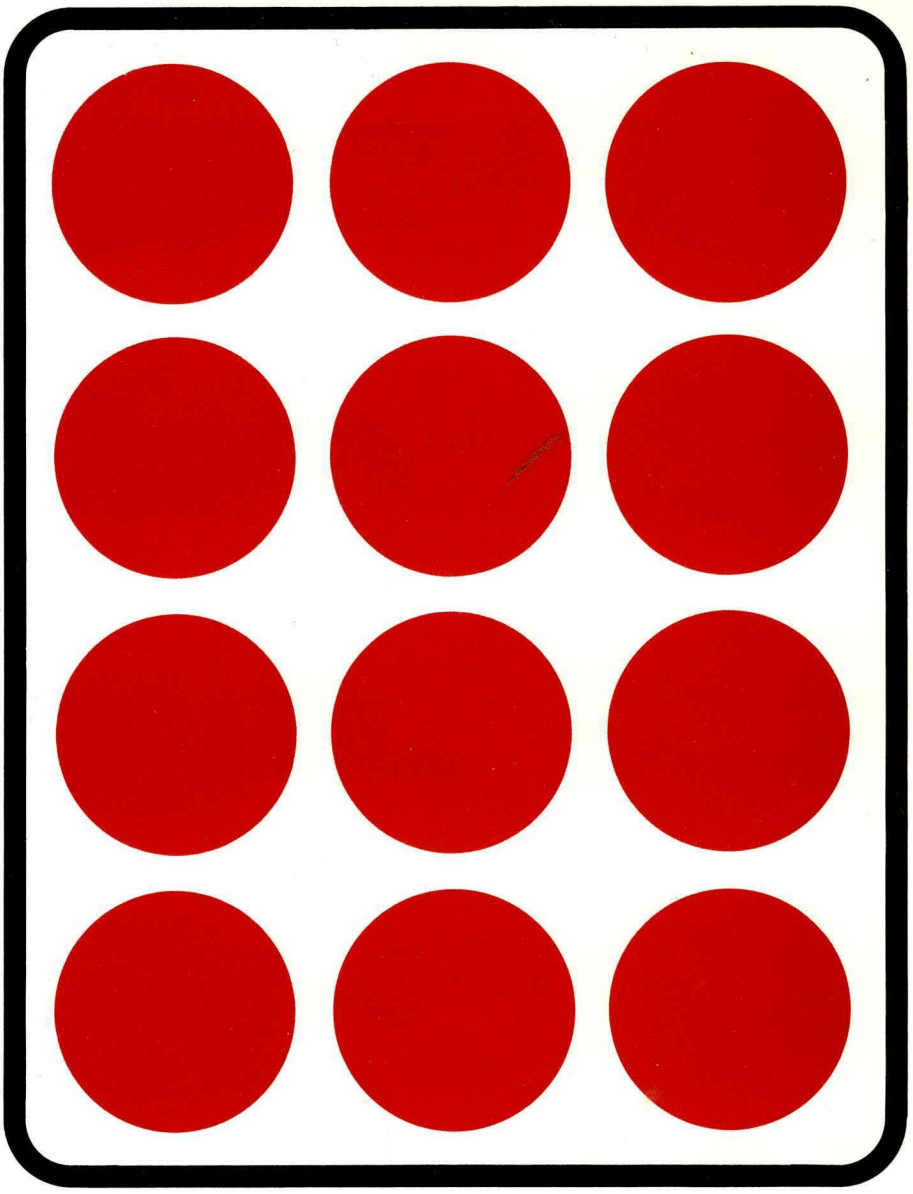
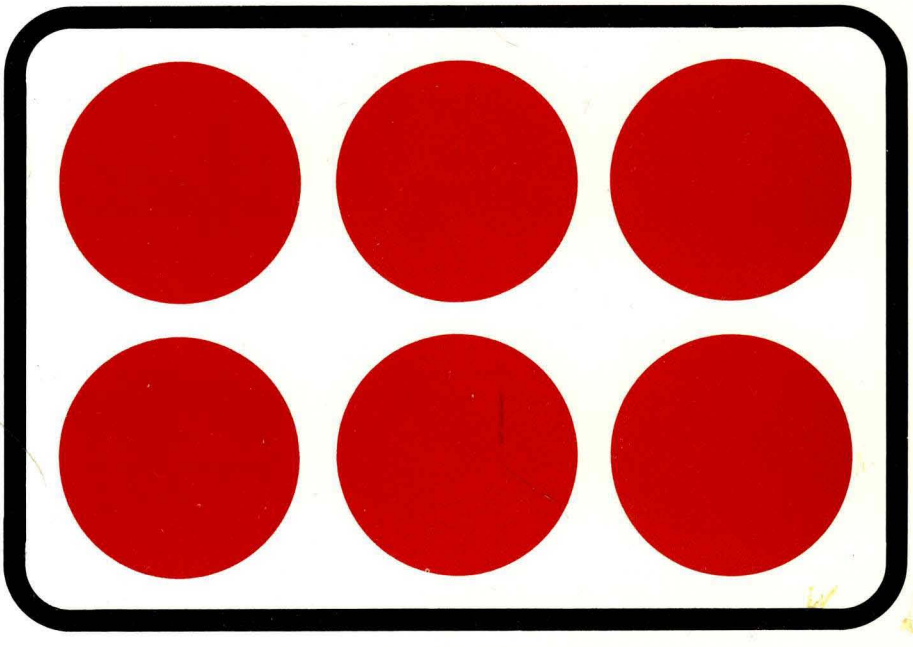


1990 DISK/TREND® REPORT

FLEXIBLE DISK DRIVES



1990 DISK/TREND® REPORT

FLEXIBLE DISK DRIVES

November, 1990

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FOREWORD

The continuing climb in flexible disk drive shipments is producing minimal revenue increases and profits which are also probably minimal for most manufacturers. No change is in sight. The product mix has evolved constantly to smaller drives with higher capacities, and with each new model, drive manufacturers have fought for market share with the tactic they know best: Cut the price.

Uncertainty over product standards is also making life difficult for drive manufacturers. IBM has nodded in the direction of the barium ferrite 4 megabyte microfloppy, but the giant has kept the industry waiting, nervously, for an IBM product introduction. The industry also seems committed to 3/4 inch high microfloppy drives, but can't decide exactly how high 3/4 inches really is.

This is the fourteenth year of the DISK/TREND Report, which is now published in three volumes, including the report on optical disk drives, published in July. A separate report on rigid disk drives was published in October.

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

James N. Porter

Robert H. Katzive

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INTRODUCTION

New tables in microfloppy section

New tables on Drive Height Analysis and Drive Capacity Analysis have been added to the microfloppy section. Included for the first time in these tables are separate forecasts for drives with heights less than 1 inch and for 4 megabyte drives.

Don't look for prices in the specification section

The information on U.S. OEM prices at the 500 unit level which was included for many years in the specification section has been deleted, starting in this edition. Unfortunately, the usefulness of the information had been reduced due to the rapid price changes in the industry and the lack of actual selling activity at low quantity levels.

Please note the market channel definitions used in DISK/TREND tables

Last year we made a change in the way shipment breakdowns by market channel are organized in the DISK/TREND Report. It is important to recognize that data for non-captive drives is broken down by separate PCM/Reseller and OEM/Integrator groups in most of the tables used in the individual product sections of the report. On the other hand, a few of the tables in the summary section combine both non-captive channels in order to summarize the data. Here are the terms, as used in this report:

* Captive -- no change; drives sold with systems also manufactured by the same company.

* PCM/Reseller -- drives used in add-on subsystems for use with computer systems of all types and sizes, plus aftermarket distribution through wholesalers, dealers and other resellers.

* OEM/Integrator -- drives sold to system manufacturers to be used as part of computer systems, plus sales to system integrators and value-added resellers which assemble complete systems.

Summary

Industry size

Worldwide shipments of flexible disk drives continue to be higher than expected, but unfortunately the industry's revenues for floppy drives continue to be lower than expected. 38.5 million floppy drives were shipped worldwide in 1989, with continuous increases forecasted through 1993, a year in which shipments of 45.7 million drives are expected. 1989 worldwide revenues dropped 10.7%, to $2.5 billion, and 1993's forecast is for $2.1 billion, continuing the long revenue decline for floppy drives.

The industry's negative revenue performance is caused by changes in product mix and the decline in average unit prices. The rapid shipment growth of microfloppy drives, which now provide 66% of the industry's unit shipments, has resulted in major displacement of 5.25 inch drives. Since the 1990 worldwide average OEM price for 5.25 inch drives is $52, while the average OEM price for microfloppies is only $46, there is a reduction in total revenues of $6 for each 5.25 inch drive displaced. The continuous decline in average OEM prices for microfloppy drives also hurts revenues. The average microfloppy OEM price in 1988 was $59, but is projected at only $38 in 1993.

We assume continuing growth for personal computer markets, which are so essential to the floppy drive industry's prosperity, but at the current sluggish rate. As a result, the average annual unit shipment growth forecasted for all floppy drives during the 1991-93 period is only 3.1%. Offsetting continuing declines in 8 inch and 5.25 inch drive shipments will be strong continuing growth in microfloppy drives and the new high capacity floppy drives grouped in a separate DISK/TREND product group.

TABLE 1

CONSOLIDATED WORLDWIDE REVENUES

ALL EXISTING FLEXIBLE DISK DRIVE GROUPS

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1989		Forecast							
	Revenues		1990		1991		1992		1993	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	9.0	16.5	4.5	9.0	--	--	--	--	--	--
Other U.S. Captive	1.6	3.6	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	10.6	20.1	4.5	9.0	--	--	--	--	--	--
PCM/Reseller	56.8	71.7	54.1	68.3	67.5	82.8	57.1	74.8	37.1	54.5
OEM/Integrator	7.5	8.4	5.1	6.1	10.6	12.8	28.4	35.6	50.0	66.3
TOTAL U.S. NON-CAPTIVE	64.3	80.1	59.2	74.4	78.1	95.6	85.5	110.4	87.1	120.8
TOTAL U.S. REVENUES	74.9	100.2	63.7	83.4	78.1	95.6	85.5	110.4	87.1	120.8
Non-U.S. Manufacturers										
Captive	32.6	535.2	16.6	459.1	15.2	362.6	17.0	305.8	20.3	263.8
PCM/Reseller	185.5	248.3	181.8	239.7	155.0	203.3	156.7	202.4	150.2	195.2
OEM/Integrator	683.2	1,663.7	670.5	1,656.8	659.0	1,651.1	655.6	1,602.2	653.1	1,518.3
TOTAL NON-U.S. REVENUES	901.3	2,447.2	868.9	2,355.6	829.2	2,217.0	829.3	2,110.4	823.6	1,977.3
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	976.2	2,547.4	932.6	2,439.0	907.3	2,312.6	914.8	2,220.8	910.7	2,098.1

Marketing channels

The number of manufacturers participating in the flexible disk drive industry continues downward from the peak of 58 companies in 1986. In 1990, the total number is 49 firms, a reduction of three from the previous year.

The list of participants is still dominated by Japanese companies, now down slightly to a total of 20. Two Japanese companies with relatively small production levels dropped floppy drives, but Verbatim has been added to the list of Japanese firms, now that it has been acquired by Mitsubishi Kasei. Other Asian manufacturers are finding it difficult to stay in the floppy drive business, due to the low prices which have resulted from intense competition for market share between the Japanese companies. Few Taiwan or Hong Kong floppy drive manufacturers plan to make 3.5 inch models, and many will probably discontinue their floppy drive products as the industry's established trend to 3.5 inch continues.

Only seven U.S. manufacturers still make floppy drives. Most remaining U.S. producers are making specialized floppy drives or the newer high capacity models except for IBM, which is not expected to stay on the list much longer.

Users of the DISK/TREND Report should note that revenues are reported at the level of each drive's first public sale. The price used for each drive is the estimated value at the first time it is sold to a non-affiliated buyer, at captive end user, PCM/Reseller or OEM/Integrator levels. An understanding of the relative prices at captive and non-captive levels is important in interpreting DISK/TREND revenue statistics, to avoid an exaggerated impression of the share of the industry's total unit shipments held by captive drives.

TABLE 2

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

REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	1989 Revenues $M	1989 Revenues %	Forecast 1990 $M	1990 %	Forecast 1991 $M	1991 %	Forecast 1992 $M	1992 %	Forecast 1993 $M	1993 %
U.S. Manufacturers										
IBM Captive	16.5 -17.9%	.6%	9.0 -45.5%	.3%	-- -100.0%	--	-- --	--	-- --	--
Other U.S. Captive	3.6 -78.6%	.1%	-- -100.0%	--	-- --	--	-- --	--	-- --	--
PCM/Reseller	71.7 +16.4%	2.8%	68.3 -4.7%	2.8%	82.8 +21.2%	3.5%	74.8 -9.7%	3.3%	54.5 -27.1%	2.5%
OEM/Integrator	8.4 -50.6%	.3%	6.1 -27.4%	.2%	12.8 +109.8%	.5%	35.6 +178.1%	1.6%	66.3 +86.2%	3.1%
Total U.S. Manufacturers	100.2 -13.2%	3.8%	83.4 -16.8%	3.3%	95.6 +14.6%	4.0%	110.4 +15.5%	4.9%	120.8 +9.4%	5.6%
Non-U.S. Manufacturers										
Captive	535.2 -28.1%	21.0%	459.1 -14.2%	18.8%	362.6 -21.0%	15.6%	305.8 -15.7%	13.7%	263.8 -13.7%	12.5%
PCM/Reseller	248.3 +26.4%	9.7%	239.7 -3.5%	9.8%	203.3 -15.2%	8.7%	202.4 -.4%	9.1%	195.2 -3.6%	9.3%
OEM/Integrator	1,663.7 -7.5%	65.5%	1,656.8 -.4%	68.1%	1,651.1 -.3%	71.7%	1,602.2 -3.0%	72.3%	1,518.3 -5.2%	72.6%
Total Non-U.S. Manufacturers	2,447.2 -10.6%	96.2%	2,355.6 -3.7%	96.7%	2,217.0 -5.9%	96.0%	2,110.4 -4.8%	95.1%	1,977.3 -6.3%	94.4%
Worldwide Recap										
Captive	555.3 -28.9%	21.8%	468.1 -15.7%	19.2%	362.6 -22.5%	15.7%	305.8 -15.7%	13.8%	263.8 -13.7%	12.6%
PCM/Reseller	320.0 +24.0%	12.6%	308.0 -3.7%	12.6%	286.1 -7.1%	12.4%	277.2 -3.1%	12.5%	249.7 -9.9%	11.9%
OEM/Integrator	1,672.1 -7.9%	65.6%	1,662.9 -.6%	68.2%	1,663.9 --	71.9%	1,637.8 -1.6%	73.7%	1,584.6 -3.2%	75.5%
Total All Manufacturers	2,547.4 -10.7%	100.0%	2,439.0 -4.3%	100.0%	2,312.6 -5.2%	100.0%	2,220.8 -4.0%	100.0%	2,098.1 -5.5%	100.0%

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

Product mix

Microfloppy drive shipments continue to grow to higher levels than expected. 1989 worldwide unit shipments were 23.2 million drives, and the expected average annual growth rate of 14.9% for the five years of this report will boost the total to 35.9 million drives in 1993. The forces of competition will continue to depress average prices, however, and worldwide revenues for microfloppy drives are expected to increase at an average annual rate of only 3.1% for the same period.

5.25 inch floppy drives have finally peaked after thirteen years, and shipments were down 10.1% in 1989, to 14.8 million drives. The outlook through 1993 is for a continuing slide in shipment levels, to 8.8 million in that year. By 1993, 94.9% of 5.25 inch floppy drive shipments are forecasted to be 1.6 megabyte models, driven by the lingering momentum of the PC AT market, reflecting IBM's inability to arbitrarily change the industry's direction in personal computers on short notice.

Even though current shipment levels for high capacity floppy drives over 5 megabytes are weak, high growth rates are expected for this product group as new 3.5 inch drives become available. The product group includes Iomega's Bernoulli principle 8 and 5.25 inch drives, as well as other 8 and 5.25 inch drives in the 6 to 24 megabyte range, none of which is likely to provide significant future growth. The expected demand for the high capacity 3.5 inch drives, especially the new downward compatible one inch high models expected in the first half of 1991, will probably be sufficient to boost shipments in this product group to new heights, despite manufacturing start-up problems and current lack of an effective media interchange standard.

Figure 1

CHANGING PRODUCT MIX

Worldwide Flexible Disk Drive Revenue

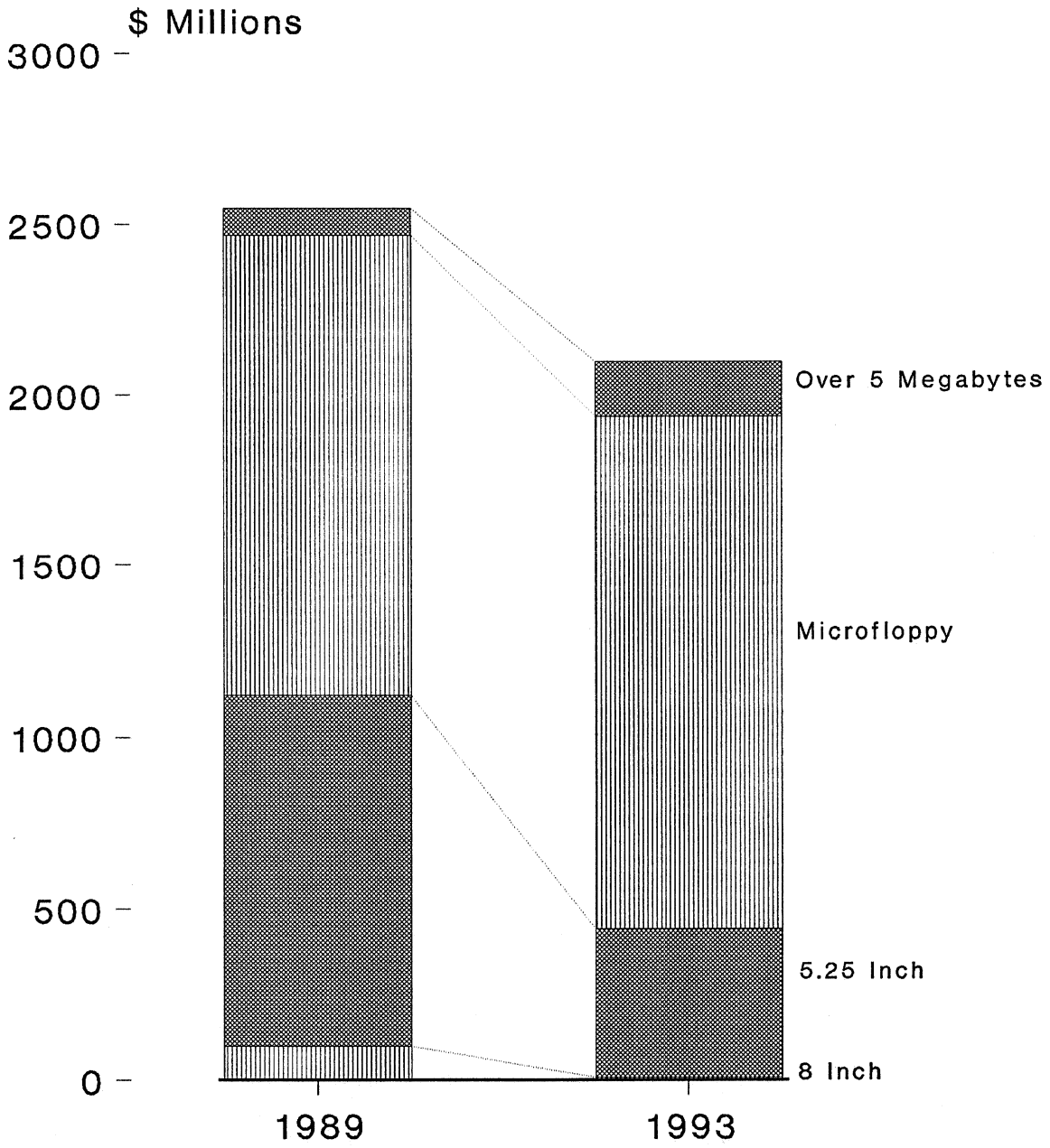

TABLE 3

WORLDWIDE SHIPMENTS

PRODUCT CATEGORY SUMMARY

ALL MANUFACTURERS

Units: Thousands Dollars: $ Million		1989 Shipments	%	1990 Forecast	%	1991 Forecast	%	1992 Forecast	%	1993 Forecast	%
		Ship		Ship		Ship		Ship		Ship	
8 INCH DRIVES											
	Units	245.4	-32.4	166.2	-32.2	108.2	-34.8	62.0	-42.6	26.0	-58.0
	$M	100.0	-38.0	67.6	-32.4	39.8	-41.1	21.2	-46.7	8.8	-58.4
5.25 INCH DRIVES											
	Units	14,886.1	-10.1	13,866.7	-6.8	12,495.0	-9.8	10,755.0	-13.9	8,817.0	-18.0
	$M	1,021.0	-23.5	895.8	-12.2	736.0	-17.8	583.3	-20.7	434.9	-25.4
MICROFLOPPY DRIVES											
	Units	23,216.2	+28.1	27,417.0	+18.0	30,270.0	+10.4	33,415.0	+10.3	35,929.0	+7.5
	$M	1,347.2	+5.0	1,399.4	+3.8	1,428.6	+2.0	1,482.9	+3.8	1,494.4	+.7
DRIVES OVER 5 MEGABYTES											
	Units	108.9	-13.8	105.0	-3.5	230.3	+119.3	463.3	+101.1	879.0	+89.7
	$M	79.2	+6.4	76.2	-3.7	108.2	+41.9	133.4	+23.2	160.0	+19.9
TOTAL ALL DRIVES											
	Units	38,456.6	+9.3	41,554.9	+8.0	43,103.5	+3.7	44,695.3	+3.6	45,651.0	+2.1
	$M	2,547.4	-10.7	2,439.0	-4.2	2,312.6	-5.1	2,220.8	-3.9	2,098.1	-5.5

