12.7 x 101.6 x 106
FIRST CUSTOMER SHIPMENT	4Q92	9/94	1Q95	1983	1994
COMMENTS	*1,7 RLL Code. **SCSI. 25 msec average positioning time Downward comp. 90 MB read/ write 44 MB read	*1,7 RLL Code. **SCSI. 18 msec average positioning time Downward comp. 150, 105, 90, 65, 35 MB read/ write; 44 MB read	*1,7 RLL Code. **SCSI/parallel port. 29 msec average positioning time. 25 and 100 MB disk cartridges available		

MANUFACTURER	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	JU-227A	JU-256A	JU-257	JU-257A	JU-259A
DISK/TREND GROUP	15	15	15	15	15
MARKET	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,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	High Density Oxide Coated	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	F: .7/1.4/2.88
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/7,680/ 9,216	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216/ 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)	17434	17434	8717/17434	8717/17434	8717/34868
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)	62.5	62.5	31.25/62.5	31.25/62.5	31.25/62.5/125
SIZE (mm: H x W x D)	12.7 x 101.6 x 106	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9
FIRST CUSTOMER SHIPMENT	1994	1994	1987	1987	4Q92
COMMENTS					SCSI interface option

MANUFACTURER	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS
DRIVE	EME-213	EME-215	EME-216	EME-262	EME-264
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	F: 1.2	F: 1.4	F: .7/1.2	F: .7
Capacity per track (Bytes)	F: 4,608	F: 7,680	F: 9,216	F: 4,608/7,680	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	14528	17434	8717/14528	8717
Rotational speed (RPM)	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)	6	3	3	3	6
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	83/100	100
Data transfer rate (KBytes/sec)	31.25	62.5	62.5	31.25/62.5	31.25
SIZE (mm: H x W x D)	17 x 96.5 x 134.6	17 x 96.5 x 134.6	17 x 96.5 x 134.6	17 x 96.5 x 134.6	17 x 96.5 x 134.6
FIRST CUSTOMER SHIPMENT	1989	1991	1991	1989	1989
COMMENTS					

MANUFACTURER	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION
DRIVE	EME-272 EME-277	EME-276	EME-278	MF 504C	MF 354F
DISK/TREND GROUP	15	15	15	14	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	5.25"	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	F: .7/1.4	F: .7/1.2	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608	F: 4,608/9,216	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	96	135
Maximum linear density (BPI)	8717/14528	8717	8717/17434	5922/9870	8717/14184
Rotational speed (RPM)	300/360	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	12	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)	83/100	100	100	100/83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	15 x 96.5 x 129.5	15 x 96.5 x 129.5	15 x 96.5 x 129.5	41 x 146 x 195	25.4 x 101.6 x 146
FIRST CUSTOMER SHIPMENT	1992	1992	4/91	2Q88	3Q93
COMMENTS					

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE	MF 355C MF 355F	MF 356F	D 509S	D 509V3	D 352E
DISK/TREND GROUP	15	15	14	14	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	5.25"	5.25"	3.5"
Recording medium	High Density Oxide Coated	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.4/2.88	F: .7/1.2	F: .7/1.2	F: .7/1.4/2.88
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/18,432	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/9,216 18,432
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	96	96	135
Maximum linear density (BPI)	8717/17434	8717/34868	5922/9646	5922/9646	8717/17434/ 34868
Rotational speed (RPM)	300	300	300/360	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	3/5	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	100/83.3	100/83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5/125	37.5/62.5	37.5/62.5	31.25/62.5/125
SIZE (mm: H x W x D)	25.4 x 101.6 x 146	25.4 x 101.6 x 146	25.4 x 149 x 193	41.3 x 146 x 188	25.4 x 101.6 x 125
FIRST CUSTOMER SHIPMENT	3Q93	3Q93	1Q95	4Q88	
COMMENTS					

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE	D 353F2	D 353P3 D 353T3 D 353T5	D 357T3	D 358F2	D 358P3 D 358T3 D 358T5
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: .7/1.2/1.4	F: .7/1.2/1.4	F: .7	F: .7/1.2	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/7,860 9,216	F: 4,608/7,860 9,216	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	80/77	80/77	80	80/77	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184/ 17434	8717/14184/ 17434	8717	8717/14184	8718/14184
Rotational speed (RPM)	300/360	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	3/6	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)	100/83.3	100/83.3	100	100/83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25
SIZE (mm: H x W x D)	12.7 x 96 x 130	25.4 x 101.6 x 150	25.4 x 101.6 x 154.9	12.7 x 96 x 130	25.4 x 101.6 x 149.9
FIRST CUSTOMER SHIPMENT			4Q88		3Q91
COMMENTS		D353P3 is in 5.25" form factor			D 358P3 is in 5.25" form factor

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE	D 359C2	D 359F2	D 359G	D 359P3 D 359T3 D 359T5	DP 1092F2
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: .7/1.4	F: .7/1.4	F: .7/1.4	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216	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)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/17434	8717/17434	8717/17434	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)	6	3	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
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 (mm: H x W x D)	17 x 101.6 x 154.9	12.7 x 96 x 130	12.7 x 101.6 x 101.6	25.4 x 101.6 x 154.9	25.4 x 101.6 x 170
FIRST CUSTOMER SHIPMENT	1Q90		1Q95	4Q88	2Q95
COMMENTS				D 359P3 is in 5.25" form factor	Combines FDD with slot for PCMCIA card types I, II, or III

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	FD 1165	FD 1157C	FD 1157D	FD 1158C	FD 1158D
DISK/TREND GROUP	13	14	14	14	14
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	8"	5.25"	5.25"	5.25"	5.25"
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: .6/1.2	F: .7/1.2	F: .7/1.2	F: .7/1.2	F: .7/1.2
Capacity per track (Bytes)	F: 4,096/8,192	F: 4,608/7,680	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	77	80	80	80	80
Track density (TPI)	48	96	96	96	96
Maximum linear density (BPI)	3408/6816	5922/9870	5922/9870	5922/9870	5922/9870
Rotational speed (RPM)	360	300/360	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)	50	35	35	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	83.3	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	57.9 x 216.9 x 322.6	41.3 x 146 x 203.2	41.3 x 146 x 203.2	25.4 x 146 x 190.5	25.4 x 146 x 190.5
FIRST CUSTOMER SHIPMENT	4Q81	1987	1987	2Q90	3Q90
COMMENTS			With VFO		With VFO

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	FD 1177C	FD 1137C	FD 1137D	FD 1138C	FD 1138D
DISK/TREND GROUP	14	15	15	15	15
MARKET	Captive, OEM	Captive, OEM	Captive, 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: .7/1.2	F: .7/1.2	F: .7/1.2	F: .7/1.2
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: 4,608/7,680
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	8717/14528	8717/14528	8717/14528	8717/14528
Rotational speed (RPM)	300/360	300/360	300/360	300/360	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Linear, Stepping Motor	Linear, Stepping 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)	100/83.3	100/83.3	100/83.3	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
SIZE (mm: H x W x D)	41 x 146 x 203	25.4 x 101.6 x 129.5	25.4 x 101.6 x 129.5	19 x 101.6 x 127	19 x 101.6 x 127
FIRST CUSTOMER SHIPMENT		1987	1987	1Q90	2Q90
COMMENTS			With VFO		With VFO

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	FD 1138H FD 1148H	FD 1138T	FD 1139C	FD 1139H	FD 1139T
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	Captive, OEM	Captive, OEM	Captive, 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: .7/1.2/1.4	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 9,216	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/ 17434	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
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 (mm: H x W x D)	19 x 101.6 x 127	19 x 101.6 x 127	15 x 101.6 x 101.6	15 x 101.6 x 101.6	15 x 101.6 x 101.6
FIRST CUSTOMER SHIPMENT	1Q90	2Q92	2/91	2/91	
COMMENTS					

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	FD 1148C	FD 1148H	FD 1148T	FD 1239H	FD 1335H
DISK/TREND GROUP	15	15	15	15	16
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, 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	Metal Powder
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.4	F: .7/1.4/10.18
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	F: 19,968
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80/255
Track density (TPI)	135	135	135	135	135/431
Maximum linear density (BPI)	8717/14528	8717/17434	8717/14528/ 17434	8717/17434	8717/17434/ 36595
Rotational speed (RPM)	300/360	300	300/360	300	360
PERFORMANCE					
Actuator type	Linear, Pulse Motor	Linear, Pulse Motor	Linear, Pulse Motor		Linear, Pulse Motor
POSITIONING: Track to track(msec)	3	3	3	3	92 (including settling)
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)	100/83.3	100	100/83.3		83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5/156
SIZE (mm: H x W x D)	19.8 x 101.6 x 130	19.8 x 101.6 x 130	19.8 x 101.6 x 130	12.5 x 101.6 x 101.6	25.4 x 101.6 x 130
FIRST CUSTOMER SHIPMENT					1/90
COMMENTS					Downward comp. with .7 & 1.4 MB (Read & Write) 329 msec average positioning time

MANUFACTURER	NEC	SAFRONIC	SAFRONIC	SAMSUNG ELECTRONICS	SAMSUNG ELECTRONICS
DRIVE	FD 2135	DS-53AC	DS-34AC DS-35AC	SFD-560D SFD-560DT	SFD-321D SFD-321DT
DISK/TREND GROUP	16	14	15	14	15
MARKET	Captive, OEM	OEM	OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	3.5"	5.25"	3.5"	5.25"	3.5"
Recording medium	Metal Powder	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 27.964 F: 21.418	F: .360/1.2	F: .7/1.4	F: .7/1.2	F: .7/1.4
Capacity per track (Bytes)	Varies by zone	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	326	80	80	80/77	80
Track density (TPI)	542	96	135	96	135
Maximum linear density (BPI)	52539	5876/9870	8717/17434	5922/9646	8717/17434
Rotational speed (RPM)	600	300	300	300/360	300
PERFORMANCE					
Actuator type	Linear, Pulse Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	82 (including settling	3	3	3	3
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)	50	100	100	83.3	100
Data transfer rate (KBytes/sec)	375/562.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 129.5	41.3 x 146 x 193	25.4 x 101.6 x 149.9	41.3 x 146 x 203.2	25.4 x 101.6 x 149.9
FIRST CUSTOMER SHIPMENT	6/93	1989	1989	4Q87	2Q89
COMMENTS	Downward comp. with .7, 1.4 & 10.18 MB (Read & Write) 319 msec average positioning time				

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
DRIVE	SD-680L	SD-780	SMD-1040	SMD-1140	SMD-1340
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: .7/1.2	F: .7/1.2	F: .7/1.4	F: .7/1.4	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/9,216	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	96	135	135	135
Maximum linear density (BPI)	5922/9870	5922/9870	1817/17434	8717/17434	8717/17434
Rotational speed (RPM)	300/360	360	300	300	300
PERFORMANCE					
Actuator type	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Lead Screw, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	35	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	83.3	100	100	100
Data transfer rate (KBytes/sec)	37.5/62.5	37.5/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	41.3 x 146 x 195.6	25.4 x 146 x 193	18 x 101.6 x 129.5	15 x 96.5 x 116.8	25.4 x 101.6 x 146
FIRST CUSTOMER SHIPMENT	3Q86	3Q93	1Q90	10/92	1Q95
COMMENTS			Direct drive motor	Also 3.3 volt version	

MANUFACTURER	SEIKO EPSON	SONY	SONY	SONY	SONY
DRIVE	SMD-340	MP-F40W	MPF120	MPF320	MPF420
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.4/2.88	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/9,216/ 18,432	F: 4,608/9,216	F: 4,608/7,680/ 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	8717/17434/ 34868	8717/17434	8717/14528/ 17434	8717/14528/ 17434
Rotational speed (RPM)	300	300	300	300/360/300	300/360/300
PERFORMANCE					
Actuator type	Rack & Pinion, 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	31.25/62.5/125	31.25/62.5	31.25/62.5/62.5	31.25/62.5/62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 146	25.4 x 101.6 x 150	25.4 x 101.6 x 150	12.7 x 96 x 130	25.4 x 101.6 x 150
FIRST CUSTOMER SHIPMENT	1/89	1Q91	4Q90	3Q92	
COMMENTS					