Figure 2

CHANGING PRODUCT MIX

Worldwide Flexible Disk Drive Shipments
All Manufacturers

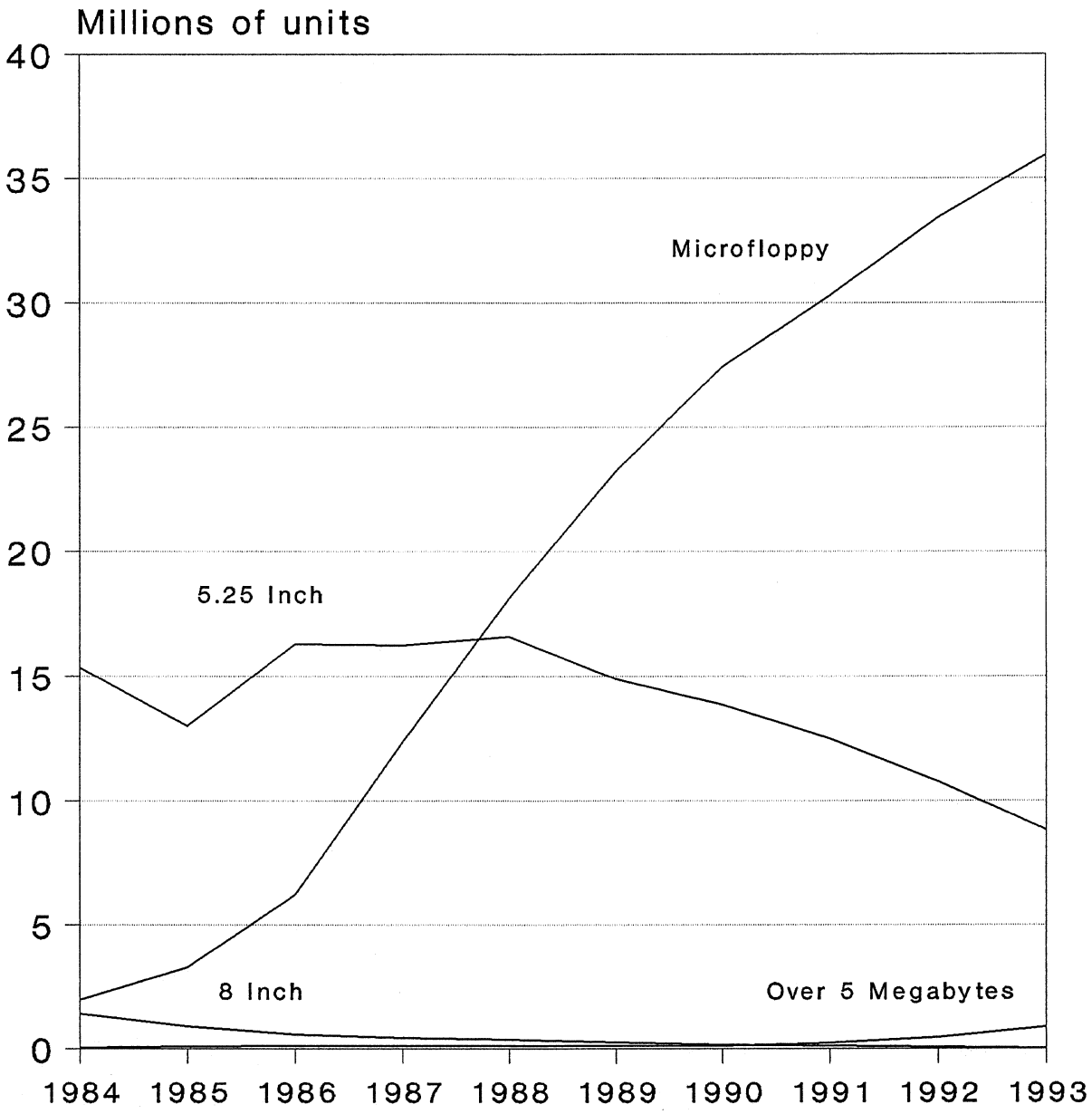

TABLE 4

WORLDWIDE SHIPMENTS

PRODUCT CATEGORY SUMMARY

MANUFACTURERS OF NON-CAPTIVE DRIVES

Units: Thousands Dollars: $ Million		1989 Ship	1989 %	1990 Ship	1990 %	1991 Ship	1991 %	Forecast 1992 Ship	Forecast 1992 %	Forecast 1993 Ship	Forecast 1993 %
8 INCH DRIVES											
	Units	139.7	-40.9	85.2	-39.0	55.2	-35.2	34.0	-38.4	14.0	-58.8
	$M	36.3	-48.8	21.2	-41.5	13.3	-37.2	7.2	-45.8	2.8	-61.1
5.25 INCH DRIVES											
	Units	13,432.6	-12.2	12,498.7	-6.9	11,445.0	-8.4	9,990.0	-12.7	8,332.0	-16.5
	$M	737.2	-21.7	650.9	-11.7	568.4	-12.6	468.7	-17.5	367.0	-21.6
MICROFLOPPY DRIVES											
	Units	21,960.1	+32.6	26,186.0	+19.2	29,068.0	+11.0	32,079.0	+10.3	34,379.0	+7.1
	$M	1,139.7	+15.6	1,224.1	+7.4	1,269.5	+3.7	1,319.0	+3.8	1,321.3	+.1
DRIVES OVER 5 MEGABYTES											
	Units	108.5	-14.0	101.7	-6.2	207.1	+103.6	428.3	+106.8	831.0	+94.0
	$M	78.9	+6.1	74.7	-5.3	98.8	+32.2	120.1	+21.5	143.2	+19.2
TOTAL ALL DRIVES											
	Units	35,640.9	+10.6	38,871.6	+9.0	40,775.3	+4.8	42,531.3	+4.3	43,556.0	+2.4
	$M	1,992.1	-3.9	1,970.9	-1.0	1,950.0	-1.0	1,915.0	-1.7	1,834.3	-4.2

Figure 3

CHANGING PRODUCT MIX

Non-Captive Flexible Drive Shipments

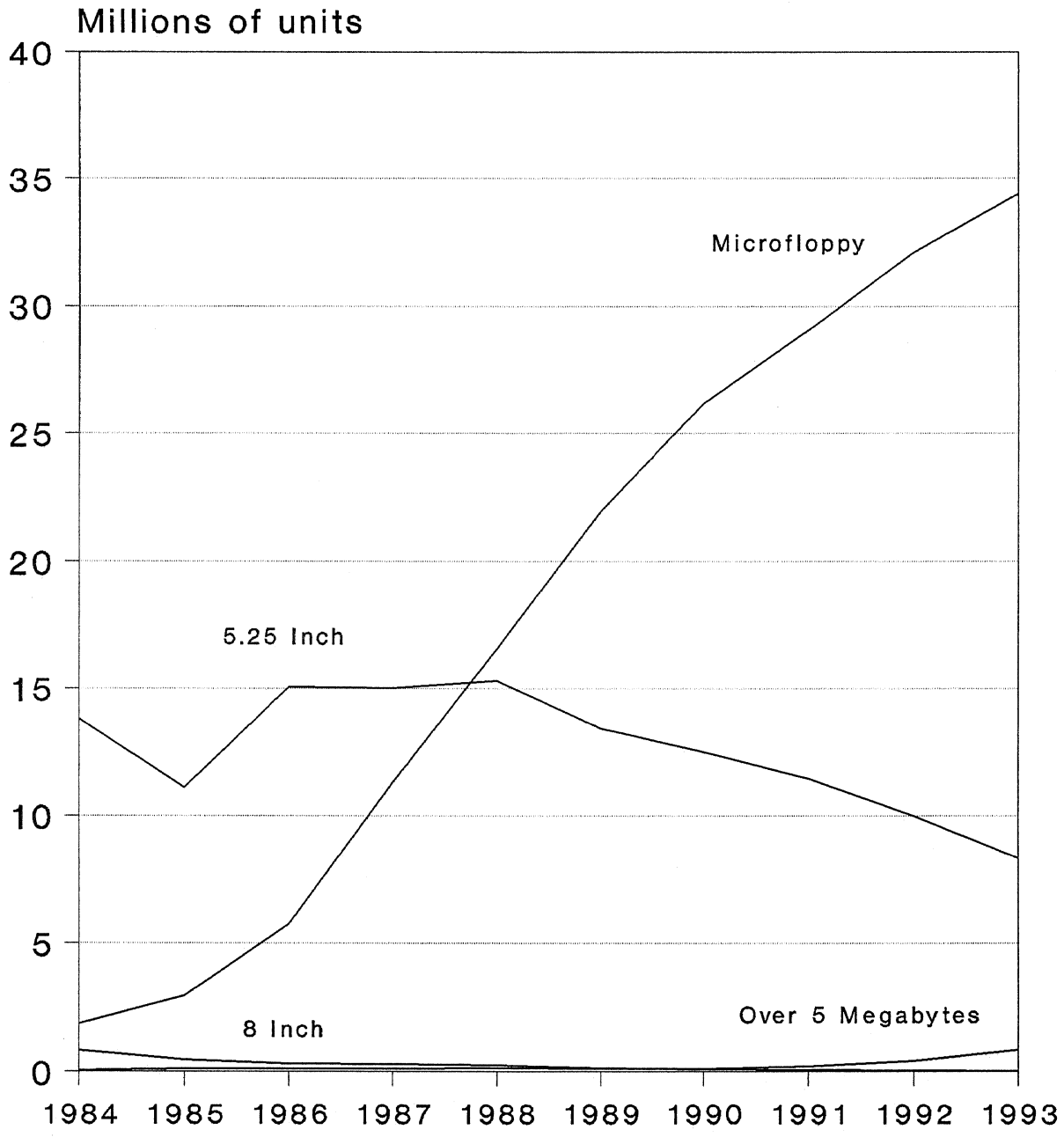

TABLE 5

1989 ESTIMATED MARKET SHARES

WORLDWIDE REVENUES OF ALL FLEXIBLE MAGNETIC DISK DRIVES
(Value of non-U.S. currencies estimated at average 1989 rates)

	CAPTIVE		PCM		OEM		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
Iomega	--	--	67.3	21.0	4.2	.3	71.5	2.8
Other U.S.	20.1	3.6	4.4	1.4	4.2	.3	28.7	1.1
U.S. Total	20.1	3.6	71.7	22.4	8.4	.5	100.2	3.9
NON-U.S. MANUFACTURERS								
Alps Electric	--	--	--	--	99.3	5.9	99.3	3.9
Canon	6.8	1.2	--	--	45.1	2.7	51.9	2.0
Chinon	--	--	63.7	19.9	66.8	4.0	130.5	5.1
Citizen	--	--	--	--	71.3	4.3	71.3	2.8
Matsushita Comm. Ind.	10.2	1.8	--	--	184.7	11.0	194.9	7.7
Mitsubishi Electric	12.5	2.3	28.4	8.9	202.5	12.1	243.4	9.6
Mitsumi Electric	--	--	6.6	2.1	66.4	4.0	73.0	2.9
NEC	345.2	62.2	--	--	51.0	3.1	396.2	15.6
Seiko Epson	51.6	9.3	10.7	3.3	74.8	4.5	137.1	5.4
Sony	11.6	2.1	--	--	282.4	16.9	294.0	11.5
Teac	--	--	54.5	17.0	285.6	17.1	340.1	13.4
Toshiba	40.6	7.3	40.0	12.5	20.8	1.2	101.4	4.0
Y-E Data	--	--	21.7	6.8	117.6	7.0	139.3	5.5
Other Non-U.S.	56.7	10.2	22.7	7.1	95.4	5.7	174.8	6.9
Non-U.S. Total	535.2	96.4	248.3	77.6	1,663.7	99.5	2,447.2	96.1
WORLDWIDE TOTAL	555.3	100.0	320.0	100.0	1,672.1	100.0	2,547.4	100.0

TABLE 6

Codes: C = Captive
P = PCM
O = OEM

CURRENT PRODUCT LINES
MANUFACTURERS OF FLEXIBLE DISK DRIVES

Numbers in table indicate TPI

U.S. MANUFACTURERS	DISK/TREND PRODUCT GROUP: TYPE	13 8 INCH	14 5.25 INCH	15 MICRO FLOPPIES	16 HIGH CAPACITY >5 MB
Brier Technology	O				777
Genisco	O			135	
IBM	C	48			
Insite Peripherals	O				1250
Iomega	P,O				300,570,641,1095
Miltope	O	48			
Qume	O				666
ASIAN MANUFACTURERS					
Alps Electric	O		48,96	135	
Asia Commercial	O		48,96		
Brother	C,O			67.5,135	
Canon	O		48,96	135	
Chinon	O		48,96	135,254	
Citizen	O			135	542
Eastern Peripherals	O		48,96		
Ergo	C,O		48	135	
Fujitsu	O		48,96	135	
GoldStar Telecommunication	O		48,96	135	
Hitachi	C,O	48	96		96,125
Ho Shin	O		48,96		
Hyundai Electronics	C,O			135	
Jin Tech Electronics	P,O		48		
Konica	O				480
Mantec Technology	P		48,96		
Matsushita Communication Indust.	O	48	48,96	135,254	135,541
Matsushita Electronic Components	O			100,135,200	
Mitsubishi Electric	O		48,96	135	
Mitsumi Electric	O		48,96	135,254	
NEC	C,O	48	96	135	431
Oriental Precision	C,O		48,96		
Roctec	O		48		
Samsung Electronics	C,O		48,96	135	
Sankyo Seiki	O			135	
Seiko Epson	O		48,96	135	
Sony	C,O			135,254	
Teac	O		48,96	135	
Tecmate	O		48,96		
Toshiba	C,O		48,96	135	542
Verbatim	C,O				666
Y-E Data	O	48	48,96	135	
EUROPEAN MANUFACTURERS					
DZU	C,O		48,96	135	
Elcomatic	O	48,96			
Magyar Optikai Muvek	O		48,96		
Peripheral Data Systems	C,O		48		
Robotron	C,O		48,96		
SOUTH AMERICAN MANUFACTURERS					
Cobra	C	48			
Elebra Informatica	O		48,96		
Flexdisc	O		48,96		
Multidigit	O		48,96		
Prologica	C,O		48		

Application mix

Personal computers used for business applications have made possible the creation of entirely new computer markets in the last ten years, and they have taken over a significant share of the functions of minicomputers and mainframes during the same period. As the role of personal computers has increased, so has that of the floppy drives used with almost all PCs. However, there are now signs that the percentage share of worldwide floppy drive shipments held by business personal computers may be saturating, as the home computer market appears headed for higher growth and as many new notebook portable computers appear without floppy drives.

In 1988 shipments of microfloppy drives overtook 5.25 inch drives for the first time in business personal computer applications. In 1989 the microfloppy share rose to 60.3%, and by 1993 microfloppies are expected to hold 78.2% of the business personal computer market.

Consumer and hobby applications are expected to grow faster than any other application in the next few years. The DISK/TREND forecasts indicate that these applications will consume 10.6% of 1993's overall shipments, up from 1989's 4.1%. As recently as 1988, 5.25 inch drives provided more than half of the floppy drive total for consumer and hobby applications, but microfloppies had risen to 79.5% of the worldwide total in 1989 and are projected to provide 96.5% of the 1993 total.

The proportion of floppy disk drives used in dedicated office systems continues to slide, as general purpose personal computers displace many specialized systems in both office and non-office environments. In 1993 the share of total floppy drive shipments used with dedicated office systems is expected to be down to 4.2%.

TABLE 7

FLEXIBLE DISK DRIVE APPLICATIONS SUMMARY

CONSOLIDATED WORLDWIDE SHIPMENTS

	1989 Estimate					1993 Projection				
	All FDD	8" All Types	5.25" All Types	Micro Floppy	Over 5 MB	All FDD	8" All Types	5.25" All Types	Micro Floppy	Over 5 MB
MAINFRAME/SUPERMINI General purpose										
Units (000)	61.8	10.7	--	51.1	--	37.0	1.0	--	35.9	--
Share %	.2%	4.3%	--	.2%	--	.1%	4.0%	--	.1%	--
MINICOMPUTERS AND MULTIPLE USER MICROS Including networks										
Units (000)	811.0	93.4	527.0	185.7	4.9	928.9	10.9	352.7	538.9	26.4
Share %	2.1%	38.1%	3.5%	.8%	4.5%	2.0%	42.0%	4.0%	1.5%	3.0%
PERSONAL COMPUTERS Single user										
Units (000)	32,364.2	68.2	12,712.7	19,501.6	81.7	36,393.3	--	7,229.9	28,455.8	707.6
Share %	84.1%	27.8%	85.4%	84.0%	75.1%	79.7%	--	82.0%	79.2%	80.5%
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application										
Units (000)	2,393.6	43.5	973.6	1,369.8	6.7	1,925.1	3.1	440.9	1,437.2	44.0
Share %	6.2%	17.7%	6.5%	5.9%	6.2%	4.2%	12.0%	5.0%	4.0%	5.0%
NON-OFFICE SYSTEMS AND WORKSTATIONS Dedicated application										
Units (000)	827.2	21.7	312.6	478.3	14.6	1,076.4	10.7	573.1	431.1	61.5
Share %	2.2%	8.9%	2.1%	2.1%	13.4%	2.4%	41.0%	6.5%	1.2%	7.0%
CONSUMER AND HOBBY COMPUTERS										
Units (000)	1,576.2	--	321.5	1,253.7	1.0	4,842.6	--	132.3	4,670.8	39.5
Share %	4.1%	--	2.2%	5.4%	.8%	10.6%	--	1.5%	13.0%	4.5%
OTHER APPLICATIONS										
Units (000)	422.6	7.9	38.7	376.0	--	447.7	.3	88.1	359.3	--
Share %	1.1%	3.2%	.3%	1.6%	--	1.0%	1.0%	1.0%	1.0%	--
TOTAL, ALL APPLICATIONS										
Units (000)	38,456.6	245.4	14,886.1	23,216.2	108.9	45,651.0	26.0	8,817.0	35,929.0	879.0
Share %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

TECHNICAL REVIEW

Competing technologies

Improvements in capacity and form factor are combining to insure that the flexible disk drive remains the generally preferred choice where reliable and inexpensive program interchange or data storage are needed for small computing systems. Other technologies are making minor inroads in these applications, but in most cases, the most effective competitors of current flexible disk drives are higher capacity or smaller flexible disk drives. The unique combination of low cost, random access and media removability provided by flexible disk drives is the reason for their success. Any competing technology must offer significant improvements at a competitive price.

Like their rigid disk cousins, flexible disk drives are evolving. Smaller form factors, higher capacities, more effective designs and lower cost manufacturing methods sustain floppy drive cost-effectiveness against that of competitive data storage technologies. Consequently, alternate technologies are finding only limited success in breaking into floppies' established markets. Some displacement of floppy drives is occurring in notebook and hand-held computers where there is insufficient space or power for floppy drives. The high capacity floppy drive designs now entering the production phase are proof that innovation in floppy disk drives is a continuing process.

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 probably also served to increase the size of the total market for small computer systems, and therefore boost the market for floppy drives. For most small fixed disk drives installed, a companion removable media recording device is necessary to provide for software distribution, save/restore of programs and files, and backup to protect against hardware, software or operator failure. Most of the time, that removable device is a floppy disk drive. With the arrival of 3.5 inch floppy drives in IBM and laptop systems, 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.

  The rigid disk challenge to flexible disk drives is most effectively presented by both disk cartridge drives and small fixed disk drives. Small disk cartridge drives, some with capacities as high as 89 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. Availability has been the limiting factor in growth of the disk cartridge share of this market, with only a few manufacturers in production.

  If floppy disk drives having capacities of 5 megabytes or more are successful, removable rigid disk drives will be less attractive as floppy disk replacements. Several high capacity floppy drives have been announced and some are in the early stages of production. Specialized products, such as the Iomega Bernoulli disk drives, also provide competition for rigid disk drives.

* Stretched surface recording: Another candidate is the stretched surface recording (SSR) technology developed by 3M, making use of a magnetic recording layer coated on a plastic film which is then stretched across concentric cylindrical rings. The chief characteristic of this technology is that it allows a head to fly on an air cushion backed by a deformable surface that bulges slightly in the region under the head. This provides the close head-media separation needed for high capacity, but also makes the product head-crash proof. The capacity of such a product may be similar to that of a Winchester disk drive of similar diameter, but the cost could eventually be less because the SSR disk has the potential of being fabricated at much lower cost than a rigid disk. 3M has had various arrangements with other firms interested in developing SSR drives for several years. Most, if not all, of these efforts have become inactive. No SSR drives or media have been announced, though reports of joint activity between 3M and Sony have appeared in the trade press.

* Read-only optical disks: The read-only optical disk category is dominated by the CD-ROM. Storage capacities of 550 to 600 megabytes are typical of these products. CD-ROM technology borrows heavily from the designs of the 4.72 inch CD audio players now in volume production, resulting in relatively low manufacturing costs. 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. In addition to the 4.72 inch CD-ROM, which is limited in capability, high performance 12 inch read-only drives are being shipped by Reference Technology. 3.14 inch CD-ROM drives were introduced by Sony in 1990. Most read-only optical drives are essentially part of a data distribution system and will be used with small systems to provide personal access to large amounts of information. They are expected to have no impact on the floppy drive's role in providing backup capabilities for small systems and to have minimal impact on the use of floppy disk drives for distribution of software for personal computers and other small systems. Even where CD-ROM appears as a system peripheral device, floppy disk drives continue to be required, because only selected software will be distributed on CD-ROM for some years to come.

* Non-reversible optical disks: The first optical disk recording systems to enter the market were "non-reversible" or "write-once" systems. Write-once 5.25 inch and 12 inch drives are being shipped in modest quantities, and CD format writable disk drives in 4.72 inch and 3.14 inch formats are being shipped in small numbers, but at high cost.

  Because they have track densities approaching 16,000 tracks per inch, write-once drives are capable of higher areal densities than magnetic recording techniques now in use. Capacity can range from about 100 megabytes per disk side to over three gigabytes. Many of the drives are being used in optical library based storage systems which access large numbers of optical disks under system control.

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

* Erasable optical disks: The possibility for real inroads into the market for magnetic disk drives, including high capacity floppy disk drives, exists with reversible optical disk systems. Magneto-optical recording drives were introduced in 1988 and phase change optical recording has now also reached the market. Low-end erasable optical drives offer the eventual promise of higher capacities and average access times equivalent to those offered by many of today's small magnetic rigid disk drives, but inferior performance

and high relative cost will keep them in niche applications until technology improves and increasing volume lowers costs.

Magneto-optic drives use a low power laser to change the magnetic state of the active layer on a disk. The laser raises temperature of the active layer into the Curie point range while a magnetic field is present, causing individual magnetic domains on the disk to align with the direction of the external field. Changes in magnetic orientation are detected during reading, as the affected spot on the disk causes a small rotation in the polarized light reflected from the surface or transmitted through the disk. However, magneto-optical disks have not yet shown the ability to overwrite in place. Each individual sector must be erased before the sector can be rewritten again, reducing performance. Most erasable optical drives currently use magneto-optic recording.

Phase change optical recording involves a different type of amorphous coating, in which individual spots on the disk are changed by polarized light from a crystalline state, during which light is reflected, to a noncrystalline state, during which light is absorbed. Fujitsu has revealed a comparable process in which different crystalline states are used to vary reflectivity. Several other firms, such as Philips and Matsushita also have active programs, and erasable phase change technology was introduced by Matsushita in 1990 in a 5.25" drive.

A third technology, potentially the least expensive to manufacture, is erasable dye/polymer. As of yet, only limited success has been obtained with this technique because developers have not been able to demonstrate an adequately large number of write/erase cycles. Tandy corporation has indicated its intent to offer a low cost erasable optical drive using dye-polymer technology and a CD-like mechanism in the early 1990s.

Individual firms are also working on other proposed reversible optical recording technologies, but none are known to have overcome all of the problems, which have included: Slow completion of the reversal cycle, limitations on the number of reversals before degradation, poor shelf life, and low recording density.

Drive and media costs for erasable optical storage are far above the costs of conventional floppy technology, and it is unlikely that floppy drives will be impacted soon. However, competition between very low-end optical drives and very high-end floppy drives may eventually occur. The capacity of low-end 3.5 inch erasable optical drives is currently 128 megabytes, but available at high prices compared to floppy disk technology. Due to optical disk drive complexity and the thickness of the optical cartridge, optical drives will have great difficulty in matching the 3/4 inch high form factor which will be the standard for the 3.5 inch floppy drives used in most applications in the near future.

For optical drives offering nominal performance and a limited degree of erasability, prices may someday approach high capacity floppy drive prices as floppy drive capacity increases above 20 megabytes, although floppy media will remain less expensive than optical media. Both products will compete against tape drives for save/restore applications in small systems and personal computers and will be appropriate for program and data interchange for the more powerful personal computers and network servers.

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

  Digital cassette and tape cartridge drives were available before most of today's floppy drives, but shipments of these drives have never approached those for floppies. The reasons lie in the inability of tape drives to offer fast direct access to individual records, generally higher prices for the tape drives, and until recently, a lack of industry-wide standards for interfaces and media interchange. Today, however, the pressing demand for backup devices that can handle the higher capacities offered by the newest small Winchester drives has expanded the opportunity for small tape drives and, potentially, for high capacity floppy drives.

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

  Tape standards, plus new tape cartridge drives designed to the same form factor as 3.5 inch and 5.25 inch Winchesters, are resulting in significant penetration by tape cartridge streamers (and 4 millimeter helical scan drives in the future) in the backup market for Winchesters in the 20-30 megabyte range and above. Tape capacities for small systems now range from 40 megabytes to several gigabytes.

Will small tape cartridge drives displace conventional flexible disk drives? The new generation of high capacity floppy drives will extend the rigid drive capacity range over which floppies can compete for a role as a backup device to 20-40 megabytes and, eventually, to 80 megabytes. Larger rigid drives will continue to create a demand for tape streamers, helical scan tape drives, or removable rigid disk drives for backup functions. In any event, floppy drives will undoubtedly continue to be used on many small systems with large capacity Winchester drives. Their role will include software distribution and data interchange, and they will remain a convenient backup method for the small files which usually accompany large files.

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

* Magnetic bubbles: If regarded as a specialized data storage product, magnetic bubbles still occupy a viable market niche, despite a serious loss of credibility after the 1981 departure of National Semiconductor, Texas Instruments and Rockwell International from the field. Intel announced its exit from the market in 1986 when it sold its bubble memory business to Memtech Technology.

  Nevertheless, the non-volatility and environmental insensitivity of magnetic bubbles and their suitability for capacities too small to be cost-effective for magnetic disk drives remain attractive to system manufacturers for applications such as industrial control systems, robots, point of sale terminals, portable computers, medical instrumentation, avionic systems and militarized systems.

  Bubble memories for both military and industrial system applications are being made by Magnesys, which was formed in 1983. In 1988, Magnesys licensed Science Applications International Corporation (SAIC), a defense contractor, as a second manufacturing source. Magnesys has begun offering bubble cartridge storage systems in 360 and 720 kilobyte configurations, but the price is ten to fifteen times that of equivalent flexible disk drives.

  In the 1990's, content addressable, high density bubble memories based upon Vertical Bloch Line (VBL) domains and bubble logic might be able to challenge disk memory in some applications. R&D efforts at Carnegie Mellon University, Boston University, Purdue, NEC, Kyushu University and other locations have shown promise, but much remains to be done to make VBL a practical technology. Ultimately, the ability of bubble memory to be a major competitor requires greatly reduced costs.

* Semiconductor memory: Semiconductor DRAM memory is still too expensive to compete directly with floppy disks. 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 non-volatility and a production process similar to that of the well understood CMOS, but is unlikely to be a significant competitor until after 1992.

  Although chips may be reliable, the integrity of the interconnections between removable media containing chips and a socket is less certain than that of the current head/magnetic media interface. However, the price of semiconductor memory is coming down. The chip cost per megabyte is expected to be in the range of one dollar by the late nineties for DRAMs and about two dollars per megabyte for SRAMs and other non-volatile memory types. By comparison, floppy disk media is expected to cost about fifty cents per megabyte in the same period. However, for semiconductor memory to continue to advance as expected, difficult problems in manufacturing technology must be overcome -- especially those concerned with producing narrower line widths. The rate of development will slow down as the plant and equipment costs increase and lead times for advanced manufacturing and production equipment become significantly longer.

  Small plastic cards containing IC memories ranging from 8 kilobytes to over 1 megabyte in capacity may challenge floppy disk drives in selected applications such as games, palmtop computers, medical history storage, programming for electronic musical instruments, and type font storage for printers. Typically the size of a credit card, the cards may contain a PROM, EPROM, or EEPROM depending upon whether the application requires read-only, write-once or rewritable storage. While more expensive than floppy disk media, the cards are less vulnerable, though not immune, to handling damage. Flash EEPROM, while non-volatile and rewritable, suffers from a limit on the number of write-erase cycles possible. Current technology is limited to about 100,000 cycles. The IC card has been promoted more widely in Europe and Japan than in the U.S., but recent agreements on dimensional and pin connection standards, coupled with the explosive growth of the notebook and smaller computer market, have revived interest among U.S. manufacturers.

  Semiconductor memory will compete with floppy drives only where the space and power required to support a floppy drive is excessive, mostly in hand-held or some notebook systems.

Flexible disk drive enhancements

IBM developed most of the basic technology used in flexible disk drives, but has failed to introduce a successful new floppy drive since the two sided 8 inch drive in 1976. In 1985, IBM announced that it would phase out production of floppy disk drives, but production continued at a low level. In the late 1970s, Shugart Associates shrunk IBM's original technology down to the 5.25 inch format, pulling off one of the most influential repackaging jobs of all time.

The floppy formats which have created the most impact in recent years are the Nippon Telephone & Telegraph 1.6 megabyte version of the 5.25 inch drive, the Sony 3.5 inch, 2 megabyte microfloppy, and, most recently, the 4 megabyte 3.5 inch drive pioneered by Toshiba. Without IBM's leadership, the industry took years to reach a consensus on these formats, while passing others by. And after all the confusion, IBM finally endorsed both the 1.6 megabyte 5.25 inch and the 3.5 inch (including the 2 megabyte version) formats through product introductions.

Recently the leading edge in floppy drive innovation has shifted to two areas: Decreasing height and increasing capacity. The vertical form factor for the newest 3.5 inch drives has decreased to 3/4 inch, spurred by the requirements of notebook and laptop system producers, while drives with capacities over 20 megabytes have entered production.

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

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

* Form factor: The newest 3.5 inch floppy drives now in production require approximately 3/4 inch of vertical front panel space. This is significant because it permits two drives to be mounted in the space of a standard 41.3 millimeter drive bay, a real advantage to system manufacturers in offering flexibility to dealers and users in installing options on a modular basis. The smaller volume also permits designers of laptop and notebook computers to reduce weight and system package size.

  Drives ranging from 17 to 19 millimeter height are currently being offered as "3/4 inch" drives. Whatever height eventually becomes the industry standard, 3/4 inch high drives are expected to rapidly displace one inch high floppy disk drives, much as the one inch high units have already largely displaced the 1.625 inch form factor. Some manufacturers expect to be able to eventually manufacture floppy drives with 1/2" height form factors.

* Media: The polyester substrate used with flexible disks suffers from limitations in its dimensional stability which derive from the manufacturing process used. As a result, today's mainstream floppy drive products using open loop head positioning systems for low cost are limited to 48 TPI with 8 inch drives, 96/100 TPI with 5.25 inch drives, and 135 TPI with microfloppy drives. The relatively small tonnage of polyester required for diskettes did not inspire plastics manufacturers to invest heavily in research targeted at dimensional stability improvements until the last few years, when the quantities became too large to ignore. However, the magnetic recording industry has been actively developing several methods of increasing track recording density with active servo tracking.

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

* Longitudinal particulate coatings: Oxide coatings have been the mainstream coating technology for floppy disks. 300 Oersted coatings capable of 5,000 to 6,000 flux changes per inch (FCI) were used on 8 inch and early 5.25 inch diskettes, while 600 Oersted cobalt modified oxide coatings are currently in use on most high density 5.25 inch and microfloppy diskettes. Cobalt modified oxide coatings typically achieve 8,000 to 10,000 FCI for 5.25 inch drives and 17,434 FCI for the 2.0 megabyte microfloppies in common use.

  Oxide coatings are beginning to be displaced by higher performance coatings such as barium ferrite and metal particle coatings. The 4 megabyte 3.5 inch floppy drive introduced by Toshiba and others

records at 34,768 FCI and Citizen has introduced a 20.6 megabyte drive (formatted) that records at 43,000 FCI on metal particle media. The U.S. producers of very high capacity floppy drives have tended to favor barium ferrite because of its similarities in manufacturing to the familiar oxide coatings and a belief that it can, with further development, be used to reach capacities of 40 to 50 megabytes per diskette. Japanese producers tend to favor metal particle coatings because of its inherently higher performance, previous experience with it in entertainment products, and a strong industry position in metal powder media.

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

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

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

  Several firms have announced tentative specifications for small flexible disk drives using perpendicular recording. Sony's experimental 3.5 inch drive provides 4 megabytes using 65,500 FCI. Matsushita Electric has claimed the capability to record at 70,000 FCI. Toshiba pioneered development of barium ferrite recording technology for flexible disk drives, and after several years of tentative market exploration introduced a 4 megabyte drive in 1988. Toshiba's design maintains the industry standard open loop 135 TPI density, and the program has been joined by Teac and other drive

and media producers. All of these 4 megabyte drives claim full compatibility with 1.0 and 2.0 megabyte media.

Many of the planned flexible disk drives using perpendicular recording would require disks with sputtered chromium-cobalt magnetic surfaces. Sputtering technology is highly developed, but throughput is relatively slow, because it is usually a batch process. If the millions of low cost diskettes necessary to support any significant penetration of the flexible disk market by perpendicular recording are to be produced by sputtering, major improvements in production rates are probably necessary. Continuous sputtering production processes have been announced by the Japanese firms which have active drive/media programs in the field.

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

Initially, two manufacturers of high capacity 5.25 inch drives attempted to develop the high capacity market using different methods of achieving higher track density. However, Amlyn's late production start spoiled its chance for acceptance of the reference track technology employed in its 3.2 megabyte drive, and the firm closed down operations.

Drivetec was more successful in getting started, however, and began shipping its 3.3 megabyte two sided drive in mid-1983. Drivetec used embedded servo information on each diskette to provide tracking information and insure media interchange. Drivetec has since ceased operations, but licensed its technology to Eastman Kodak. Eastman Kodak started production of the 3.3 megabyte drive in 1984, and, in 1985, introduced 6.6 and 12 megabyte drives operating at 384 and 333 TPI, respectively. The 12 megabyte unit, now manufactured by Qume, offers 65 millisecond average access time using a voice coil positioner.

Iomega developed a unique design, widely known as the Bernoulli box, that reaches 641 tracks per inch in a media cartridge of unconventional design. Production began in 1983. The Iomega design uses the hydraulic effects of the rapidly spinning disk to properly position the media relative to the head.

Konica's drive achieved a track density of 480 TPI using a two-stage servo system. An optical sensor is used for coarse positioning and an embedded closed-loop servo provides fine positioning using prewritten servo information.

Brier Technology has announced a 3.5 inch drive using preformatted floppy media and offering a formatted capacity of 21.4 megabytes and 35 millisecond average head positioning time. A track density of 777 TPI is used. Insite Peripherals has achieved a track density of 1,250 TPI using optical tracking of a visible servo pattern on the disk surface. Brier has announced future availability of a drive with 1,555 TPI and 43.2 megabytes. Citizen has made a preliminary announcement of a 20 megabyte drive with 540 TPI and bit density of 43,000 FCI using metal particle media.

* 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 in the new generation of 3.5 inch drives with capacities of 4 megabytes and higher now entering the market. A particularly innovative approach has been proposed by Springer Technologies, which is developing an array of thin film heads to provide a high degree of media interchange and compatibility with conventional 3.5 inch floppy disk drives. All of the high capacity floppy disk drives currently contemplated for production will use multigap heads to achieve downward compatibility with 1.0 and 2.0 megabyte 3.5 inch floppy drives.