MANUFACTURER	SONY	SWAN INSTRUMENTS	SWAN INSTRUMENTS	TEAC	TEAC
DRIVE	MPF520	88/44	170/88	FD-155GF	FD-55BR
DISK/TREND GROUP	15	16	16	14	14
MARKET	Captive, OEM	OEM, PCM	OEM, PCM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	5.25"	5.25"
Recording medium	High Density Oxide Coated	Metal Powder	Metal Powder	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2/1.4	F: 88 Fixed F: 44 Remov. F: 1.44 Remov.	F: 170.3 Fixed F: 88.3 Remov. F: 1.44 Remov.	F: .7/1.2	F: .360
Capacity per track (Bytes)	F: 4,608/7,680/ 9,216	Varies by zone	Varies by zone	F: 4,608/7,680	F: 4,608
Data surfaces per spindle	2	4	4	2	2
Tracks per surface	50	1172/586	1840/937	80/77	40
Track density (TPI)	135	1890/945/135	2970/1512/135	96	48
Maximum linear density (BPI)	8717/14528/ 17434	62800/17434	73200/17434	5922/9646	5876
Rotational speed (RPM)	300/360/300	3600	3600	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track(msec)	3	3.5	3.5	3	4/6
Settling time (msec)	15			15	10/15
Head load time(msec)	Continuous Contact			Continuous Contact	50
Average rotational delay (msec)	100	8.3	8.3	100/83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5/62.5	6000	6000/10000	31.25/62.5	31.25
SIZE (mm: H x W x D)	25.4 x 101.6 x 145	25.4 x 101.6 x 146.1	25.4 x 101.6 x 146.1	25.4 x 146 x 191	41.3 x 146 x 203.2
FIRST CUSTOMER SHIPMENT	2Q94	2Q95	3Q95	8/91	1987
COMMENTS		18 msec. average head positioning PCMCIA, SCSI or PC AT interface	18 msec. average head positioning PCMCIA, SCSI or PC AT interface		

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-55FR	FD-55GFR	FD-55GR	FD-55GS	CF-506A
DISK/TREND GROUP	14	14	14	14	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	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	F: .7/1.2	F: 1.2	F: .7/1.2	F: .7/1.4
Capacity per track (Bytes)	F: 4,608	F: 4,608/7,680	F: 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	80/77	77	80/77	80
Track density (TPI)	96	96	96	96	135
Maximum linear density (BPI)	5922	5922/9646	9646	5922/9646	8717/17434
Rotational speed (RPM)	300	300/360	360	300/360	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, 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	50	50	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	83.3	100/83.3	100
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	41.3 x 146 x 203.2	41.3 x 146 x 203.2	41.3 x 146 x 203.2	43.2 x 144.8 x 203.2	41.3 x 146 x 203
FIRST CUSTOMER SHIPMENT	1987	1987	1987	1990	1Q95
COMMENTS		Dual speed		SCSI interface	Combines FDD with 4X CD-ROM drive

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-05GF	FD-05GFL	FD-05HF	FD-05HFL	FD-05HG
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: .7/1.4	F: .7/1.4	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/7,680	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)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184	8717/14184	8717/17434	8717/17434	8717/17434
Rotational speed (RPM)	300/360	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
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	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	31.25/62.5
SIZE (mm: H x W x D)	12.7 x 101.6 x 129.5	12.7 x 101.6 x 129.5	12.7 x 101.6 x 129.5	12.7 x 101.6 x 129.5	12.7 x 101.6 x 129.5
FIRST CUSTOMER SHIPMENT	10/91		10/91		
COMMENTS	Direct drive motor 101.6 mm or 96 mm width available	Direct drive motor 3.3 volts 101.6 mm or 96 mm width available	Direct drive motor 101.6 mm or 96 mm width available	Direct drive motor 3.3 volts 101.6 mm or 96 mm width available	Direct drive motor 101.6 mm or 96 mm width available

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-05HGL	FD-05HGS	FD-05HS	FD-05J	FD-05JS
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	Barium Ferrite	Barium Ferrite	Barium Ferrite	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.4	F: .7/1.4/2.88	F: .7/1.2/1.4/ 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)	300/360	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)	100/83.3	100/83.3	100	100	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5/125	31.25/62.5/125	31.25/62.5/125	31.25/62.5/125
SIZE (mm: H x W x D)	12.7 x 101.6 x 129.5	25.4 x 101.6 x 144.5	25.4 x 101.6 x 144.5	12.7 x 101.6 x 145	25.4 x 101.6 x 144.5
FIRST CUSTOMER SHIPMENT		2Q93	2Q93		2Q93
COMMENTS	Direct drive motor 101.6 mm or 96 mm width available 3.3 volts	SCSI interface	SCSI interface		SCSI interface

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 (mm: H x W x D)	15.5 x 106.2 x 146	15.5 x 106.2 x 146	15.5 x 106.2 x 146	25.4 x 101.6 x 145	25.4 x 101.6 x 145
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 (mm: H x W x D)	25.4 x 101.6 x 145	25.4 x 101.6 x 145	41.9 x 104.1 x 161.8	25.4 x 101.6 x 145	41.9 x 104.1 x 161.8
FIRST CUSTOMER SHIPMENT	2Q88		1990	1Q89	1990
COMMENTS			SCSI interface		SCSI interface

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	YD-180	YD-380B-1710B	YD-380B-1714B	YD-380B-1734H	YD-380B-1734S
DISK/TREND GROUP	13	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	8"	5.25"	5.25"	5.25"	5.25"
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: .6/1.2	F: 1.2	F: .7/1.2	F: .7/1.2	F: .7/1.2
Capacity per track (Bytes)	F: 4,096/8,192	F: 7,680	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	77	77	80/77	80	80/77
Track density (TPI)	48	96	96	96	96
Maximum linear density (BPI)	3408/6816	9646	5922/9646	5922/9870	5922/9870
Rotational speed (RPM)	360	360	300/360	600/720	600/720
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)	50	50	50	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	83.3	100/83.3	50/41.6	50/41.6
Data transfer rate (KBytes/sec)	31.25/62.5	62.5	31.25/62.5	75/125	75/125
SIZE (mm: H x W x D)	57.2 x 217.2 x 320	41.3 x 146 x 203.2	41.3 x 146 x 203.2	41.3 x 146 x 203.2	41.3 x 146 x 203.2
FIRST CUSTOMER SHIPMENT	9/81	4/86	4/86	6/90	6/91
COMMENTS				Double speed drive sold for duplicators	Double speed R/W drive sold for duplicators

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	YD-380C-1711C	YD-380D-1711D	YD-801 YD-802	2100	YD-665C
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	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: 1.2/2.4	F: .7/1.4	F: 1.2
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/7,680	F: 20,832	F: 4,608/9,216	F: 7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	77
Track density (TPI)	96	96	96	135	135
Maximum linear density (BPI)	5922/9870	5922/9870	19740	8717/17434	14184
Rotational speed (RPM)	360	360	180/360	300	360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, 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	50	50	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	83.3	166.7	100	83.3
Data transfer rate (KBytes/sec)	37.5/62.5	37.5/62.5	62.5	31.25/62.5	62.5
SIZE (mm: H x W x D)	41.3 x 146 x 203.2	41.3 x 146 x 203.2	41.3 x 146 x 203.2	25.4 x 101.8 x 150	25.4 x 101.6 x 149.9
FIRST CUSTOMER SHIPMENT	3/91	4/86	1Q87	1Q95	1986
COMMENTS			Compatible with 1.0 and 1.6 MB formats	Combines FDD with slot for PCMCIA card types I, II, or III	

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-702D	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: .7/1.2/1.4	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/7,680 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	80/77/80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184	8717/14184	8717/14184	8717/14184/ 17434	8717/17434
Rotational speed (RPM)	600/720	300/360	300/360	300/360	600/720
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	62.5/125
SIZE (mm: H x W x D)	17.3 x 101.6 x 149.9	25.4 x 101.6 x 149.9	17.3 x 96 x 149.9	25.4 x 101.6 x 149.9	17.3 x 101.6 x 149.9
FIRST CUSTOMER SHIPMENT	6/90	1Q87	1/90	1Q87	6/90
COMMENTS	Double speed drive sold for duplicators				Double speed drive sold for duplicators

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	YD-701B-6030S	YD-701B-6030Q	YD-702F	YD-702G	YD-702J
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: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 4,608/7,680/ 9,216	F: 4,608/7,680/ 9,216	F: 4,608/7,680 9,216	F: 4,608/7,680/ 9,216	F: 4,608/7,680 9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77/80	80/77/80	80/77/80	80/77/80	80/77/80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184/ 17434	8717/14184/ 17434	8717/14184 17434	8717/14184/ 17434	8717/14184/ 17434
Rotational speed (RPM)	600/720/600	1200/1440/1200	300/360/300	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)	50/41.6/50	25/20.8/25	100	100/83.3/100	100/83.3/100
Data transfer rate (KBytes/sec)	62.5/125/125	125/250/250	31.25/62.5/62.5	31.25/62.5/62.5	31.25/62.5/62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	17.3 x 96 x 149.9	15.0 x 96 x 129.5	12.7 x 96 x 129.5
FIRST CUSTOMER SHIPMENT	6/91	1Q95	1/90	7/91	2Q94
COMMENTS	Double speed R/W drive sold for duplicators	Quad speed R/W drive sold for duplicators		Direct drive motor	

MANUFACTURER	Y-E DATA				
DRIVE	YD-742				
DISK/TREND GROUP	15				
MARKET	OEM				
MEDIA: Nominal disk diameter	3.5"				
Recording medium	Barium Ferrite				
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4/2.88				
Capacity per track (Bytes)	F: 4,608/18,432				
Data surfaces per spindle	2				
Tracks per surface	80				
Track density (TPI)	135				
Maximum linear density (BPI)	8717/17434 34868				
Rotational speed (RPM)	300				
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor				
POSITIONING: Track to track(msec)	3				
Settling time (msec)	15				
Head load time(msec)	Continuous Contact				
Average rotational delay (msec)	100				
Data transfer rate (KBytes/sec)	31.25/62.5/125				
SIZE (mm: H x W x D)	25.4 x 101.6 x 149.9				
FIRST CUSTOMER SHIPMENT	1990				
COMMENTS					

MANUFACTURER PROFILES

1994 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 "1993 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. "1993 total net sales" covers the fiscal year ending in 1993 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, 1993, 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 1993 is used, as reported by the U.S. Federal Reserve Bulletin and rounded to three significant figures.

Country	Currency	Currency units per U.S. dollar
Japan	Yen	111.0
South Korea	Won	806.0
Taiwan	Dollar	26.4

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

U.S Manufacturers

INTERNATIONAL BUSINESS MACHINES CORPORATION
Route 22
Armonk, NY 10504

1993 total net sales: $62,716,000,000 Net income: ($7,987,000,000)

IBM introduced the original one and two sided 8" 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" 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" drives, and this configuration became an industry standard.

IBM made an abortive attempt to introduce a unique 3.9" floppy drive design in 1983, but it had so many disadvantages in access time, physical size, special controller requirements and unique file organization that even IBM's name failed to attract customers, and the product was withdrawn the same year. The 1987 introduction of the IBM PS/2 series of personal computers using both .7 and 1.44 megabyte 3.5" microfloppies reinforced the 3.5" floppy trend and gave the 1.44 megabyte format a major boost. IBM made extensive preparations to design and manufacture its own 5.25" 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" floppy drives continued until recent years to support older system families.