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

* Disk diameter: In 1987, smaller diameter flexible disk drives began to receive some notice. 2.0 inch drives have been announced by two firms, but no obvious standard has emerged. Matsushita Communication Industrial's design approach mapped a standard 3.5 inch drive format onto 2.0 inch media and won at least one major OEM contract for a notebook computer, but the unconventional, non-interchangeable media failed to win broad acceptance.

  Sony has been making a drive and media based upon a video drive used in the Mavica camera. While the Sony specifications are impressive -- 819 kilobyte formatted capacity, 14.3 megabits/second data transfer rate and 3600 RPM rotation rate -- incompatibility with standard floppy disk drive controllers impedes acceptance. Lack of media interchange capability with the 3.5 inch floppy drives, now the dominant standard for office computers, also restrains the industry's enthusiasm.

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

  Error correction is not yet in use on floppy drives, but will probably be introduced 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 system 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. Most DISK/TREND statistics separate data between IBM captive and "other captive", but the term still pertains to the disk drives involved, not the manufacturer.

Example:

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

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

Example:

* Shipments by Sony are non-captive, except for drives sold with systems by the parent company or other subsidiaries.

* Shipments by Alps Electric are non-captive.

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:

* An OEM shipment to a European system manufacturer is included in worldwide totals, even if the drive is integrated into a system within the U.S.

* 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:

* Shugart Corporation is considered a U.S. manufacturer, even though Shugart manufactures disk drives in non-U.S. locations.

* Alps Electric is considered a non-U.S. manufacturer, even though some of the firm's floppy drives are 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, even though some drive configurations, such as the DEC RX02 include more than one spindle.

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 1990 constant dollars.

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

Examples:

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

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

APPLICATION CLASSIFICATION

Shipments of disk drives are analyzed by attachment to the following classes of equipment:

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

Minicomputers/multiple user microcomputers: Drives attached to smaller general-purpose processors typically serving multiple users, including network file servers. Examples: IBM System AS/400, AT&T 3B2, Hewlett-Packard 3000.

Personal computers: Attached to a general purpose microcomputer normally used by a single user. Examples: IBM PS/2, Apple Macintosh.

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

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

Consumer and hobby computers: Systems sold primarily to consumers for non-business applications. Examples: Commodore 64, MSX systems, most Atari models (Apple II is considered to be a professional/business microcomputer).

Other applications: Any application not included above.

FLEXIBLE DISK DRIVES, 8 INCH

1990 DISK/TREND REPORT

FLEXIBLE DISK DRIVES, 8 INCH

Coverage

Examples of flexible disk drives in this group include:

One side

Elcomatic	ACP 500
Miltope	DD 400

Two sides

Cobra	MM 500
Elcomatic	ACP 700
Hitachi	FDD-412
IBM	4964, 4966
Matsushita Communication Ind.	JA-751
Miltope	DD 450, DD 550
NEC	FD 1165
Y-E Data	YD-180

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

Most of the flexible disk drives in this group use IBM's recording formats for 8 inch flexible disks, "Diskette 2" for two sided standard density or "Diskette 2D" for two sided double density. IBM's diskette magazine drive is included in the group, since it uses standard media in a conventional drive, fed by a diskette-changing mechanism.

Drives using special recording formats to achieve higher capacity than the IBM standard are currently offered by only one manufacturer. Elcomatic's ACP 1500 provides 3.2 megabytes by using 96 TPI and normal recording densities. Burroughs' high capacity floppy drives, which pio-

neered the use of a reference track for head positioning, are no longer in production.

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

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1989	1990	1991	1992	1993
U.S. manufacturers	19.6	10.0	1.0	--	--
All manufacturers	100.0	67.6	39.8	21.2	8.8

The inevitable decline of this product group is continuing. Worldwide shipments for 8 inch one sided drives peaked in 1981, at 746,600 units, and two sided drives peaked two years later, with 1,275,900 units. Worldwide unit shipments are declining at about 32% annually, with a total of 166,200 expected in 1990.

In recent years, the largest factor in maintaining shipments of drives in this product group at a high level has been continuing usage of the two sided 8 inch format in the Japanese domestic market for office computers. But the tide has long since turned, as 8 inch drives were displaced first by the 1.6 megabyte 5.25 inch models, and later by the 3.5 inch drives used in most of the newer systems.

U.S. production of 8 inch drives was only 23,000 drives in 1988, and continues to decline. The low U.S. total is attributed to the fact that

U.S. system manufacturers have long since shifted to smaller diameter floppy drives for personal computers, specialized workstations and most terminals, leaving systems now approaching the end of their manufacturing cycles as the principal remaining market for 8 inch floppy drives.

Shugart Associates, the early leader in floppy drive shipments, was sold in early 1986, after years of decline under inept Xerox ownership. The Narlinger Group acquired the 8 inch floppy product line, and now operates as Shugart Corporation, while manufacturing the 8 inch floppy drive product lines purchased from Xerox, Siemens, Tandon and Control Data. Shugart now provides most of the remaining small U.S. OEM shipments, but is expected to discontinue these product lines when inventories are depleted.

Y-E Data continues to dominate recent non-captive shipments in this group, with 63.7% of 1989 worldwide shipments.

Marketing trends

The drives in this product group are considered obsolete by most system manufacturers, and the current rate of decline in shipments is expected to accelerate. The last shipments by U.S. manufacturers are expected next year, and the remaining non-U.S. markets will be limited primarily to domestic Japan.

It is believed that this product group's current lack of vigor is traceable to a combination of factors: (1) Rapid development during the 1980s of the 5.25 and 3.5 inch formats, offering capacities equaling those of 8 inch drives at much lower prices, (2) Reliability problems most manufacturers experienced with 8 inch, two sided drives in the late 1970's, which kept many OEMs from committing to the format, and (3) Lack

of further development of the 8 inch drive format by IBM, which inhibited manufacturers of OEM drives from investing in higher density versions.

In Japan's domestic market, demand for 8 inch drives continued to grow after the U.S. market started to decline. Most manufacturers of small office computer systems felt the pressure to move to desktop versions of their older systems, and the 1.6 megabyte 5.25 inch floppy drive developed under the sponsorship of Nippon Telephone & Telegraph made it possible to do so. More recent availability of 3.5 inch drives in this capacity range have intensified the problem for 8 inch drives.

But the knockout punch for 8 inch drives was delivered by IBM, their originator. IBM used 360 kilobyte 5.25 inch drives in the PC and PC XT and 1.6 megabyte 5.25 inch drives in the PC AT, with a resulting drop in production of 8 inch drives. IBM has de-emphasized internal production of flexible disk drives, in view of the ready availability of all types of floppy drives at depressed OEM price levels, and internal production of 8 inch drives is now at low levels, with the end expected soon.

Technical trends

With the exception of limited programs by Burroughs, PerSci, and Elcomatic, there have been few serious attempts to introduce higher capacity drives in this group.

The key reason that development of 8 inch drives has been stuck at 1.6 megabytes since 1976 is IBM's lack of innovation in the area. Since the existing 8 inch diskette's physical design and recording format were defined by IBM, and because of IBM's dominant leadership in the applications for 8 inch, two sided floppies, most manufacturers of OEM drives

hesitated to attempt the introduction of their own improvements, even though some had undertaken development programs.

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

After all the waiting, the momentum passed to the smaller diameter floppy formats. The high growth of desktop and portable systems is encouraging most manufacturers remaining in the flexible disk drive business to put their development resources into smaller drives.

Forecasting assumptions

1. IBM will continue the transition to smaller floppy drives for new versions of its personal computer and other small systems, and will end internal production of 8 inch drives in 1990.

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

TABLE 8

FLEXIBLE DISK DRIVES, 8 INCH

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1989		Forecast							
	Revenues		1990		1991		1992		1993	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	9.0	16.5	4.5	9.0	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	9.0	16.5	4.5	9.0	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	3.1	3.1	1.0	1.0	1.0	1.0	--	--	--	--
TOTAL U.S. NON-CAPTIVE	3.1	3.1	1.0	1.0	1.0	1.0	--	--	--	--
TOTAL U.S. REVENUES	12.1	19.6	5.5	10.0	1.0	1.0	--	--	--	--
Non-U.S. Manufacturers										
Captive	--	47.2	--	37.4	--	26.5	--	14.0	--	6.0
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	6.9	33.2	3.6	20.2	1.3	12.3	.4	7.2	--	2.8
TOTAL NON-U.S. REVENUES	6.9	80.4	3.6	57.6	1.3	38.8	.4	21.2	--	8.8
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	19.0	100.0	9.1	67.6	2.3	39.8	.4	21.2	--	8.8
OEM Average Price ($000)	.327	.260	.324	.249	.371	.241	.200	.212	--	.200

TABLE 9

FLEXIBLE DISK DRIVES, 8 INCH

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1989		Forecast							
	Shipments		1990		1991		1992		1993	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	6.0	11.0	3.0	6.0	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	6.0	11.0	3.0	6.0	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	6.2	6.2	.2	.2	.2	.2	--	--	--	--
TOTAL U.S. NON-CAPTIVE	6.2	6.2	.2	.2	.2	.2	--	--	--	--
TOTAL U.S. SHIPMENTS	12.2	17.2	3.2	6.2	.2	.2	--	--	--	--
Non-U.S. Manufacturers										
Captive	--	94.7	--	75.0	--	53.0	--	28.0	--	12.0
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	24.4	133.5	14.0	85.0	6.0	55.0	2.0	34.0	--	14.0
TOTAL NON-U.S. SHIPMENTS	24.4	228.2	14.0	160.0	6.0	108.0	2.0	62.0	--	26.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	36.6	245.4	17.2	166.2	6.2	108.2	2.0	62.0	--	26.0

Cumulative Shipments (Units in thousands)										
IBM	1,217.9	1,793.4	1,220.9	1,799.4	1,220.9	1,799.4	1,220.9	1,799.4	1,220.9	1,799.4
Non-IBM	4,097.8	10,147.8	4,112.0	10,308.0	4,118.2	10,416.2	4,120.2	10,478.2	4,120.2	10,504.2
WORLDWIDE TOTAL	5,315.7	11,941.2	5,332.9	12,107.4	5,339.1	12,215.6	5,341.1	12,277.6	5,341.1	12,303.6

TABLE 10

FLEXIBLE DISK DRIVES, 8 INCH

WORLDWIDE SHIPMENTS (000)

DRIVE HEIGHT ANALYSIS

	1989 --Shipments--		Forecast 1990		1991		1992		1993	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	11.0		6.0		--		--		--	
Full Size	11.0	100.0	6.0	100.0	--	--	--	--	--	--
OEM Total	6.2		.2		.2		--		--	
Full Size	4.2	67.8	.2	100.0	.2	100.0	--	--	--	--
Half High	2.0	32.2	--	--	--	--	--	--	--	--
Total U.S.	17.2		6.2		.2		--		--	
Full Size	15.2	88.5	6.2	100.0	.2	100.0	--	--	--	--
Half High	2.0	11.5	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS										
Captive Total	94.7		75.0		53.0		28.0		12.0	
Full Size	--	--	--	--	--	--	--	--	--	--
Half High	94.7	100.0	75.0	100.0	53.0	100.0	28.0	100.0	12.0	100.0
OEM Total	133.5		85.0		55.0		34.0		14.0	
Full Size	.5	.4	.5	.6	.4	.7	.2	.6	--	--
Half High	133.0	99.6	84.5	99.4	54.6	99.3	33.8	99.4	14.0	100.0
Total Non-U.S.	228.2		160.0		108.0		62.0		26.0	
Full Size	.5	.2	.5	.3	.4	.4	.2	.3	--	--
Half High	227.7	99.8	159.5	99.7	107.6	99.6	61.8	99.7	26.0	100.0
WORLDWIDE RECAP										
Total Worldwide Shipments	245.4		166.2		108.2		62.0		26.0	
	-32.4%		-32.2%		-34.9%		-42.7%		-58.0%	
Full Size	15.7	6.4	6.7	4.0	.6	.6	.2	.3	--	--
	-74.6%		-57.3%		-91.0%		-66.6%		-100.0%	
Half High	229.7	93.6	159.5	96.0	107.6	99.4	61.8	99.7	26.0	100.0
	-23.8%		-30.5%		-32.5%		-42.5%		-57.9%	

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	1989 Estimate Units (000)	1989 Estimate %	1993 Projection Units (000)	1993 Projection %
MAINFRAME/SUPERMINI General purpose	10.7	4.3	1.0	4.0
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	93.4	38.1	10.9	42.0
PERSONAL COMPUTERS Business and professional, single user	68.2	27.8	--	--
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	43.5	17.7	3.1	12.0
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	21.7	8.9	10.7	41.0
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	7.9	3.2	.3	1.0
Total	245.4	100.0	26.0	100.0

TABLE 12

FLEXIBLE DISK DRIVES, 8 INCH

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1989 Net Shipments			
	To United States Destinations		Worldwide	
Drive Manufacturers	Units (000)	%	Units (000)	%
Y-E Data	13.0	42.5	89.0	63.7
Other U.S.	6.2	20.2	6.2	4.4
Other Non-U.S.	11.4	37.3	44.5	31.9
TOTAL	30.6	100.0	139.7	100.0

FLEXIBLE DISK DRIVES, 5.25 INCH

1990 DISK/TREND REPORT

FLEXIBLE DISK DRIVES, 5.25 INCH

Coverage

Examples of flexible disk drives in this group include:

One side: 48 tracks per inch

Asia Commercial	FD-103
Chinon	FZ-501A
Ho Shin	HS-550
Jin Tech	OC-118
Magyar Optikai Muvek	MF 54S
Mantec	MTL-FD102E/C
Peripheral Data Systems	MFDD-110
Robotron	K 5600.10
Roctec	RF501A
Tecmate	MT-501A

One side: 96/100 tracks per inch

Magyar Optikai Muvek	MF 58S
Robotron	K 5600.20

Two sides: 48 tracks per inch

Alps Electric	DFE 222A
Asia Commercial	FD-104
Canon	MD 5201
Chinon	FZ-502
DZU	ES 5326
Ergo	DS-7
Flexdisc	FF 650
Goldstar Telecommunication	GSF 548N
Ho Shin	HD-551
Jin Tech	OB-1
Magyar Optikai Muvek	MF 54D
Mantec	MTL-FD128
Matsushita Communication Ind.	JA-455
Mitsubishi Electric	MF501C
Mitsumi Electric	D 503V
Multidigit	DF0511
Oriental Precision	OFD 546R
Peripheral Data Systems	BD-120
Prologica	D 500SL
Samsung Electronics	SFD-500P
Seiko Epson	SD-621L
Teac	FD-55BR
Tecmate	MT-502
Toshiba	ND-04DT-A
Y-E Data	YD-580

Two sides: 96 tracks per inch, 1.0 megabyte

Alps Electric	DFE 422A
DZU	ES 5323
Ho Shin	HD-552
Magyar Optikai Muvek	MF 58D
Oriental Precision	OFD 596R
Teac	FD-55FR
Toshiba	ND-06D/DT

Two sides: 96 tracks per inch, 1.6 megabytes

Alps Electric	DFE 642A, DFE 682A
Asia Commercial	FD-106
Canon	MD-5501
Chinon	FZ-506
DZU	EC 5327
Elebra	9410-D
Flexdisc	FF 950
Fujitsu	M2553B
Goldstar Telecommunication	GSF 596N
Hitachi	HFD 516C
Ho Shin	HD-553
Mantec	MTL-FD228
Matsushita Communication Ind.	JU-475
Mitsubishi Electric	MF504B
Mitsumi Electric	D 509V
Multidigit	DF1622
NEC	FD 1157D
Samsung Electronics	SFD-560D
Seiko Epson	SD-680L
Teac	FD-55GR, FD-55GFR
Tecmate	MT-504
Toshiba	ND-08DE
Y-E Data	YD-380B

Two sides: 96 tracks per inch, 3.3 megabytes

Y-E Data	YE-801

Starting with the 1989 edition of the DISK/TREND Report, all 5.25 inch drives have been combined into a single product group, replacing the previous separate groups for one and two sided drives, in view of the continuing decline in shipments for one sided 5.25 inch flexible disk drives.

The basic standards for physical size and recording format for this product group were created by the introduction of the Shugart SA 400, the

original minifloppy, in 1976. Early growth in small microcomputer systems inspired several innovative one sided 5.25 inch drives, some of which achieved success until the industry's movement to two sided versions.

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

Two sided 5.25 inch floppy drives became a reality in 1978. The original 48 TPI drives were joined by 96 TPI drives from Tandon, Micro Peripherals and Micropolis in 1980. However, a more influential development occurred in 1982, when 1.6 megabyte 5.25 inch drives were first shipped by Y-E Data, designed to a standard coordinated by Nippon Telephone and Telegraph.

IBM's 1984 introduction of the PC AT, using Y-E Data's 1.6 megabyte drive, stampeded the market into rapid worldwide usage of the 1.6 megabyte 5.25 inch format. The 2.0 megabyte drive using slightly higher linear densities did not provide enough improvement to generate wide interest.

Drivetec's half high drive using an embedded servo technique -- with 192 TPI, and capacity of 3.3 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 3.3 megabyte formats from Matsushita Communication Industrial and Y-E Data. Usage of 3.3 megabyte drives has been limited, due to lack of industry standards and the movement to 3.5 inch microfloppies.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1989	1990	1991	1992	1993
U.S. manufacturers	3.9	--	--	--	--
All manufacturers	1,021.0	895.8	736.0	583.3	434.9

Total shipments of 5.25 inch drives began to decline in 1989 as expected. Worldwide unit shipments for 1989 were 14,886,100 drives, down 10.1% from the peak year of 1989, and revenues also continued to drop, down 23.6% at $1,021,000,000.

Total shipments are expected to be down another 6.8% in 1990, but not all types of 5.25 inch floppy drives have peaked in shipments yet. Sharp reductions in shipments are being experienced by one sided drives, 0.5 megabyte two sided drives, and 1.0 megabyte two sided drives. On the other hand, shipments of 1.6 megabyte 5.25 inch floppy drives continue to grow, up an estimated 8.6% in 1990, boosted by the continuing sales momentum for PC AT clones.

1.6 megabyte two sided 5.25 inch floppy drives were used predominantly with IBM PC AT personal computers, plus the clones offered by numerous manufacturers. IBM has moved on to the PS/2 personal computer family, using 3.5 inch microfloppies, but the older IBM standards have been tough to kill. Despite abandonment by IBM, the PC AT standard has continued its momentum and has contributed to increased sales of 1.6 megabyte two sided 5.25 inch drives.

Worldwide revenues are another story, however. Despite a modest increase in 1988, the long-term trend for this product group since 1984 has been a continuing decline in revenues, which is expected to continue.

The reason is well known: Average unit prices for OEM drives continue to decline, from $114 in 1984, to $55 in 1989, with a further drop under way in 1990, to $52. Major Japanese floppy drive producers have concentrated on aggressive cost reduction programs, including product redesign and plant relocation, which have resulted in continuing price competition.

Personal computer systems dominate applications for drives in this product group. 82% of 1989 worldwide unit shipments were used with personal computers, with minor usage attributed to consumer and hobby computers, office systems and minicomputer applications.

Teac moved up to first place in 1989 shipments of non-captive 5.25 inch drives, with 3,695,000 units, for 27.5% of the worldwide total, as some manufacturers withdrew from the 5.25 inch market. Matsushita Communication Industrial held second position with 1,940,000 drives, for 14.4%, and Chinon rose to third place with 1,519,000 drives, 11.3% of the total.

Marketing trends

Overall unit shipments for this product group are expected to decrease at an average annual rate of 13.9% during the 1991-93 period, with the 1993 total forecasted at only 8.8 million drives.

The shipment momentum for 1.6 megabyte 5.25 inch drives is now expected to continue a bit longer, peaking in 1991 with an estimated 10.7 million drives. The outlook for later years is downward, as the momentum of PC AT compatible PC systems drops off. By 1993, 1.6 megabyte drives are expected to hold 94.9% of the unit shipments for this product group, but their shipment total is forecasted at only 8.4 million drives.

Total revenue for this product group will decline at a more rapid pace than the shipment decline, averaging -21.3% annually during 1991-93.

The revenue loss will be even greater if average unit prices should decline at the same rate experienced in the last few years. However, it is believed that drive manufacturers will be concentrating on 3.5 inch models and little effort will be expended in the future to redesign 5.25 inch drives for lower cost, now that shipments have peaked.

During the forecast period covered by this report, production of floppy drives in Eastern Bloc countries will start to reach significant levels. One result of this development will be growth in 5.25 inch floppy drives, since most of the Eastern Bloc manufacturing organizations making floppy drives will be several years behind the West in product design.

High capacity flexible disk drives over 5 megabytes are covered in a different product group. However, 3.3 megabyte drives are still included in this product group. A few years ago it seemed possible that additional development of higher capacity 5.25 inch drives might lead to new major products for the industry, with attention focused on drives with double the capacity of the 1.6 megabyte models then becoming a standard.

However, with the decision by IBM to utilize 3.5 inch drives with personal computers, most of the potential market for a double capacity version of the 1.6 megabyte 5.25 inch drive evaporated. At this time, the principal remaining market opportunity for the currently offered 3.3 megabyte drives appears to be in specialized applications such as Japanese language word processors.

Technical trends

It is considered unlikely that drive manufacturers will devote their resources to further product development for most of the products in this

group, considering the outlook for declining production and the obvious need to place development priorities in other product areas.

The one possible product area which may still receive attention is in the 3.3 megabyte capacity range. The early 5.25 inch drives at this capacity level used embedded servo techniques for head positioning to achieve double the normal TPI, requiring preformatted diskettes. A variation of the pioneering drive introduced by Drivetec in 1982 was offered until recently by Eastman Kodak.

Another approach has been followed by Y-E Data, which introduced a 3.3 megabyte drive without embedded servo in early 1987. This drive employs the standard 96 TPI, with standard track positioning, and doubles the linear density, at 19,740 BPI.

The principal advantage of this method is the ability to maintain full read and write compatibility with both 1.0 and 1.6 megabyte diskettes, even though a special diskette is required for usage at 3.3 megabytes. This drive has been designed for 180 RPM, in order to hold the transfer rate to the standard level, making it possible to use stock single chip controllers, but doubling the latency.

Forecasting assumptions

1. IBM's efforts to make PS/2 and the microchannel bus into dominant industry standards will eventually prevail, forcing continually increasing usage of 3.5 inch microfloppy drives on new systems. However, the existing momentum of the PC AT format will decline slowly, insuring a residual market for 1.6 megabyte 5.25 inch drives for several years.

2. A positive growth rate for personal computers will be maintained.

3. The dollar/yen exchange rate will stay in the current range, and the major Japanese floppy disk drive producers will maintain prices at approximately the current levels or slightly lower.

TABLE 13

FLEXIBLE DISK DRIVES, 5.25 INCH

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1989 Revenues		Forecast 1990		1991		1992		1993	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	1.6	3.6	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	1.6	3.6	--	--	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	.2	.3	--	--	--	--	--	--	--	--
TOTAL U.S. NON-CAPTIVE	.2	.3	--	--	--	--	--	--	--	--
TOTAL U.S. REVENUES	1.8	3.9	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	21.4	280.2	8.7	244.9	4.8	167.6	2.3	114.6	.7	67.9
PCM/Reseller	104.9	157.8	97.4	141.5	87.9	123.2	76.6	104.0	64.0	84.6
OEM/Integrator	183.0	579.1	154.2	509.4	130.1	445.2	105.8	364.7	82.4	282.4
TOTAL NON-U.S. REVENUES	309.3	1,017.1	260.3	895.8	222.8	736.0	184.7	583.3	147.1	434.9
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	311.1	1,021.0	260.3	895.8	222.8	736.0	184.7	583.3	147.1	434.9
OEM Average Price ($000)	.056	.055	.053	.052	.050	.050	.047	.047	.044	.044

TABLE 14

FLEXIBLE DISK DRIVES, 5.25 INCH

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1989		Forecast							
	Shipments		1990		1991		1992		1993	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	2.0	4.5	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	2.0	4.5	--	--	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	.8	1.2	--	--	--	--	--	--	--	--
TOTAL U.S. NON-CAPTIVE	.8	1.2	--	--	--	--	--	--	--	--
TOTAL U.S. SHIPMENTS	2.8	5.7	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	119.0	1,449.0	51.0	1,368.0	30.0	1,050.0	15.0	765.0	5.0	485.0
PCM/Reseller	1,908.2	2,947.6	1,905.0	2,801.2	1,790.0	2,521.0	1,645.0	2,238.0	1,462.0	1,933.0
OEM/Integrator	3,274.0	10,483.8	2,932.0	9,697.5	2,607.0	8,924.0	2,250.0	7,752.0	1,871.0	6,399.0
TOTAL NON-U.S. SHIPMENTS	5,301.2	14,880.4	4,888.0	13,866.7	4,427.0	12,495.0	3,910.0	10,755.0	3,338.0	8,817.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	5,304.0	14,886.1	4,888.0	13,866.7	4,427.0	12,495.0	3,910.0	10,755.0	3,338.0	8,817.0
Cumulative Shipments (Units in millions)										
IBM	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
Non-IBM	55.5	109.9	60.4	123.7	64.8	136.2	68.7	147.0	72.1	155.8
WORLDWIDE TOTAL	55.9	110.3	60.8	124.2	65.2	136.7	69.1	147.4	72.5	156.3

TABLE 15

FLEXIBLE DISK DRIVES, 5.25 INCH

WORLDWIDE SHIPMENTS (000)

DRIVE HEIGHT ANALYSIS

	1989 --Shipments-- Units	%	Forecast 1990 Units	%	1991 Units	%	1992 Units	%	1993 Units	%
U.S. MANUFACTURERS										
Captive Total	4.5		--		--		--		--	
Full Size	4.5	100.0	--	--	--	--	--	--	--	--
Non-Captive Total	1.2		--		--		--		--	
Half High	1.2	100.0	--	--	--	--	--	--	--	--
Total U.S.	5.7		--		--		--		--	
Full Size	4.5	79.0	--	--	--	--	--	--	--	--
Half High	1.2	21.0	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS										
Captive Total	1,449.0		1,368.0		1,050.0		765.0		485.0	
Full Size	--	--	--	--	--	--	--	--	--	--
Half High	1,449.0	100.0	1,368.0	100.0	1,050.0	100.0	765.0	100.0	485.0	100.0
Non-Captive Total	13,431.4		12,498.7		11,445.0		9,990.0		8,332.0	
Full Size	21.0	.2	--	--	--	--	--	--	--	--
Half High	13,410.4	99.8	12,498.7	100.0	11,445.0	100.0	9,990.0	100.0	8,332.0	100.0
Total Non-U.S.	14,880.4		13,866.7		12,495.0		10,755.0		8,817.0	
Full Size	21.0	.1	--	--	--	--	--	--	--	--
Half High	14,859.4	99.9	13,866.7	100.0	12,495.0	100.0	10,755.0	100.0	8,817.0	100.0
WORLDWIDE RECAP										
Total Worldwide Shipments	14,886.1		13,866.7		12,495.0		10,755.0		8,817.0	
	-10.1%		-6.8%		-9.8%		-13.9%		-18.0%	
Full Size	25.5	.2	--	--	--	--	--	--	--	--
	-61.9%		-100.0%		--		--		--	
Half High	14,860.6	99.8	13,866.7	100.0	12,495.0	100.0	10,755.0	100.0	8,817.0	100.0
	-9.9%		-6.6%		-9.8%		-13.9%		-18.0%	

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

TABLE 16
FLEXIBLE DISK DRIVES, 5.25 INCH
WORLDWIDE SHIPMENTS (000)
TRACK DENSITY ANALYSIS

	1989 --Shipments--		Forecast 1990		1991		1992		1993	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	4.5		--		--		--		--	
96 TPI 1.0 MB	4.5	100.0	--	--	--	--	--	--	--	--
Non-Captive Total	1.2		--		--		--		--	
48 TPI	--	--	--	--	--	--	--	--	--	--
96 TPI 1.6 MB	1.2	100.0	--	--	--	--	--	--	--	--
Total U.S.	5.7		--		--		--		--	
48 TPI	--	--	--	--	--	--	--	--	--	--
96 TPI 1.0 MB	4.5	79.0	--	--	--	--	--	--	--	--
96 TPI 1.6 MB	1.2	21.0	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS										
Captive Total	1,449.0		1,368.0		1,050.0		765.0		485.0	
48 TPI	154.0	10.6	96.0	7.0	45.0	4.3	20.0	2.6	--	--
96 TPI 1.0 MB	20.0	1.4	10.0	.7	--	--	--	--	--	--
96 TPI 1.6 MB	1,275.0	88.0	1,262.0	92.3	1,005.0	95.7	745.0	97.4	485.0	100.0
Non-Captive Total	13,431.4		12,498.7		11,445.0		9,990.0		8,332.0	
48 TPI	4,793.8	35.8	3,097.5	24.8	1,638.0	14.3	830.0	8.3	407.0	4.9
96 TPI 1.0 MB	265.5	2.0	183.0	1.5	122.0	1.1	70.0	.7	40.0	.5
96 TPI 1.6 MB	8,372.1	62.2	9,218.2	73.7	9,685.0	84.6	9,090.0	91.0	7,885.0	94.6
Total Non-U.S.	14,880.4		13,866.7		12,495.0		10,755.0		8,817.0	
48 TPI	4,947.8	33.3	3,193.5	23.0	1,683.0	13.5	850.0	7.9	407.0	4.6
96 TPI 1.0 MB	285.5	1.9	193.0	1.4	122.0	1.0	70.0	.7	40.0	.5
96 TPI 1.6 MB	9,647.1	64.8	10,480.2	75.6	10,690.0	85.5	9,835.0	91.4	8,370.0	94.9
WORLDWIDE RECAP										
Total Worldwide Shipments	14,886.1		13,866.7		12,495.0		10,755.0		8,817.0	
	-10.1%		-6.8%		-9.8%		-13.9%		-18.0%	
48 TPI	4,947.8	33.2	3,193.5	23.0	1,683.0	13.5	850.0	7.9	407.0	4.6
	-36.4%		-35.4%		-47.3%		-49.4%		-52.1%	
96 TPI 1.0 MB	290.0	1.9	193.0	1.4	122.0	1.0	70.0	.7	40.0	.5
	-1.3%		-33.4%		-36.7%		-42.6%		-42.8%	
96 TPI 1.6 MB	9,648.3	64.9	10,480.2	75.6	10,690.0	85.5	9,835.0	91.4	8,370.0	94.9
	+13.6%		+8.6%		+2.0%		-8.0%		-14.9%	

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 1.6 MB totals.

TABLE 17

FLEXIBLE DISK DRIVES, 5.25 INCH

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1989 Estimate Units (000)	1989 Estimate %	1993 Projection Units (000)	1993 Projection %
MAINFRAME/SUPERMINI General purpose	--	--	--	--
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	527.0	3.5	352.7	4.0
PERSONAL COMPUTERS Business and professional, single user	12,712.7	85.4	7,229.9	82.0
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	973.6	6.5	440.9	5.0
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	312.6	2.1	573.1	6.5
CONSUMER AND HOBBY COMPUTERS	321.5	2.2	132.3	1.5
OTHER APPLICATIONS	38.7	.3	88.1	1.0
Total	14,886.1	100.0	8,817.1	100.0

TABLE 18

FLEXIBLE DISK DRIVES, 5.25 INCH

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1989 Net Shipments			
	To United States Destinations		Worldwide	
Drive Manufacturers	Units (000)	%	Units (000)	%
Teac	1,540.0	29.7	3,695.0	27.5
Matsushita Commun. Ind.	453.0	8.7	1,940.0	14.4
Chinon	548.0	10.6	1,519.0	11.3
Y-E Data	69.0	1.3	1,010.0	7.5
Mitsubishi Electric	480.0	9.3	792.0	5.9
Mitsumi Electric	230.0	4.4	730.0	5.4
Canon	340.0	6.6	670.0	5.0
Seiko Epson	200.0	3.9	660.0	4.9
Alps Electric	500.0	9.7	585.0	4.4
Other U.S.	.8	--	1.2	--
Other Non-U.S.	822.2	15.9	1,830.4	13.7
TOTAL	5,183.0	100.0	13,432.6	100.0

FLEXIBLE DISK DRIVES, MICROFLOPPIES

1990 DISK/TREND REPORT

FLEXIBLE DISK DRIVES, MICROFLOPPIES

Coverage

Examples of flexible disk drives in this group include:

3.5" disk diameter, one side, 67.5 TPI

Brother	FB 300

3.5" disk diameter, one side, 135 TPI

Brother	FB 015
Matsushita Electronic Comp.	EME-112

3.5" disk diameter, two sides, 135 TPI, 1.0 megabyte

Alps Electric	DFR 423A
Canon	MD 3411
Chinon	F-354
Citizen	OSDC, UODC, V1DC
DZU	ISA 235HF
Fujitsu	M2532B
Hyundai Electronics	HMF-311
Matsushita Communication Ind.	JU-253A
Matsushita Electronic Comp.	EME-212
Mitsubishi Electric	MF353C
Mitsumi Electric	D357C
NEC	FD 1037A, FD 1038A
Oriental Precision	OFD-356R
Sankyo Seiki	FDU-380
Seiko Epson	SMD-380
Sony	MP-F11W
Teac	FD-235F, FD-334F
Toshiba	ND-3521
Y-E Data	YD-645C

3.5" disk diameter, two sides, 135 TPI, 1.6 megabytes

Alps Electric	DFP 683A
Canon	MD 3511
Citizen	OUDB
Matsushita Communication Ind.	JU-255
Matsushita Electronic Comp.	EME-262
Mitsubishi Electric	MF354C
NEC	FD 1137C
Sankyo Seiki	FDU-480
Seiko Epson	SMD-320
Teac	FD-235G, FD-334GF
Toshiba	ND-355S/T
Y-E Data	YD-686C

3.5" disk diameter, two sides, 135 TPI, 2.0 megabytes

Alps Electric	DFP 723A
Canon	MD 3611
Chinon	FT-357
Citizen	OSDA, UODA, V1DE
Ergo	MD-21
Fujitsu	M2537K
Goldstar Telecommunication	GFS-313
Hyundai Electronics	HMF-341
Matsushita Communication Ind.	JU-257
Mitsubishi Electric	MF355C
Mitsumi Electric	D359B
NEC	FD 1137H, FD 1138H
Samsung Electronics	SFD-321K
Sankyo Seiki	FDU-580
Seiko Epson	SMD-340
Sony	MP-F17W
Teac	FD-235HF, FD-334HF
Toshiba	ND-356S/T, ND-3531
Y-E Data	YD-701, YD-702F

3.5" disk diameter, two sides, 135 TPI, 4.0 megabytes

Alps Electric	DFR 823
Chinon	FX-358
Citizen	OSDG
Fujitsu	M2539B
Matsushita Communication Ind.	JU-259A
Mitsubishi Electric	MF 356C
Mitsumi Electric	D352T2, D352C
Sony	MP-F40W
Teac	FD-235J, FD-335J
Toshiba	PD-212
Y-E Data	YD-742

3.0" disk diameter, one side

Matsushita Electronic Comp.	EME-156

3.0" disk diameter, two sides

Matsushita Electronic Comp.	EME-232

2.0" disk diameter, 254 TPI, 1.0 megabyte

Chinon	FJ-205
Matsushita Communication Ind.	JU-202
Mitsumi Electric	D 201
Sony	PDD-110

All microfloppy drives with capacities less than 5 megabytes and disk diameters of 3.5 inches or less are included in this product group. The separate types of products include: (1) 3.5 inch drives, both one and two sided versions, which are now manufactured by 23 companies, (2) the 3.0 inch drive, which is currently offered only by Matsushita Electronic Components, the company which originally introduced the format in cooperation with Hitachi, and (3) 2.0 inch drives, currently offered only by Sony, Chinon (Sony format), Mitsumi Electric (Sony format), and Matsushita Communication Industrial, which uses a separate format.

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

1.6 and 2.0 megabyte 3.5 inch drives were announced in 1985, and are intended for use with the high density media originally proposed by Sony, and operate at up to 17,434 BPI, using the 135 TPI standard of today's production drives. All of the current 1.6 and 2.0 megabyte drives claim "downward compatibility," the ability to read and write on lower capacity diskettes. Since the adoption of 2.0 megabyte drives by IBM in April, 1987, for the PS/2 systems, most major manufacturers of microfloppy drives have announced similar drives.

Most manufacturers of 3.5 inch drives have also made the transition from the earlier 41.3 millimeter high drives ("half high", in 5.25 inch drive terms) to the 25.4 millimeter (one inch) high drives pioneered by Citizen in 1984. Several companies have also started 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 has announced 15 millimeter high models for delivery in the first quarter of 1991, possibly triggering a further movement to thinner 3.5 inch drives.

While the 3.0 inch microfloppy format has lost all of its original adherents except Matsushita Electronic Components, the newly emerging 2.0 inch drives could eventually have a brighter future with very small systems. Initial shipments with "notebook" portable computers have met resistance from buyers who did not want to bother with interchange problems, but there may be enough applications in home computers, electronic typewriters and games to keep the 2.0 inch format alive. However, there are competing interchange standards, and it is not yet clear how many other manufacturers will join the fray.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1989	1990	1991	1992	1993
U.S. manufacturers	--	--	--	--	--
All manufacturers	1,347.2	1,399.4	1,428.6	1,482.9	1,494.4

1989's shipments of 23.2 million microfloppy drives exceeded expectations, and the DISK/TREND forecast for 1990 worldwide shipments has been increased to 27.4 million drives. The worldwide microfloppy shipment total for 1989 represented 60% of all flexible disk drive shipments.

On the other hand, the expectation for revenues is slipping, due to greater erosion in average prices for non-captive drives. The overall average for non-captive microfloppy drives was only $51 in 1989 and is

expected to drop to $46 in 1990. As a result, 1990's expected 18% increase in worldwide unit shipments will provide an increase in total revenues of only 3.8%.

The last U.S. production of microfloppy drives occurred in 1984, and most drives in this product group are now manufactured by Japanese companies, with only limited production in other countries.

3.5 inch microfloppies have found adequate stimulus for growth from IBM's PS/2 personal computer family, Apple's Macintosh and extensive usage with other U.S., Japanese and European computers. In addition, the strong laptop computer market has boosted floppy drive shipments, with most systems using 3.5 inch drives. One by-product of this growth is increased use of 3.5 inch drives with PC AT compatible office computers to provide interchange with portables.

Shipments of all drives with disks less than 3.5 inches diameter are grouped together in the disk diameter breakdown tables in this year's DISK/TREND Report. OEM shipments of Matsushita 3.0 inch drives have declined in the last few years. The major market for these drives has been the European home computer market, but newer systems with other data storage devices have now gained the initiative. 3.0 inch drives have never significantly penetrated the U.S. market, and after an early lead have been overtaken in the Japan domestic market by 3.5 inch drives.