In 1991, IBM finally announced 2.88 megabyte barium ferrite 3.5" 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 added 2.88 megabyte drives to over 30 new PS/2 models, but did not use them with PS/1 and ValuePoint personal computer systems.

In 1994, IBM relabeled most of its personal computers, returning to the "PC" name for desktop systems aimed at business applications -- and the 2.88 megabyte floppy drives slipped from the status of standard equipment on most PS/2 models to optional equipment on most of the PC models. IBM remains the only major system manufacturer to offer 2.88 megabyte floppy drives on its personal computers, either as standard equipment or as an optional feature.

IOMEGA CORPORATION
1821 West Iomega Way
Roy, UT 84067

1993 FDD sales: $64,300,000
1993 total net sales: $147,123,000 Net income: ($14,425,000)

Iomega, founded in 1980 by former IBM managers, was successful in establishing production capability for its unique 8" flexible disk 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" subsystem for the IBM PC market provided most of the company's early revenue growth until surpassed by the 20 megabyte half high 8" drives introduced in 1985. However, half high 5.25" models in production since 1987 have largely displaced 8" drives, and Iomega discontinued 8" drives in 1991. The 5.25" 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.

Attempting to broaden its product coverage, Iomega licensed the Insite Peripherals "floptical" drive and media, and selected Chinon as a manufacturing partner for the drive. Iomega's "floptical" drive was introduced in late 1992. However, after a year of limited sales success, and the arrival of new management, the Iomega floptical program is being phased out. The new Iomega program to broaden its customer base is the "Zip drive", a 3.5" high performance flexible disk drive, using either 100 or 25 megabyte disk cartridges. The Zip drive will be priced below the historical levels for Iomega drives in an attempt to penetrate less sophisticated personal computer markets, with availability planned for early 1995.

SWAN INSTRUMENTS
3000 Olcott Street
Santa Clara, CA 95054

Swan Instruments, founded in 1984, is a producer of rigid disk drive head testing instruments and fixtures. It is also among the ranks of the few firms developing high capacity flexible disk drives, and in 1994 announced a floppy disk drive in a 3.5" form factor, with the combination of fixed and removable metal powder flexible disks. The fixed disk will store 170 megabytes, and the removable disk 88 megabytes, and the drive will also have the capability to read and write conventional 1.44 megabyte 3.5" floppy disks. The company plans to begin production in 1995.

Asian Manufacturers

(All fiscal years end in March, 1994, unless otherwise noted. All companies are in Japan unless otherwise noted.)

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

1993 FDD sales: $108,700,000
1994 total net sales: $3,548,622,000 Net income: ($83,261,000)

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 19% of Alps' revenues, and magnetic heads account for an additional 19%. The firm's big increase in floppy drive shipments came in 1981, with a rapid buildup of shipments to Apple Computer.

In the spring of 1987, Alps became the first Japanese company to manufacture floppy drives in the U.S., with 5.25" drives made in Garden Grove, California. Alps has also manufactured floppy drives in Ireland. Alps began shipping 3.5" microfloppy drives in mid-1984. A prototype 2.5" 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. Alps also offers a product line of rigid disk drives.

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

1993 total net sales: $1,882,865,000 Net income: ($8,964,000)
(FY ending 11/30/93)

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" 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

1993 FDD sales: $79,700,000
1993 total net sales: $660,027,000 (FY ending 12/31/93) Net income: ($4,604)

Canon Electronics produces electronic subassemblies for Canon cameras, as well as other electronic components, including magnetic heads, and systems. Floppy disk drives represent 13% of Canon Electronics' revenues, up from 11% in 1991. One and two sided 5.25" 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" microfloppies in late 1984. One inch high 3.5" drives began production in mid-1986, and in 1988 Canon commenced production of 1.44 megabyte 3.5" drives. 19.5 millimeter high 3.5" drives were introduced in late 1989, followed by 15.5 millimeter high versions in 1991. Canon was one of the early producers of a half high combination drive assembly, using its one third high 5.25" drives and 15.5 millimeter high 3.5" drives.

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

1993 FDD sales: $160,000,000
1994 total net sales: $328,468,000 Net income: ($48,793,000)

Chinon, founded in 1948, is a manufacturer of electronics, cameras and photographic equipment, with worldwide distribution. Eastman Kodak is a minority 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 69% in 1994, 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" drives and 3.5" microfloppies. In mid-1992, Chinon established Chinon Asia Private Ltd., a Singapore based company, which manufactures flexible disk drives. Chinon and Iomega had an agreement for Chinon to manufacture the "floptical" disk drive that Iomega licensed from Insite Peripherals, and production started in the second half of 1992. Due to the limited size of the floptical market, the Chinon production program is now inactive.

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

1993 FDD sales: $115,800,000
1994 total net sales: $3,403,505,000 Net income: $66,685,000

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 47% of sales, machine tools hold 7% and electronic equipment the balance. In addition to printers, displays, and small computers, Citizen introduced 3.5" 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" 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, if the JEIDA program results in significant industry participation. In late 1992 Citizen announced the thinnest 3.5" 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" 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" 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 manufactured 5.25" floppy disk drives for the Apple compatible market,

with drives for the IBM personal computer market added in 1986. 3.5" drives were added in 1989, with the mechanisms assembled under contract in China. Ergo discontinued floppy drive production in 1993.

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" 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. However, after several years of 3.5" drive production, the floppy drive program was discontinued in 1993, due to continued pricing pressure from the major producers.

INSITE PERIPHERALS, INC.
Subsidiary of O.R. Computer System Pte. Ltd.
2050 Bering Drive
San Jose, CA 95131

Insite's announcement of a 20 megabyte 3.5" microfloppy, combining an optical head positioning scheme with magnetic recording, aroused widespread interest in the disk drive 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" barium ferrite media. A one inch high version that is downward compatible with standard 3.5" .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 has attempted to achieve mainstream status for the "floptical" through licensing of established drive and media manufacturers, with Iomega as the first announced licensee. 3M and Hitachi Maxell have been granted licenses as media producers, and have made equity investments in Insite.

Despite establishment of reliable drive and media manufacturing sources, the Insite drive's price has been several times higher than low capacity 3.5" floppy drives during a period of intense price competition in the personal computer industry, the largest market opportunity. As a result, personal computer manufacturers have been unwilling to add floptical drives as standard products, assuming the market opportunity for the drives is specialized and that the majori-

ty of their customers would be unwilling to pay a higher price for personal computers with floptical drives. So far, the available market has been confined to storage subsystem builders active in the add-on market and to OEM sales for engineering workstations.

Insite's development activities and other operations were funded by several rounds of venture capital investments, which were mostly exhausted by the second half of 1993. In late 1993, negotiations for the sale of Insite to O.R. Computer, a subsidiary of Ocean Radio Group, based in Singapore, were completed. Ocean Radio has been active for 50 years as a trading company in consumer electronics, components, computers and peripherals. With the new owner's financial backing, the manufacturing arrangement with Matsushita Kotobuki Electronics has been continued and a new emphasis on OEM sales has been established.

MATSUSHITA COMMUNICATION INDUSTRIAL CO., LTD.
Subsidiary of Matsushita Electric Industrial Co., Ltd.
4-3-1 Tsunashima-Higashi
Kohoku-ku, Yokohama 223
Japan

1993 FDD sales: $247,600,000
1994 total net sales: $4,555,721,000 Net income: $52,198,000

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" and 3.5" microfloppy drives. The firm made half high 5.25" 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 Philippines, Precision Electronics Corporation, to manufacture floppy disk drives and other computer components, and all flexible disk drive production is now located in the Philippines.

The firm introduced a .7 megabyte 2" floppy drive that was adopted by Zenith in 1989 for use in a notebook computer but was otherwise shunned by the computer industry. After several attempts to pioneer various high capacity floppy drive configurations, most of the MCI floppy drive activity is centered on mainstream 5.25" and 3.5" floppy drives.

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

1993 total net sales: $2,938,126,000 (FY ending 3/31/93) Net income: ($58,568,000)

A member of the Matsushita Electric Industrial group, Matsushita Electronic Components Co. (MACO), is a diversified manufacturer of electro-mechanical and circuit components, plus various system and audio products. The company joined with Hitachi in attempting to establish a 3" microfloppy standard, which had widest acceptance in the European market, but was discontinued in 1991. Production of 3.5" floppy drives began in 1987.

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

1993 FDD sales: $155,100,000
1994 total net sales: $27,976,856,000 Net income: $186,468,000

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. A family of half high 5.25" floppy drives was introduced in 1982, with capacities up to 1.6 megabytes. Mitsubishi also started shipping a 3.5" microfloppy drive in 1983 and introduced a 1.44 megabyte version as early as 1985. Mitsubishi became a major supplier of flexible disk drives to IBM, following the IBM introduction of PS/2 in 1987. In 1991, the firm introduced a 2.88 megabyte 3.5" drive. After several years of flexible disk drive production at Mitsubishi's Koriyama Works, Melco Manufacturing (Thailand), a joint venture for the manufacture of floppy drives was established with Kang Yong Electric Manufacturing Co. The joint venture is largely owned by Mitsubishi.

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

1993 FDD sales: $253,000,000
1994 total net sales: $1,676,505,000 (FY ending 1/31/94) Net income: $21,441,000

Mitsumi is a leading manufacturer of electronic subassemblies and components, including magnetic heads. Floppy disk drives represent about 18% of

sales, up from 10% in 1991. The firm established a joint venture facility with Commodore, named Newtronics, to produce 5.25" and 3.5" floppy drives, and acquired complete ownership of Newtronics in 1986. During the last few years, Mitsumi has established a pattern of high growth in floppy drive sales, the result of low cost manufacturing operations and the company's aggressive pricing policy.

In 1984, Mitsumi introduced a very low cost 2.8" drive using a special Maxell disk under the name "Quick Disk", which used a single spiral track with 64,000 kilobytes capacity. It was used primarily in low-end home systems, including games, with final shipments in 1991. One inch high 3.5" 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" drive was introduced in 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

1993 FDD sales: $242,000,000
1994 total net sales: $32,250,333,000 Net income: $59,514,000

About 51% of NEC's revenues are generated by computer mainframes, small business systems, minicomputers and desktop systems -- and the firm remains the leader in the growing Japan domestic personal computer market. Since 1978 the company has manufactured two sided 8" floppy disk drives, and was one of the earliest firms to offer half high 8" floppy drives, with shipments starting in late 1981. 3.5" microfloppy drives and half high 5.25" drives were introduced in 1984. The majority of NEC's floppy drive shipments have been for captive applications.

NEC moved into the high capacity floppy drive market with the 1988 introduction of a 3.5" 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" floppy disk drives, and has announced a 21.4 megabyte drive. In 1989 NEC established a subsidiary in Hong Kong to oversee procurement and manufacturing in Southeast Asia, including production of floppy disk drives in the Philippines.

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

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, including floppy disk drives made by Safronic. Safronic has used contract manufacturing sources for the firm's half high 5.25" drives and 1.44 megabyte 3.5" drives, and in the second half of 1993 started production in China through a contract manufacturing arrangement managed by a Hong Kong firm. Sales of floppy drives are mostly through distribution.

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

1993 FDD sales: $85,400,000
1993 total net sales: $10,118,000,000 Net income: $192,000,000
(FY ending 12/31/93)

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 Associates granted a license to manufacture and market the Shugart 5.25" floppy drives in South Korea. Samsung is currently making half high 5.25" drives with capacities up to 1.2 megabytes, and production of 3.5" 1.44 megabyte one inch high drives began in 1989.