The subgroup for less than 3.5 inch drives also includes 2.0 inch drives in both the Sony and Matsushita Communication Industrial formats. The MCI drive, which maintains logical file compatibility with 1 megabyte 3.5 inch and 5.25 inch floppy drives, achieved something of a breakthrough in 1989 as the result of its adoption by Zenith for a major "notebook" computer. But 2.0 inch drives obviously cannot provide physical diskette

compatibility with 3.5 inch or 5.25 inch drives, and potential users have demonstrated considerable sales resistance for business computer applications, where convenient media interchange is essential. 2.0 inch drives are more likely to find their near term successes with typewriter and game applications, for which they are clearly well suited.

Within the 3.5 inch format, a complete reversal in the rankings of one sided and two sided drives has occurred since 1984. In 1984, one sided 3.5 inch drives held almost 65% of all microfloppy unit shipments, but in 1989 two sided drives accounted for over 99% of shipments. Almost all new systems introduced in the last few years which use microfloppies have adopted two sided 3.5 inch models.

This year's DISK/TREND Report includes a new Drive Capacity Analysis table for microfloppy drives, which provides detailed historical and forecast data for the major capacity groupings. The 2.0 megabyte models now offered by nearly all major floppy drive manufacturers have become the industry's fastest growing products, stimulated by IBM's adoption of 2.0 megabyte drives for high end PS/2 models.

The similar 1.6 megabyte drives are used mostly in Japan, primarily by NEC and with computers designed to be compatible with NEC's PC product line. 1.6/2.0 megabyte drives took the lead in 1989 unit shipments, with 64.3% of the total of all microfloppy formats, with further growth to 75.5% forecasted for 1990. 4.0 megabyte 3.5 inch drives are expected to become an important part of the industry in future years, but shipments through 1990 are still small.

In 1989 the share of microfloppy shipments sold through non-captive distribution channels increased to 94.6% of the worldwide total, including

both PCM/Reseller or OEM/Integrator channels, reflecting the trend toward more dynamic growth by independent manufacturers of personal computers.

The leadership in microfloppy non-captive unit shipments was retained in 1989 by Sony, the originator of the 3.5 inch format, with 4,956,000 drives, 22.6% of the worldwide total. Teac climbed to second place with 2,975,000 drives, for 13.6%, and Mitsubishi Electric's 2,907,000 drives provided 13.2% of the worldwide total.

Marketing trends

The dominance of 2 megabyte 3.5 inch microfloppies is expected to continue for years, with the format forecasted to hold 82.3% of all microfloppy shipments in 1993.

However, it is expected that during the next year major system manufacturers will start to utilize the new 4 megabyte drives designed for the barium ferrite media originally proposed by Toshiba, creating another growth product. Although there has been no formal announcement, most of the floppy drive industry now believes that IBM has selected the barium ferrite 4 megabyte floppy as a future standard product.

It is still difficult to forecast the growth rate for 4 megabyte drives, since much of the industry is still waiting for IBM to make the first move, but a widespread movement to use these models on high-end personal computers is expected in 1991, with over half a million drives forecasted for shipment. Strong continuing growth is believed likely, and if market reaction is enthusiastic, the 1993 forecast for 2.5 million drives could be exceeded.

During the last few years another major microfloppy trend has been the movement to one inch high 3.5 inch drives. In the early 1980's there

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

Amidst all the confusion, Citizen Watch entered the microfloppy business with one inch high drives in 1984, with little immediate following. However, during the last four years, all significant producers of 3.5 inch drives added one inch high drives, which are now the dominant physical configuration with 82.3% of 1990 shipments of 3.5 inch drives.

Citizen's 1989 introduction of 3/4 inch drives again exerted a strong influence on the industry. Most of the other Japanese floppy drive manufacturers have also announced 3/4 inch high drives, stimulated by the potential market in very small portable computers.

There is still some confusion over what the term "3/4 inch high" will mean in actual practice. Strictly speaking, 3/4 inches is 19.05 millimeters, but the 3/4 inch microfloppy drives announced to date have been in a range of 17 to 19 millimeters. It is likely that many of the new drives will be in the low end of that range, to provide maximum versatility. Citizen's new 15 millimeter high models may also prove to be popular with manufacturers of notebook computers if users want a floppy drive with their notebook computers enough to tolerate the slight increase in size and weight, compared to notebook computers which use hard disks alone, without floppy drives.

Technical trends

Now that IBM has apparently settled the argument over barium ferrite versus cobalt modified oxide for 4 megabyte drives, the next challenge for most manufacturers of 3.5 inch drives will be packaging problems in reducing the height of the drive.

The industry appears to be moving to a standard height of 3/4 inches, but the change will not be a easy one. 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. The first 3/4 inch high microfloppy 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. 3/4 inch high 3.5 inch drives will become the dominant floppy drive configuration by 1993 and 2.0 megabyte capacities will maintain leadership through 1993.

2. IBM will continue worldwide usage of 3.5 inch floppy drives with all newly introduced personal computers and will use 4 megabyte 3.5 inch drives on selected systems starting in the first half of 1991.

3. A positive growth rate for personal computers will be maintained.

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

TABLE 19

FLEXIBLE DISK DRIVES, MICROFLOPPIES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1989		Forecast							
	Revenues		1990		1991		1992		1993	
	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. NON-CAPTIVE	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	11.2	207.5	7.9	175.3	9.2	159.1	12.0	163.9	16.1	173.1
PCM/Reseller	79.2	89.1	84.4	98.2	67.1	80.1	77.9	95.5	81.4	103.8
OEM/Integrator	493.3	1,050.6	512.7	1,125.9	525.2	1,189.4	545.4	1,223.5	561.6	1,217.5
TOTAL NON-U.S. REVENUES	583.7	1,347.2	605.0	1,399.4	601.5	1,428.6	635.3	1,482.9	659.1	1,494.4
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	583.7	1,347.2	605.0	1,399.4	601.5	1,428.6	635.3	1,482.9	659.1	1,494.4
OEM Average Price ($000)	.055	.051	.049	.046	.045	.044	.042	.041	.039	.038

TABLE 20

FLEXIBLE DISK DRIVES, MICROFLOPPIES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1989		Forecast							
	Shipments		1990		1991		1992		1993	
	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. NON-CAPTIVE	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	70.0	1,256.1	57.0	1,231.0	72.0	1,202.0	96.0	1,336.0	136.0	1,550.0
PCM/Reseller	1,367.0	1,565.0	1,635.0	1,913.0	1,505.0	1,792.0	1,780.0	2,175.0	1,984.0	2,525.0
OEM/Integrator	8,950.0	20,395.1	10,573.0	24,273.0	11,737.0	27,276.0	13,015.0	29,904.0	14,397.0	31,854.0
TOTAL NON-U.S. SHIPMENTS	10,387.0	23,216.2	12,265.0	27,417.0	13,314.0	30,270.0	14,891.0	33,415.0	16,517.0	35,929.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	10,387.0	23,216.2	12,265.0	27,417.0	13,314.0	30,270.0	14,891.0	33,415.0	16,517.0	35,929.0
Cumulative Shipments (Units in millions)										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	28.7	65.5	41.0	92.9	54.3	123.2	69.2	156.6	85.7	192.6
WORLDWIDE TOTAL	28.7	65.5	41.0	92.9	54.3	123.2	69.2	156.6	85.7	192.6

TABLE 21

FLEXIBLE DISK DRIVES, MICROFLOPPIES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1989 Revenues			Forecast 1990			1991			1992			1993		
	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS
U.S. MANUFACTURERS															
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS															
Captive	7.2	13.1	187.2	8.0	14.0	153.3	8.4	6.8	143.9	8.5	2.7	152.7	8.4	.7	164.0
PCM/Reseller	--	--	89.1	--	--	98.2	--	--	80.1	--	--	95.5	--	--	103.8
OEM/Integrator	9.1	3.4	1,038.1	6.9	2.5	1,116.5	5.5	1.8	1,182.1	2.9	1.1	1,219.5	.4	.4	1,216.7
TOTAL NON-U.S. REVENUES	16.3	16.5	1,314.4	14.9	16.5	1,368.0	13.9	8.6	1,406.1	11.4	3.8	1,467.7	8.8	1.1	1,484.5
WORLDWIDE RECAP															
Captive	7.2	13.1	187.2	8.0	14.0	153.3	8.4	6.8	143.9	8.5	2.7	152.7	8.4	.7	164.0
	-43.7%	+1.6%	-31.0%	+11.1%	+6.9%	-18.1%	+5.0%	-51.4%	-6.1%	+1.2%	-60.3%	+6.1%	-1.2%	-74.1%	+7.4%
PCM/Reseller	--	--	89.1	--	--	98.2	--	--	80.1	--	--	95.5	--	--	103.8
	--	--	+174.2%	--	--	+10.2%	--	--	-18.4%	--	--	+19.2%	--	--	+8.7%
OEM/Integrator	9.1	3.4	1,038.1	6.9	2.5	1,116.5	5.5	1.8	1,182.1	2.9	1.1	1,219.5	.4	.4	1,216.7
	-79.6%	-54.1%	+15.2%	-24.2%	-26.5%	+7.6%	-20.3%	-28.0%	+5.9%	-47.3%	-38.9%	+3.2%	-86.2%	-63.6%	-.2%
Total Revenues	16.3	16.5	1,314.4	14.9	16.5	1,368.0	13.9	8.6	1,406.1	11.4	3.8	1,467.7	8.8	1.1	1,484.5
	-71.6%	-18.7%	+9.1%	-8.6%	--	+4.1%	-6.7%	-47.9%	+2.8%	-18.0%	-55.8%	+4.4%	-22.8%	-71.1%	+1.1%
ANNUAL SHARE, BY DIAMETER	1.2%	1.2%	97.6%	1.1%	1.2%	97.7%	1.0%	.6%	98.4%	.8%	.3%	98.9%	.6%	.1%	99.3%

TABLE 22

FLEXIBLE DISK DRIVES, MICROFLOPPIES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1989 Shipments			Forecast 1990			1991			1992			1993		
	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS
U.S. MANUFACTURERS															
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS															
Captive	48.0	143.0	1,065.1	53.0	159.0	1,019.0	60.0	82.0	1,060.0	65.0	35.0	1,236.0	70.0	10.0	1,470.0
PCM/Reseller	--	--	1,565.0	--	--	1,913.0	--	--	1,792.0	--	--	2,175.0	--	--	2,525.0
OEM/Integrator	175.0	85.0	20,135.1	138.0	69.0	24,066.0	113.0	53.0	27,110.0	60.0	35.0	29,809.0	8.0	15.0	31,831.0
TOTAL NON-U.S. SHIPMENTS	223.0	228.0	22,765.2	191.0	228.0	26,998.0	173.0	135.0	29,962.0	125.0	70.0	33,220.0	78.0	25.0	35,826.0
WORLDWIDE RECAP															
Captive	48.0	143.0	1,065.1	53.0	159.0	1,019.0	60.0	82.0	1,060.0	65.0	35.0	1,236.0	70.0	10.0	1,470.0
	-43.5%	+3.9%	-20.5%	+10.4%	+11.2%	-4.3%	+13.2%	-48.4%	+4.0%	+8.3%	-57.3%	+16.6%	+7.7%	-71.4%	+18.9%
PCM/Reseller	--	--	1,565.0	--	--	1,913.0	--	--	1,792.0	--	--	2,175.0	--	--	2,525.0
	--	--	+206.3%	--	--	+22.2%	--	--	-6.3%	--	--	+21.4%	--	--	+16.1%
OEM/Integrator	175.0	85.0	20,135.1	138.0	69.0	24,066.0	113.0	53.0	27,110.0	60.0	35.0	29,809.0	8.0	15.0	31,831.0
	-77.2%	-29.2%	+32.9%	-21.1%	-18.8%	+19.5%	-18.1%	-23.2%	+12.6%	-46.9%	-34.0%	+10.0%	-86.7%	-57.1%	+6.8%
Total Shipments	223.0	228.0	22,765.2	191.0	228.0	26,998.0	173.0	135.0	29,962.0	125.0	70.0	33,220.0	78.0	25.0	35,826.0
	-73.9%	-11.5%	+33.9%	-14.3%	--	+18.6%	-9.4%	-40.8%	+11.0%	-27.7%	-48.1%	+10.9%	-37.6%	-64.3%	+7.8%
ANNUAL SHARE, BY DIAMETER	1.0%	1.0%	98.0%	.7%	.8%	98.5%	.6%	.4%	99.0%	.4%	.2%	99.4%	.2%	.1%	99.7%

TABLE 23
FLEXIBLE DISK DRIVES, MICROFLOPPIES
WORLDWIDE SHIPMENTS (000)
DRIVE HEIGHT ANALYSIS

	1989 --Shipments-- Units	%	Forecast 1990 Units	%	1991 Units	%	1992 Units	%	1993 Units	%
U.S. MANUFACTURERS										
Captive Total	--		--		--		--		--	
Non-Captive Total	--		--		--		--		--	
Total U.S.	--		--		--		--		--	
NON-U.S. MANUFACTURERS										
Captive Total	1,256.1		1,231.0		1,202.0		1,336.0		1,550.0	
Less than 1 inch	.1	--	210.0	17.1	382.0	31.8	656.0	49.2	1,070.0	69.1
1 inch	959.0	76.4	743.0	60.5	638.0	53.2	560.0	41.9	400.0	25.8
More than 1 inch	297.0	23.6	278.0	22.4	182.0	15.0	120.0	8.9	80.0	5.1
Non-Captive Total	21,960.1		26,186.0		29,068.0		32,079.0		34,379.0	
Less than 1 inch	280.0	1.3	1,603.0	6.1	7,440.0	25.6	15,367.0	48.0	24,515.0	71.4
1 inch	17,480.1	79.7	21,785.0	83.3	19,762.0	68.1	15,320.0	47.8	8,921.0	25.9
More than 1 inch	4,200.0	19.0	2,798.0	10.6	1,866.0	6.3	1,392.0	4.2	943.0	2.7
Total Non-U.S.	23,216.2		27,417.0		30,270.0		33,415.0		35,929.0	
Less than 1 inch	280.1	1.2	1,813.0	6.6	7,822.0	25.8	16,023.0	48.1	25,585.0	71.3
1 inch	18,439.1	79.5	22,528.0	82.3	20,400.0	67.5	15,880.0	47.5	9,321.0	25.9
More than 1 inch	4,497.0	19.3	3,076.0	11.1	2,048.0	6.7	1,512.0	4.4	1,023.0	2.8
WORLDWIDE RECAP										
Total Worldwide Shipments	23,216.2		27,417.0		30,270.0		33,415.0		35,929.0	
	+28.1%		+18.0%		+10.4%		+10.3%		+7.5%	
Less than 1 inch	280.1	1.2	1,813.0	6.6	7,822.0	25.8	16,023.0	48.1	25,585.0	71.3
	--		+547.2%		+331.4%		+104.8%		+59.6%	
1 inch	18,439.1	79.5	22,528.0	82.3	20,400.0	67.5	15,880.0	47.5	9,321.0	25.9
	+53.6%		+22.1%		-9.4%		-22.1%		-41.3%	
More than 1 inch	4,497.0	19.3	3,076.0	11.1	2,048.0	6.7	1,512.0	4.4	1,023.0	2.8
	-26.4%		-31.6%		-33.4%		-26.1%		-32.3%	

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

TABLE 24
FLEXIBLE DISK DRIVES, MICROFLOPPIES
WORLDWIDE SHIPMENTS (000)
DRIVE CAPACITY ANALYSIS

	1989 --Shipments--		Forecast 1990		1991		1992		1993	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	--		--		--		--		--	
Non-Captive Total	--		--		--		--		--	
Total U.S.	--		--		--		--		--	
NON-U.S. MANUFACTURERS										
Captive Total	1,256.1		1,231.0		1,202.0		1,336.0		1,550.0	
1 Megabyte or Less	386.0	30.7	285.0	23.2	206.0	17.1	152.0	11.4	116.0	7.5
1.6/2.0 Megabytes	870.1	69.3	946.0	76.8	996.0	82.9	1,114.0	83.5	1,224.0	79.1
4.0 Megabytes	--	--	--	--	--	--	70.0	5.1	210.0	13.4
Non-Captive Total	21,960.1		26,186.0		29,068.0		32,079.0		34,379.0	
1 Megabyte or Less	7,888.0	36.0	6,422.0	24.5	5,393.0	18.6	4,620.0	14.4	3,738.0	10.9
1.6/2.0 Megabytes	14,072.1	64.0	19,731.0	75.4	23,095.0	79.6	26,189.0	81.7	28,301.0	82.4
4.0 Megabytes	--	--	33.0	.1	580.0	1.8	1,270.0	3.9	2,340.0	6.7
Total Non-U.S.	23,216.2		27,417.0		30,270.0		33,415.0		35,929.0	
1 Megabyte or Less	8,274.0	35.7	6,707.0	24.5	5,599.0	18.5	4,772.0	14.3	3,854.0	10.7
1.6/2.0 Megabytes	14,942.2	64.3	20,677.0	75.5	24,091.0	79.7	27,303.0	81.8	29,525.0	82.3
4.0 Megabytes	--	--	33.0	--	580.0	1.8	1,340.0	3.9	2,550.0	7.0
WORLDWIDE RECAP										
Total Worldwide Shipments	23,216.2		27,417.0		30,270.0		33,415.0		35,929.0	
			+28.1%		+18.0%		+10.4%		+10.3%	+7.5%
1 Megabyte or Less	8,274.0	35.7	6,707.0	24.5	5,599.0	18.5	4,772.0	14.3	3,854.0	10.7
			-25.4%		-18.9%		-16.5%		-14.7%	-19.2%
1.6/2.0 Megabytes	14,942.2	64.3	20,677.0	75.5	24,091.0	79.7	27,303.0	81.8	29,525.0	82.3
			+112.9%		+38.3%		+16.5%		+13.3%	+8.1%
4.0 Megabytes	--	--	33.0	--	580.0	1.8	1,340.0	3.9	2,550.0	7.0
			--		--		+131.0%		+90.3%	

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

TABLE 25

FLEXIBLE DISK DRIVES, MICROFLOPPIES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1989 Estimate Units (000)	1989 Estimate %	1993 Projection Units (000)	1993 Projection %
MAINFRAME/SUPERMINI General purpose	51.1	.2	35.9	.1
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	185.7	.8	538.9	1.5
PERSONAL COMPUTERS Business and professional, single user	19,501.6	84.0	28,455.8	79.2
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	1,369.8	5.9	1,437.2	4.0
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	478.3	2.1	431.1	1.2
CONSUMER AND HOBBY COMPUTERS	1,253.7	5.4	4,670.8	13.0
OTHER APPLICATIONS	376.0	1.6	359.3	1.0
Total	23,216.3	100.0	35,929.0	100.0

TABLE 26

FLEXIBLE DISK DRIVES, MICROFLOPPIES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1989 Net Shipments			
	To United States Destinations		Worldwide	
Drive Manufacturers	Units (000)	%	Units (000)	%
Sony	2,920.0	28.3	4,956.0	22.6
Teac	1,145.0	11.1	2,975.0	13.6
Mitsubishi Electric	2,575.0	25.0	2,907.0	13.2
Y-E Data	663.0	6.4	1,666.0	7.6
Matsushita Commun. Ind.	214.0	2.1	1,568.0	7.1
Citizen	480.0	4.7	1,430.0	6.5
Alps Electric	810.0	7.9	1,210.0	5.5
Matsushita Elec. Comp.	--	--	1,125.0	5.1
Seiko Epson	360.0	3.5	1,075.0	4.9
Chinon	471.0	4.6	894.0	4.1
Toshiba	435.0	4.2	637.0	2.9
Mitsumi Electric	120.0	1.2	600.0	2.7
NEC	35.0	.3	563.0	2.6
Other U.S.	--	--	--	--
Other Non-U.S.	89.0	.7	354.1	1.7
TOTAL	10,317.0	100.0	21,960.1	100.0

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

1990 DISK/TREND REPORT

FLEXIBLE DISK DRIVES, CAPACITY OVER 5 MEGABYTES

Coverage

Examples of flexible disk drives included in this group are:

8" Bernoulli principle drives

Iomega	Alpha-10H, A120H

5.25" Bernoulli principle drives

Iomega	Beta-20, B120, B144

8" flexible disk drives

Hitachi	FDD 441

5.25" flexible disk drives

Hitachi	FDD 541
Konica	KT-510
Qume	HF-24
Verbatim	6.6, 20 Plus

3.5" flexible disk drives

Brier Technology	BR 3020, BR 3225
Citizen	IFDD-20
Insite Peripherals	I325VM
Matsushita Communication Ind.	JU-351X
NEC	FD 1335C, FD 1335H
Toshiba	PD-401

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

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

Iomega announced the 8 inch Alpha-10 in May, 1981, and deliveries of production drives, with 10 megabytes formatted capacity, started in September, 1982. The original drive was replaced by a half high 8 inch model in 1984, also with 10 megabyte capacity, and a 21 megabyte version was added in 1985. A 5 megabyte full size 5.25 inch drive was introduced in 1983, followed by a 21 megabyte half high model in 1986 and a 44 megabyte version in first quarter, 1989.