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

1993 FDD sales: $160,700,000

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. For years, Epson was best known for the

matrix printers 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" 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" models, including 3.5" drives with very low power requirements. Currently, the product line includes half high 5.25" drives and 25.4, 18 and 15 millimeter high 3.5" drives.

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

1993 FDD sales: $309,000,000
1994 total net sales: $33,637,126,000 Net income: $137,820,000

Sony, founded in 1946, is best known as a consumer electronics producer, but expansion in communications and computer products markets continues to be a major company objective. Sony pioneered the 3.5" microfloppy format, with first shipments in 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" media standard by Sony and several U.S. drive and media manufacturers -- and a growing number of Japanese firms rushing to make 3.5" 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" 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" diskette in 1985, which has become a de facto industry standard, with help from IBM, which adopted the standard for the PS/2 family in 1987. Also in 1987, Sony responded to the growing industry support for one inch high 3.5" drives by introducing its own model. A 2.88 megabyte 3.5" floppy disk drive was introduced in 1991. Sony pioneered the submicrofloppy field with a very high bandwidth .7 megabyte 2" floppy disk drive based upon a design used in the Mavica video camera storage device, but the data version of the 2" drive did not find a following in the computer industry. 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

1993 FDD sales: $418,100,000
1994 total net sales: $1,028,126,000 Net income: ($66,207,000)

TEAC is a leading manufacturer of consumer and professional audio recorders, but digital recording equipment is an increasing portion of the firm's product mix, currently providing about 74% of total revenues. Shipments of 5.25" floppy drives for the OEM market started in 1978, and in 1985 TEAC announced its line of 3.5" drives, including a 1.44 megabyte model and subsequently added one inch high models.

Rapid growth made TEAC the leader in worldwide noncaptive floppy drive revenues during the last few years. The firm joined Toshiba in 1987 in announcing 2.88 megabyte 3.5" floppy drives using barium ferrite media. 19 millimeter high 3.5" 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" 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. The company has also established a drive component manufacturing operation in Singapore.

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

1994 total net sales: $41,719,883,000 Net income: $109,369,000

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" floppy drives for both captive and OEM markets were produced starting in 1977. Half high two sided 5.25" drives were added in 1982, followed in the mid-1980's by microfloppy drives. High capacity barium ferrite media was developed by Toshiba for 2.88 megabyte 3.5" floppies, with production of drives and media starting in 1988. Several other firms have licensed the drive and media. In recent years, Toshiba has relied on contract manufacturing arrangements for its supply of floppy drives, which were sold primarily in the North American market.

Y-E DATA, INC.
182 Shinkoh, Iruma
Saitama, 358
Japan

1993 FDD sales: $120,600,000
1994 total net sales: $165,189,000 Net income: ($35,667,000)

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" one sided floppy drives in 1974 under an Orbis license. Disk drives represent about two thirds of current sales. Manufacturing is currently split between Japan, China and Thailand.

Y-E Data became an early leader in the Japanese OEM markets for both 8" and 5.25" two sided drives. Y-E Data also cooperated with NTT on the standard for 1.2 megabyte 5.25" 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" drive for use with the PC AT. In 1986, one inch high 3.5" drives were added to the product line. A 2.88 megabyte 3.5" microfloppy drive using cobalt modified oxide media was introduced in 1988 in an unsuccessful attempt to develop an industry standard, and a 2.88 megabyte 3.5" drive using standard barium ferrite media was first shipped in 1990. Y-E Data attempted to provide industry leadership in pioneering the market for high capacity floppy drives. A preliminary announcement of a 27.8 megabyte drive using metal particle media was made in 1989, with specifications revised in 1991. The final capacity specification became 20.8 megabytes, with initial shipments in late 1992, but the program has been discontinued, due to low demand.

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
z.lh 6

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. 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, were first produced in the 1960s, later joined by 8" and 5.25" floppy drives. As a result of the economic upheaval in the former Eastern Bloc countries, DZU production has been curtailed and extensive reorganization of the facilities which produced floppy drives has been under way.

DISK/TREND ON DISK

1994 DISK/TREND REPORT

DISK/TREND ON DISK

Introduction

DISK/TREND ON DISK is a licensed set of floppy disks available for separate purchase that contain 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 AutoImport useful with other file translation tasks, it may be purchased independently from DISK/TREND or White Crane Systems, Inc.

IMPORTANT NOTE: Effective July, 1994, White Crane began shipping version 3.13 or higher of AutoImport. Instructions in this section are written to work with the newer version. If you have version 2.xx of AutoImport, refer to instructions in previous DISK/TREND Reports. You must have AutoImport 3.xx to use DISK/TREND ON DISK with these instructions.

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 1994 DISK/TREND Report as a separately purchased option to subscribers to the corresponding 1994 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., 8255 Overview Court, Suite 100, Roswell, GA 30076.

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.

1994 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 shipped on 1.44 megabyte 3.5" floppy diskettes. 1.2 megabyte 5.25" diskettes are available upon request.

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:MASK?2.MSK (if you are using AutoImport Version 2.xx)
   COPY A:MASK?3.MSK (if you are using AutoImport Version 3.xx)

   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 V3.xx: 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: COPY A:*.* 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)
   A (Disk drive array data)
   V (Removable data storage 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
   File AT3.WK1 is Disk Drive Array Report Table 3
   File VT4.WK1 is Removable Data Storage Report Table 4

   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	Removable Report
MASKA	<-------- Table 1--------->		Tables 1,2	Table 1
	<-------------- Product Group Revenue ---------->			
	<-------------- Product Group Shipment ---------->			
MASKB	<-------- Table 2 -------->		Tables 3,4	Table 2
MASKC	Tables 3,4,6,9, 10,11	Tables 3,4	Tables 5 to 12	Tables 3 to 6
MASKD	<-------- All Product Group Application Tables -------->			
MASKE	N/A	Drive Height, Track Density, Drive Capacity	Write-Once/ Erasable Analysis	N/A
MASKF	N/A	Applications Summary	N/A	N/A
MASKG	*	Product Group Market Share	*	*
MASKH	Tables 7,8	N/A	N/A	Table 31
MASKI	Product Group Price/Megabyte	N/A	N/A	Product Group Price/ Megabyte