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 9.6 megabyte 8 inch drive in 1984, followed in 1985 by a 6.5 megabyte 5.25 inch drive. Both of these drives have been used only in limited applications, and only in Japan.

Building on the technology used in its earlier 3.3 megabyte 5.25 inch drive licensed from Drivetec, Eastman Kodak started shipments of a 6.6 megabyte 5.25 inch drive in the second half of 1986, followed by a more advanced 12 megabyte embedded servo drive in the second half of 1987. These drives are now sold by Verbatim, which was sold to Mitsubishi Kasei

in 1990, and now operates as a separate subsidiary. Primary responsibility for manufacturing this drive was turned over to Data Technology, a firm in which Eastman Kodak had an investment, and which has since been merged into Qume. Qume added a 24 megabyte version in 1988, which is also sold by Verbatim, by doubling the track density to 666 TPI.

The newest developments in high capacity floppies involve 3.5 inch drives announced by Brier Technology and Insite Peripherals, plus several drives by Japanese companies. Because 3.5 inch microfloppies have become the standard floppy format on major personal computer systems from IBM and Apple, as well as many IBM clones, it is expected that most new activity in the high capacity marketplace will involve 3.5 inch drives.

NEC delivered its 9.4 megabyte (formatted) drive in August, 1988, with NEC systems in the domestic Japanese market, and in 1990 superseded it with a 10.18 megabyte model which incorporates read and write compatibility with 1 and 2 megabyte diskettes. Both drives use embedded servo, and use metal powder media.

Brier Technology has announced two 21 megabyte (formatted) 3.5 inch drives using a unique "dual level" or "buried" recording system in which embedded servo information occupies the same position as data tracks without reducing track capacity. The first version of the 21 megabyte Brier drive was delivered in early 1990, and a new drive with downward read/write compatibility to 1 and 2 diskettes is promised for delivery in early 1991.

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

diskettes to achieve high track density (1,250 TPI), resulting in a capacity of 20.8 megabytes (formatted). Insite has demonstrated a new version of the drive promised for volume production by April, 1991, which provides downward read/write compatibility with 1 and 2 megabyte 3.5 inch drives. The firm also has licensed Iomega to manufacture and sell its drives.

Several other Japanese manufacturers have announced various high capacity 3.5 inch floppy drives, including Matsushita Communication Industrial, Toshiba, Citizen, Y-E Data and others, but to date only Citizen appears committed to a specific manufacturing program. The Citizen drive will be read/write downward compatible with 1 and 2 megabyte diskettes, using metal powder media with embedded servo which will be written by users' drives.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1989	1990	1991	1992	1993
U.S. manufacturers	76.7	73.4	94.6	110.4	120.8
All manufacturers	79.2	76.2	108.2	133.4	160.0

Despite all of the trade publicity about various 3.5 inch high capacity floppy drives, Iomega's shipments of Bernoulli type drives still dominate this product group. The firm's late start in replacing its original 8 inch drives with smaller models is the reason for the group's indifferent shipment history in recent years, but the transition to 5.25 inch Bernoulli models is now almost complete. 1990 unit shipments for the product group are expected to decline slightly to 105,000 drives, of which 85% will be Iomega Bernoulli types.

Iomega's Bernoulli principle drives: The capacity, performance, and pricing of Iomega's drives has traditionally placed them in competition with small Winchester disks and removable rigid disk cartridge drives, rather than with most of the flexible disk drives available in the past. Iomega initially attracted great interest in the industry, but orders for OEM drives from system manufacturers were slow in coming.

The firm achieved much better success through its program to sell Bernoulli Box subsystems in the personal computer add-on market with distribution through dealers. During 1983-85, an 8 inch subsystem sold through dealers to IBM PC users was the key to the firm's growth to over $100 million in annual sales.

In 1986, however, sales grew only modestly and profits went into a slide, due to competition from small hard disks and industry-wide decline of the 8 inch form factor. Success of a 21 megabyte half high 5.25 inch drive introduced in 1986 was delayed by technical problems, but the product started to take off in 1987.

Although the company followed a policy of emphasizing sales of the 5.25 inch drive in the OEM market in an attempt to diversify its distribution channels, most current shipments are still sold in the PCM/reseller distribution channel.

For years, Iomega's main difficulty in selling to major system manufacturers on an OEM basis has been lack of credible 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-source product. Attempts to establish token alternate sources in Japan and the U.S. have been abortive.

Other flexible disk drives: Although announcements of 3.5 inch high capacity floppy drives have received extensive press coverage, most of the non-Bernoulli high capacity drives produced so far have been 5.25 inch drives previously introduced by Konica, Eastman Kodak (now sold by Verbatim), and Data Technology (now Qume). While Qume's 10 megabyte drives built most of the group's shipment momentum in recent years, they were quickly replaced by the 20 megabyte models now sold by both Qume and Verbatim.

The non-Bernoulli 5.25 inch drives have average head positioning times in the 60 to 75 millisecond range, much faster than conventional floppy drives, but also much slower than the Bernoulli drives. Latencies are much the same story: The 20 megabyte 5.25 inch drives, with 42 millisecond latency, are twice as fast as conventional floppies, but less than half as fast as the Bernoulli drives.

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

The potential impact of 3.5 inch high capacity floppy drives continues to be promising, but it is still in the future, with limited production to date. Both Insite Peripherals and Brier Technology have made arrangements for contract manufacturing of downward compatible drives

through Japanese manufacturers starting in the first half of 1991, and Citizen has indicated plans for a manufacturing start in the second half of 1991. But the industry's attempts to achieve standardization for media interchange are still in the tentative stage.

Marketing trends

Despite continuing delays in establishing high volume production capability, it is expected that 3.5 inch high capacity drives will establish a serious challenge to 5.25 inch high capacity floppy drives. Because of the large latent demand believed to exist for improved system backup devices, rapid growth is expected for this product group. Once high capacity 3.5 inch drives are in production from multiple vendors, it is anticipated that the window for 5.25 inch drives will start to close.

Now that volume production for 3.5 inch drives seems assured for next year, the 5.25 inch share of shipments for this product group is forecasted to drop to 41.7% in 1991, declining to 6.0% in 1993. 3.5 inch drives are expected to provide 94.0% of 1993 shipments, totaling 825,000 units.

Although 3.5 inch drives are expected to prevail in the high capacity floppy drive market, there will be many challenges along the way. The most important of these is the lack of a consensus in the industry on just what formats should be used. As a result, the high capacity 3.5 inch drives active in the market during the next few years will include several models with various embedded servo head positioning techniques and at least one with optical tracking methods.

As usual, the customers will be put off by all of the ensuing bickering over standards and will find it easy to delay purchases. For these reasons, current DISK/TREND forecasts could be conservative if any of the

competing 3.5 inch products quickly becomes a mainstream de facto standard -- but the industry's history argues against the probability of a quick consensus, unless IBM makes an early choice among the contenders.

Iomega's Bernoulli drives, currently the main products in this product group, are expected to undergo major changes in product mix and market acceptance during the forecast period of this report. 8 inch drives will continue to decline, and are expected to be out of production in the next year. Today's 5.25 inch Bernoulli floppy drives are expected to top out in shipments in 1991, under pressure from 3.5 inch drives.

Technology trends

The major product development challenges in this product group during the remainder of the 1990's will be to increase capacity and lower product cost. If high capacity floppy drives are to achieve prominence in data storage markets, they must offer sufficient capacity to be attractive for most small system backup requirements and they must provide aggressive price competition to tape cartridge drives, removable hard disk drives and erasable optical disk drives. Since the 3.5 inch form factor for data storage products in this class is clearly destined to prevail, the development task will be to produce drives which offer capacities of 20 megabytes and more.

Brier Technology, the first company to announce a specific high capacity 3.5 inch floppy drive, uses a "dual servo" technique, in order to avoid wasting valuable capacity in each data track for servo information. Other firms are known to be developing drives using conventional embedded (interspersed) servo technology.

Insite Peripherals' optical tracking method is perhaps the most innovative approach, with obvious potential for greater capacity and low manufacturing costs -- if the first hurdle of establishing quantity production can be accomplished smoothly.

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

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

Forecasting assumptions

1. Volume production of 3.5 inch high capacity drives from multiple vendors will start in the first half of 1991.
2. No major system OEM, such as IBM or Apple Computer, will adopt a product in this group for system usage through 1990.
3. Shipments of 5.25 inch Bernoulli drives will peak in 1991.

TABLE 27

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1989		Forecast							
	Revenues		1990		1991		1992		1993	
	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	56.8	71.7	54.1	68.3	67.5	82.8	57.1	74.8	37.1	54.5
OEM/Integrator	4.2	5.0	4.1	5.1	9.6	11.8	28.4	35.6	50.0	66.3
TOTAL U.S. NON-CAPTIVE	61.0	76.7	58.2	73.4	77.1	94.6	85.5	110.4	87.1	120.8
TOTAL U.S. REVENUES	61.0	76.7	58.2	73.4	77.1	94.6	85.5	110.4	87.1	120.8
Non-U.S. Manufacturers										
Captive	--	.3	--	1.5	1.2	9.4	2.7	13.3	3.5	16.8
PCM/Reseller	1.4	1.4	--	--	--	--	2.2	2.9	4.8	6.8
OEM/Integrator	--	.8	--	1.3	2.4	4.2	4.0	6.8	9.1	15.6
TOTAL NON-U.S. REVENUES	1.4	2.5	--	2.8	3.6	13.6	8.9	23.0	17.4	39.2
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	62.4	79.2	58.2	76.2	80.7	108.2	94.4	133.4	104.5	160.0
OEM Average Price ($000)	.592	.513	.554	.418	.238	.238	.167	.167	.132	.131

TABLE 28

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1989		Forecast							
	Shipments		1990		1991		1992		1993	
	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	74.0	94.2	68.3	86.4	118.0	140.0	126.0	158.0	121.0	162.0
OEM/Integrator	7.1	8.3	7.4	9.2	38.5	46.5	169.0	212.0	379.0	504.0
TOTAL U.S. NON-CAPTIVE	81.1	102.5	75.7	95.6	156.5	186.5	295.0	370.0	500.0	666.0
TOTAL U.S. SHIPMENTS	81.1	102.5	75.7	95.6	156.5	186.5	295.0	370.0	500.0	666.0
Non-U.S. Manufacturers										
Captive	--	.4	--	3.3	3.0	23.2	7.0	35.0	10.0	48.0
PCM/Reseller	3.0	3.0	--	--	--	--	12.0	16.0	32.0	45.0
OEM/Integrator	--	3.0	--	6.1	12.0	20.6	25.0	42.3	70.0	120.0
TOTAL NON-U.S. SHIPMENTS	3.0	6.4	--	9.4	15.0	43.8	44.0	93.3	112.0	213.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	84.1	108.9	75.7	105.0	171.5	230.3	339.0	463.3	612.0	879.0
Cumulative Shipments (Units in thousands)										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	499.2	607.2	574.9	712.2	746.4	942.5	1,085.4	1,405.8	1,697.4	2,284.8
WORLDWIDE TOTAL	499.2	607.2	574.9	712.2	746.4	942.5	1,085.4	1,405.8	1,697.4	2,284.8

TABLE 29

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1989 Revenues			Forecast 1990			1991			1992		1993	
	3.5"	5.25"	8"	3.5"	5.25"	8"	3.5"	5.25"	8"	3.5"	5.25"	3.5"	5.25"
U.S. MANUFACTURERS													
PCM/Reseller	--	56.6	15.1	.3	63.3	4.7	10.8	68.9	3.1	14.0	60.8	15.4	39.1
OEM/Integrator	--	3.7	1.3	.1	4.3	.7	7.6	4.2	--	33.1	2.5	65.3	1.0
TOTAL U.S. REVENUES	--	60.3	16.4	.4	67.6	5.4	18.4	73.1	3.1	47.1	63.3	80.7	40.1
NON-U.S. MANUFACTURERS													
Captive	--	--	.3	1.2	--	.3	9.2	--	.2	13.3	--	16.8	--
PCM/Reseller	--	1.4	--	--	--	--	--	--	--	2.9	--	6.8	--
OEM/Integrator	.4	.2	.2	1.0	.2	.1	4.0	.2	--	6.7	.1	15.6	--
TOTAL NON-U.S. REVENUES	.4	1.6	.5	2.2	.2	.4	13.2	.2	.2	22.9	.1	39.2	--
WORLDWIDE RECAP													
Captive	--	--	.3	1.2	--	.3	9.2	--	.2	13.3	--	16.8	--
	-100.0%	--	--	--	--	--	+666.7%	--	-33.3%	+44.6%	--	+26.3%	--
PCM/Reseller	--	58.0	15.1	.3	63.3	4.7	10.8	68.9	3.1	16.9	60.8	22.2	39.1
	--	+47.2%	-35.5%	--	+9.1%	-68.9%	--	+8.8%	-34.0%	+56.5%	-11.8%	+31.4%	-35.7%
OEM/Integrator	.4	3.9	1.5	1.1	4.5	.8	11.6	4.4	--	39.8	2.6	80.9	1.0
	--	-42.6%	-65.1%	+175.0%	+15.4%	-46.7%	+954.5%	-2.2%	-100.0%	+243.1%	-40.9%	+103.3%	-61.5%
Total Revenues	.4	61.9	16.9	2.6	67.8	5.8	31.6	73.3	3.3	70.0	63.4	119.9	40.1
	-20.0%	+34.0%	-39.0%	+550.0%	+9.5%	-65.7%	--	+8.1%	-43.1%	+121.5%	-13.5%	+71.3%	-36.8%
ANNUAL SHARE, BY DIAMETER	.5%	78.3%	21.2%	3.4%	89.1%	7.5%	29.2%	67.8%	3.0%	52.6%	47.4%	75.0%	25.0%

TABLE 30

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1989 Shipments			Forecast 1990			1991			1992		1993	
	3.5"	5.25"	8"	3.5"	5.25"	8"	3.5"	5.25"	8"	3.5"	5.25"	3.5"	5.25"
U.S. MANUFACTURERS													
PCM/Reseller	--	74.6	19.6	.8	79.6	6.0	49.0	87.0	4.0	80.0	78.0	110.0	52.0
OEM/Integrator	--	6.5	1.8	.2	8.0	1.0	38.0	8.5	--	207.0	5.0	502.0	2.0
TOTAL U.S. SHIPMENTS	--	81.1	21.4	1.0	87.6	7.0	87.0	95.5	4.0	287.0	83.0	612.0	54.0
NON-U.S. MANUFACTURERS													
Captive	.1	--	.3	3.0	--	.3	23.0	--	.2	35.0	--	48.0	--
PCM/Reseller	--	3.0	--	--	--	--	--	--	--	16.0	--	45.0	--
OEM/Integrator	2.0	.6	.4	5.0	.8	.3	20.0	.5	.1	42.0	.3	120.0	--
TOTAL NON-U.S. SHIPMENTS	2.1	3.6	.7	8.0	.8	.6	43.0	.5	.3	93.0	.3	213.0	--
WORLDWIDE RECAP													
Captive	.1	--	.3	3.0	--	.3	23.0	--	.2	35.0	--	48.0	--
	--	--	--	--	--	--	+666.7%	--	-33.3%	+52.2%	--	+37.1%	--
PCM/Reseller	--	77.6	19.6	.8	79.6	6.0	49.0	87.0	4.0	96.0	78.0	155.0	52.0
	--	+16.2%	-46.4%	--	+2.6%	-69.4%	--	+9.3%	-33.3%	+95.9%	-10.3%	+61.5%	-33.3%
OEM/Integrator	2.0	7.1	2.2	5.2	8.8	1.3	58.0	9.0	.1	249.0	5.3	622.0	2.0
	--	-48.9%	-68.6%	+160.0%	+23.9%	-40.9%	--	+2.3%	-92.3%	+329.3%	-41.1%	+149.8%	-62.3%
Total Shipments	2.1	84.7	22.1	9.0	88.4	7.6	130.0	96.0	4.3	380.0	83.3	825.0	54.0
	--	+5.0%	-49.3%	+328.6%	+4.4%	-65.6%	--	+8.6%	-43.4%	+192.3%	-13.2%	+117.1%	-35.2%
ANNUAL SHARE, BY DIAMETER	1.9%	77.9%	20.2%	8.6%	84.3%	7.1%	56.5%	41.7%	1.8%	82.1%	17.9%	94.0%	6.0%

TABLE 31

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1989 Estimate Units (000)	1989 Estimate %	1993 Projection Units (000)	1993 Projection %
MAINFRAME/SUPERMINI General purpose	--	--	--	--
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	4.9	4.5	26.4	3.0
PERSONAL COMPUTERS Business and professional, single user	81.7	75.1	707.6	80.5
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	6.7	6.2	44.0	5.0
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	14.6	13.4	61.5	7.0
CONSUMER AND HOBBY COMPUTERS	1.0	.8	39.5	4.5
OTHER APPLICATIONS	--	--	--	--
Total	108.8	100.0	879.1	100.0

TABLE 32

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1989 Net Shipments			
	To United States Destinations		Worldwide	
Drive Manufacturers	Units (000)	%	Units (000)	%
IOMEGA	72.3	86.0	90.2	83.1
Other U.S.	8.8	10.5	12.3	11.3
Other Non-U.S.	3.0	3.5	6.0	5.6
TOTAL	84.1	100.0	108.5	100.0

FLEXIBLE DISK DRIVE SPECIFICATIONS

1990 DISK/TREND REPORT

FLEXIBLE DISK DRIVE SPECIFICATIONS

Coverage

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

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

Capacities

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

Accuracy

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

OEM prices

Previous editions of the DISK/TREND Report included information in the specifications section on the OEM/Integrator price for drives sold in the United States at the 500 unit level, or for larger quantities in some cases. Starting with this year's edition of the report, price information for individual products is no longer included, because of the rapid changes involved and the lack of actual selling activity at the low quantity level for which prices were provided.