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	1994 Rigid Report	1994 Flexible Report	1994 Optical Report	1994 Array Report	1994 Removable Report
1	MASKA	MASKA	MASKA	MASKA	MASKA
2	MASKB	MASKB	MASKA	MASKB	MASKB
3	MASKC	MASKC	MASKB	MASKC	MASKC
4	MASKC	MASKC	MASKB	MASKC	MASKC
5	MASKC	--	MASKC	MASKC	MASKC
6	MASKC	--	MASKC	MASKC	MASKC
7	MASKH	MASKF	MASKC	MASKC	--
8	MASKH	MASKA	MASKC	--	--
9	MASKC	MASKA	MASKC	--	MASKA
10	MASKC	MASKE	MASKC	MASKA	MASKA
11	MASKC	MASKD	MASKC	MASKA	MASKC
12	--	MASKG	MASKC	--	MASKC
13	--	MASKA	--	--	--
14	MASKA	MASKA	--	--	MASKI
15	MASKA	MASKE	--	MASKA	--
16	--	MASKE	--	MASKA	MASKI
17	--	MASKD	MASKA	--	--
18	MASKD	MASKG	MASKA	--	MASKI
19	MASKI	MASKA	--	--	--
20	--	MASKA	--	MASKA	MASKI
21	MASKA	--	MASKD	MASKA	--
22	MASKA	--	--	--	MASKA
23	--	MASKE	MASKA	--	MASKA
24	--	MASKE	MASKA	--	MASKC
25	MASKD	MASKD	--	MASKA	MASKC
26	MASKI	MASKG	--	MASKA	MASKA
27	--	MASKA	--	--	MASKA
28	MASKA	MASKA	--	--	MASKA
29	MASKA	--	MASKE	--	MASKA
30	--	--	MASKD		MASKA
31	--	MASKD	--		MASKH
32	MASKD	MASKG	MASKA		MASKD
33	MASKI		MASKA		--
34	--		--		MASKA
35	MASKA		--		MASKA
36	MASKA		MASKD		--
37	--		--		--
38	--		MASKA		MASKI
39	MASKD		MASKA		MASKD
40	MASKI		--		--
41	--		--		MASKA
42	MASKA		MASKA		MASKA
43	MASKA		MASKA		--
44	--		--		--
45	--		--		MASKD
46	MASKD		MASKE		--
47	MASKI		MASKA		MASKA

Cross-reference (continued)

Table Number	1994 Rigid Report	1994 Flexible Report	1994 Optical Report	1994 Array Report	1994 Removable Report
48	--		MASKA		MASKA
49	MASKA		--		--
50	MASKA		--		--
51	--		MASKE		MASKD
52	--		MASKA		--
53	MASKD		MASKA		
54	MASKI		--		
55	--		--		
56	MASKA		MASKE		
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:MASK?2.MSK (if using AutoImport version 2.xx)
   COPY A:MASK?3.MSK (if using AutoImport version 3.xx)

   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 "File" menu bar item using the mouse keys or just type "/F". (The AutoImport menu system works just like the menus in Lotus 1-2-3.)

3. When the next screen appears, (File Selection Menu) use the arrow keys or the mouse to select the Mask Name option, then press (or click on) the down arrow to get a list of mask names. 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" (or double click on the selected name). Now position the cursor on the "RETRIEVE MASK" button and select it to load the mask.

4. Select the input file name option on the File Selection Menu.

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

   Examples: RT4.94R FT12.94F OT14.94O AT3.94A VT6.94V

5. Select the Output File Name on the File Selection Menu. (Should always be done after mask retrieval)

   Enter the name of the file. The file name form recommended is ?Tnn, where ? is the type of report (A, R, V, 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 AT11 VT13

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 selecting "Format" from the File Selection Menu and then selecting your preference from the menu of choices displayed.

7. You are ready to translate. Recheck all the file names displayed to be CERTAIN they are correct. Select the "CONVERT" button using the mouse or arrow keys and ENTER. If you are asked "Do you want to load input file named in mask?", answer "NO". 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 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 "File" using the arrow keys or type "/F".

2. Select the Input File Name option on the File Selection Menu and name the input 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 (A, R, F, V, or O), nn is the table number and yy is the report year.

   Example: FT10.94F

   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 select "Lines" from the menu bar, then select "Headings" from the pop-up window that opens. Using the down arrow key, expand the highlighted area until it extends to just above the first row of numerical data. Press 'ENTER'. The area that will be treated as header will be displayed in bright red.

   If there are any footnotes at the bottom, the lines in which they appear can be treated the same way by locating the cursor at the left margin of the first footnote line, selecting "Lines" and "Headings" again, and 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. Select "Column" from the menu bar, then "Auto Define". 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. Select "Column", then "Width & Move". Select the column you wish to adjust with the mouse (or arrows and ENTER), and then use the arrow keys to move the right column margin clear of the column of values. If you need to move an entire column without changing width, use the arrow keys while depressing the CONTROL key.

5. Save the mask in a mask file. Select "File", then "Mask", then the SAVE MASK button. Fill in the name of the mask file when asked.

   Example: FT10MSK

6. Name the output file as described in the previous section.

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

7. To make more masks, repeat from step 2. To quit AutoImport and return to DOS, type "/QY".

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. If you have a two floppy disk system: Place the floppy disk marked "Specifications" in a floppy disk drive. 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.

   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 files to the hard disk. This can be done in one step using the copy command as follows:

   COPY A:?S*.*

2. Use the DOS "DIR" command to examine the file directory on the "Specifications" 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

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)
   A (Disk Drive Array data)
   V (Removable Data Storage 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: FS194 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:

- There are other "pop-up" programs resident in the memory of your computer. These should be removed.
- 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.
- 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.

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 ??91 in the criterion field for the First Ship Date column will cause all drives first shipped in 1991 to be extracted.

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.