DISK/TREND product groups

In most cases the product groups used for individual drives are clear, but a few arbitrary decisions have been made. The IBM magazine drive has been included in the 8 inch group, since the magazine mechanism uses a single drive.

1990 DISK/TREND product groups for flexible disk drives

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

MANUFACTURER	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC
DRIVE	DFE 222A	DFE 422A	DFE 642A	DFE 682A	DFP 423A DFP 423D DFP 423E DFP 423F
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	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5	U: 1.0	U: 1.6	U: 1.0/1.6	U: 1.0
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 10,416	U: 6,250/10,416	U: 6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	80	77	80/77	80
Track density (TPI)	48	96	96	96	135
Maximum linear density (BPI)	5876	5922	9646	5922/9646	8717
Rotational speed (RPM)	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)	4/6	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	300	83.3	100/83.3	100
Data transfer rate (KBytes/sec)	31.25	31.25	62.5	31.25/62.5	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1987	1987	1987	1987	1987
COMMENTS					

MANUFACTURER	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC
DRIVE	DFP 723A DFP 723D DFP 723E DFP 723F	DFR 423A DFR 423D DFR 423E DFR 423F	DFR 683A DFR 683D DFR 683E DFR 683F	DFR 723A DFR 723D DFR 723E DFR 723F	DFR 783A DFR 783D DFR 783E DFR 783F
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	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: 1.0	U: 1.0/1.6	U: 1.0/2.0	U: 1.0/1.6/2.0
Capacity per track (Bytes)	U: 6,250/12,500	U: 6,250	U: 6,250/10,416	U: 6,250/12,500	U: 6,250/12,500
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)	8717/17434	8717	8717/14518	8717/17434	8717/17434
Rotational speed (RPM)	300	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	100	100/83.3	100	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 (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.7	1.0 x 4.0 x 5.7	1.0 x 4.0 x 5.7	1.0 x 4.0 x 5.7
FIRST CUSTOMER SHIPMENT	1987	5/90	5/90	5/90	5/90
COMMENTS					

MANUFACTURER	ALPS ELECTRIC	ASIA COMMERCIAL	ASIA COMMERCIAL	ASIA COMMERCIAL	ASIA COMMERCIAL
DRIVE	DFR 823	FD-103	FD-104 FD-104E	FD-106 FD-106E	FD-148
DISK/TREND GROUP	15	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	5.25"	5.25"	5.25"	5.25"
Recording medium	Barium Ferrite	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0/4.0	U: .125/.250	U: .250/.5	U: .8/1.6	U: .125/.250
Capacity per track (Bytes)	U: 6,250/25,000	U: 3,125/6,250	U: 3,125/6,250	U: 5,208/10,416	U: 3,125/6,250
Data surfaces per spindle	2	1	2	2	1
Tracks per surface	80	40	40	80	40
Track density (TPI)	135	48	48	96	48
Maximum linear density (BPI)	8717/34868	2768/5536	2938/5876	4823/9646	2768/5536
Rotational speed (RPM)	300	300	300	360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	6	6	3	6
Settling time (msec)	15	20	15	18	20
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5/125	15.63/31.25	15.63/31.25	31.25/62.5	15.63/31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.7	1.625 x 5.75 x 8.25	1.625 x 5.75 x 8.25	1.625 x 5.75 x 8.25	1.625 x 5.88 x 8.0
FIRST CUSTOMER SHIPMENT	8/90	2Q85	1Q86	3Q87	4Q85
COMMENTS		For Apple IIC and Apple IIE	For IBM PC XT FD-104E is externally mounted	For IBM AT FD-106E is externally mounted	For Commodore C64

MANUFACTURER	ASIA COMMERCIAL	ASIA COMMERCIAL	BRIER TECHNOLOGY	BRIER TECHNOLOGY	BROTHER
DRIVE	FD-200	FD-201	BR 3020	BR 3225	FB 015 FB 400
DISK/TREND GROUP	14	14	16	16	15
MARKET	OEM	OEM	OEM	OEM	Captive, OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	3.5"	3.5"	3.5
Recording medium	Oxide Coated	Oxide Coated	Barium Ferrite	Barium Ferrite	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5	U: 1.6	F: 21.4	F: 21.4	U: .320
Capacity per track (Bytes)	U: 6,250	U: 10,416	**	**	U: 4,102
Data surfaces per spindle	2	2	2	2	1
Tracks per surface	80	160	516	516	78
Track density (TPI)	48	96	777	777	135
Maximum linear density (BPI)	5536	9646	26000*	26000*	5180
Rotational speed (RPM)	300	360	720	720	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	6	3	15	15	20
Settling time (msec)	15	15	--	--	10
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	83.3	41.6	41.6	100
Data transfer rate (KBytes/sec)	31.25	62.5	1250	1250	19.50
SIZE (Inches: H x W x D)	1.81 x 6.0 x 9.0	1.81 x 6.0 x 9.0	1.625 x 4.0 x 5.75	1.0 x 4.0 x 5.75	1.0 x 4.06 x 6.69
FIRST CUSTOMER SHIPMENT			1Q90	1Q91	10/87
COMMENTS			Dual level embedded servo 35 msec average head positioning *RLL Code **Varies by zone	Dual level embedded servo. 35 msec average head position. *RLL Code. **Varies by zone. Downward comp. with 1 & 2 MB (Read & Write)	FB 400 is kit for typewriter GCR encoded

MANUFACTURER	BROTHER	BROTHER	CANON	CANON	CANON
DRIVE	FB 100	FB 300	MD 5201	MD 5501	MD 3411 MD 3421
DISK/TREND GROUP	15	15	14	14	15
MARKET	Captive, OEM	Captive	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	5.25"	5.25"	3.5"
Recording medium	High Density Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .1024	U: .250	U: .250/.5	U: 1.0/1.6	U: 1.0
Capacity per track (Bytes)	F: 2,560	U: 6,250	U: 3,125/6,250	U: 6,250/10,416	U: 6,250
Data surfaces per spindle	1	1	2	2	2
Tracks per surface	40	40	40	80/77	80
Track density (TPI)	67.5	67.5	48	96	135
Maximum linear density (BPI)	4064	8128	2938/5876	5922/9646	8717
Rotational speed (RPM)	300	300	300	360	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	60	24	6	3	3
Settling time (msec)	20	24	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
Data transfer rate (KBytes/sec)	15.63	31.25	15.63/31.25	31.25/62.5	250
SIZE (Inches: H x W x D)	2.16 x 5.1 x 6.5	2.51 5.19 x 8.03	1.06 x 5.75 x 7.8	1.06 x 5.75 x 7.8	1.0 x 4.0 x 5.89
FIRST CUSTOMER SHIPMENT	1984	1985	7/86	7/86	4Q88
COMMENTS					

MANUFACTURER	CANON	CANON	CANON	CANON	CANON
DRIVE	MD 3441	MD 3511 MD 3521	MD 3541	MD 3611 MD 3621	MD 3641
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	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0	U: 1.0/1.6	U: 1.0/1.6	U: 1.0/2.0	U: 1.0/2.0
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,420	U: 6,250/10,416	U: 6,250/12,500	U: 6,250/12,500
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	8717/14527	8717/14527	8717/17434	8717/17434
Rotational speed (RPM)	300	300/360	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)	100	100/83.3	83.3	100	100
Data transfer rate (KBytes/sec)	31.25	250/500	37.5/62.5	250/500	31.25/62.5
SIZE (Inches: H x W x D)	.77 x 4.0 x 5.1	1.0 x 4.0 x 5.89	.77 x 4.0 x 5.1	1.0 x 4.0 x 5.89	.77 x 4.0 x 5.1
FIRST CUSTOMER SHIPMENT	1990	4/88	4/90	4/88	4/90
COMMENTS	Direct drive motor		Direct drive motor		Direct drive motor

MANUFACTURER	CHINON	CHINON	CHINON	CHINON	CHINON
DRIVE	FR-506	FZ-501A	FZ-502	FZ-506	FB-354 FB-354I
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	Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: .125/.250	U: .250/.5	U: 1.0/1.6	U: .5/1.0
Capacity per track (Bytes)	U: 6,250/10,416	U: 3,125/6,250	U: 3,125/6,250	U: 6,250/10,416	U: 3,125/6,250
Data surfaces per spindle	2	1	2	2	2
Tracks per surface	80	40	40	80	80
Track density (TPI)	96	48	48	96	135
Maximum linear density (BPI)	5922/9870	2768/5536	2938/5876	5922/9870	4359/8717
Rotational speed (RPM)	300/360	300	300	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	6	5	3	3
Settling time (msec)	15	20	20	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	100/83.3	100
Data transfer rate (KBytes/sec)	37.5/62.5	15.63/31.25	15.63/31.25	37.5/62.5	15.63/31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 7.6	1.625 x 5.75 x 7.6	1.625 x 5.75 x 7.6	1.625 x 5.75 x 7.6	1.26 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1Q91	8/83	3/87	4/87	11/84
COMMENTS					FB-354I in 5.25" frame

MANUFACTURER	CHINON	CHINON	CHINON	CHINON	CHINON
DRIVE	FB-357 FB-357I	FJ-205	FT-357	FX-354 FX-354I	FX-357 FX-357I
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	2.0"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	Metal Powder	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: 1.0	U: 1.0/2.0	U: .5/1.0	U: 1.0/2.0
Capacity per track (Bytes)	U: 6,250/12,500	U: 20,000	U: 6,250/12,500	U: 3,125/6,250	U: 6,250/12,500
Data surfaces per spindle	2	1	2	2	2
Tracks per surface	80	50	80	80	80
Track density (TPI)	135	254	135	135	135
Maximum linear density (BPI)	8717/17434	51200	8717/17434	4359/8717	8717/17434
Rotational speed (RPM)	300	3600	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	4	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)	100	8.3	100	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	1787.5	31.25/62.5	15.63/31.25	31.25/62.5
SIZE (Inches: H x W x D)	1.26 x 4.0 x 5.9	.79 x 2.5 x 3.5	.67 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	7/86	1Q91	1Q91	7/86	3Q87
COMMENTS	FB-357I in 5.25" frame	Compatible with Sony 2.0" FDD		FX-354I in 5.25" frame	FX-357I in 5.25" frame

MANUFACTURER	CHINON	CHINON	CHINON	CITIZEN	CITIZEN
DRIVE	FX-358	FZ-354 FZ-354I	FZ-357 FZ-357I	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	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0/4.0	U: .5/1.0	U: 1.0/2.0	U: 1.0/2.0	U: 1.0/1.6
Capacity per track (Bytes)	U: 6,250/12,500 25,000	U: 3,125/6,250	U: 6,250/12,500	U: 6,250/12,500	U: 6,250/10,416
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)	8717/17434/ 34868	4359/8717	8717/17434	8717/17434	8717/14184
Rotational speed (RPM)	300	300	300	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5/125	15.65/31.25	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.11	1.0 x 4.0 x 5.11	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1Q90	1Q90	1Q90	4Q87	4Q87
COMMENTS		FZ-354I in 5.25" frame	FZ-357I 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)	U: 1.0	U: 1.0	U: 1.0/1.6/2.0	U: 1.0/2.0/4.0	U: 1.0/1.6/4.0
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 6,250/12,500	U: 6,250/25,000	U: 6,250/25,000
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80/77	80	80/77
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717	8717	8717/17434	8717/17434/ 34868	8717/14184/ 34868
Rotational speed (RPM)	300	300	300	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	6	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	100/83.3
Data transfer rate (KBytes/sec)	31.25	31.25	31.25/62.5	31.25/62.5/125	31.25/62.5/125
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	4Q87	4Q87	4Q89	4Q90	4Q90
COMMENTS					

MANUFACTURER	CITIZEN	CITIZEN	CITIZEN	CITIZEN	CITIZEN
DRIVE	U0DA U1DA	U0DB U1DB	U0DC U1DC	U0DD U1DD	V1DA
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)	U: 1.0/2.0	U: 1.0/1.6	U: 1.0	U: 1.0	U: 1.0/2.0
Capacity per track (Bytes)	U: 6,250/12,500	U: 6,250/10,416	U: 6,250	U: 6,250	U: 6,250/12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/14184	8717	8717	8717/17434
Rotational speed (RPM)	300	300/360	300	300	300
PERFORMANCE					
Actuator type	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	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	100/83.3	100	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25	31.25	31.25/62.5
SIZE (Inches: H x W x D)	.77 x 4.0 x 5.1	.77 x 4.0 x 5.1	.77 x 4.0 x 5.1	.77 x 4.0 x 5.1	.59 x 3.8 x 5.1
FIRST CUSTOMER SHIPMENT	3Q89	2Q90	2Q89	2Q89	1Q91
COMMENTS					

MANUFACTURER	CITIZEN	CITIZEN	CITIZEN	CITIZEN	COBRA
DRIVE	V1DB	V1DC	V1DE	IFDD-20	MM 500
DISK/TREND GROUP	15	15	15	16	13
MARKET	OEM	OEM	OEM	OEM	Captive
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	8"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Metal Powder	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: 1.0	U: 1.0/1.6/2.0	F: 20.6	U: .802/1.6
Capacity per track (Bytes)	U: 6,250/10,416	U: 6,250	U: 6,250/12,500	F: 32,000	U: 10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80/77/80	320	77
Track density (TPI)	135	135	135	542	48
Maximum linear density (BPI)	8717/14184	8717	8717/17434	64500 BPI* 43000 FCI	3268/6536
Rotational speed (RPM)	300/360	300	300/360	600	360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Linear, Voice Coil	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	6
Settling time (msec)	15	15	15	--	10
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	30
Average rotational delay (msec)	100/83.3	100	100/83.3	50	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25	31.25	437.5	31.25/62.5
SIZE (Inches: H x W x D)	.59 x 3.8 x 5.1	.59 x 3.8 x 5.1	.59 x 3.8 x 5.1	1.0 x 4.0 x 6.2**	4.9 x 8.4 x 15.0
FIRST CUSTOMER SHIPMENT	1Q91	1Q91	1Q91	2Q91	1979
COMMENTS				*2,7 RLL Code 50 msec average head position. SCSI interface. Downward comp. with 1 & 2 MB (Read & Write) **Without SCSI interface board	

MANUFACTURER	DZU	DZU	DZU	DZU	DZU
DRIVE	EC 5327.01	ES 5323	ES 5323.01	ES 5326	ISA 235HF
DISK/TREND GROUP	14	14	14	14	15
MARKET	OEM	Captive, OEM	OEM	OEM	Captive, OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	3.5"
Recording medium	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5/1.0/1.6	U: .5/1.0	U: .5/1.0	U: .250/.5	U: 1.0
Capacity per track (Bytes)	U: 10,416	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250	U: 6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	40	80
Track density (TPI)	96	96	96	48	135
Maximum linear density (BPI)	9646	2961/5922	2961/5922	2938/5876	8717
Rotational speed (RPM)	360/300	300	300	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	6	3	6	3
Settling time (msec)	15	15	15	15	20
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	100	100	100	100
Data transfer rate (KBytes/sec)	31.25	15.63/31.25	15.63/31.25	15.63/31.25	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 4.0 x 5.75
FIRST CUSTOMER SHIPMENT	1988	1985	1988	1988	1989
COMMENTS					

MANUFACTURER	EASTERN PERIPHERALS	EASTERN PERIPHERALS	ELCOMATIC	ELCOMATIC	ELCOMATIC
DRIVE	TM 65-2	TM 75-8	ACP 500 ACP 550	ACP 700 ACP 750	ACP 1500
DISK/TREND GROUP	14	14	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	8"	8"	8"
Recording medium	Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5	U: .5/1.6	U: .401/.802	U: .8/1.6	U: 1.6/3.2
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,416	U: 5,208/10,416	U: 5,208/10,416	U: 10,416
Data surfaces per spindle	2	2	1	2	2
Tracks per surface	40	80	77	77	154
Track density (TPI)	48	96	48	48	96
Maximum linear density (BPI)	5877	4823/9646	3268/6536	3408/6816	3408/6816
Rotational speed (RPM)	300	360	360	360	360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	6	3/6	3	3	1.5
Settling time (msec)	15	15	15	15	32
Head load time(msec)	Continuous Contact	Continuous Contact	35	35	35
Average rotational delay (msec)	100	83.3	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	31.25	31.25	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	4.35 x 8.55 x 12.0	4.35 x 8.55 x 12.0	4.35 x 8.55 x 12.0
FIRST CUSTOMER SHIPMENT	1982	1985	4Q81	4Q81	1983
COMMENTS			ACP 500: AC ACP 550: DC	ACP 700: AC ACP 750: DC	

MANUFACTURER	ELEBRA	ELEBRA	ERGO	ERGO	FLEXDISC
DRIVE	9410-B	9410-D	DS-7	MD-21 MD-22	FF650
DISK/TREND GROUP	14	14	14	15	14
MARKET	OEM	OEM	Captive, OEM	Captive, OEM	OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	3.5"	5.25"
Recording medium	Oxide Coated	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5	U: 1.6	U: .250/.5	U: 1.0/2.0	U: .250/.5
Capacity per track (Bytes)	U: 6,250	U: 10,416	U: 3,125/6,250	U: 6,250/12,500	U: 3,125/6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	80	40	80	40
Track density (TPI)	48	96	48	135	48
Maximum linear density (BPI)	5877	14528	2938/5876	8717/17434	2938/5876
Rotational speed (RPM)	300	300/360	300	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	6	3	6	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	83.3	100	100	100
Data transfer rate (KBytes/sec)	31.25	62.5	15.63/31.25	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.67 x 5.88 x 8.0	1.67 x 5.88 x 8.0	1.625 x 5.75 x 8.0	1.0 x 4.0 x 5.9	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	2Q85	1Q86	12/88	1Q90	--
COMMENTS				MD-22 is tested to tighter specifications	

MANUFACTURER	FLEXDISC	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	FF950	M2553B	M2532B	M2537B	M2537D
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)	U: .8/1.6	U: .8/1.6	U: 1.0	U: 2.0	U: 2.0
Capacity per track (Bytes)	U: 5,208/10,416	U: 5,208/10,416	U: 6,250	U: 12,500	U: 12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	77	77	80	80	80
Track density (TPI)	96	96	135	135	135
Maximum linear density (BPI)	4823/9646	4823/9646	8717	17434	17434
Rotational speed (RPM)	360	360	300	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	83.3	100	100	100
Data transfer rate (KBytes/sec)	62.5/125	31.25/62.5	31.25	62.5	62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	.68 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1990	1/86	4Q87	4Q87	4Q90
COMMENTS					

MANUFACTURER	FUJITSU	GENISCO MEMORY PRODUCTS	GOLDSTAR TELE-COMMUNICATION	GOLDSTAR TELE-COMMUNICATION	GOLDSTAR TELE-COMMUNICATION
DRIVE	M2539B	EDR-350	GSF-548N	GSF-596N	GSF-313
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	Barium Ferrite	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0/4.0	U: 1.0	U: .5	U: 1.6	U: 1.0/2.0
Capacity per track (Bytes)	U: 6,250/25,000	U: 6,250	U: 6,250	U: 10,416	U: 6,250/12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	40	77	80
Track density (TPI)	135	135	48	96	135
Maximum linear density (BPI)	8717/34868	8717	5870	9600	8717/17434
Rotational speed (RPM)	300	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	6	6	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5/125	31.25	31.25	62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	3.75 x 5.75 x 7.37	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.0 x 4.0 x 6.06
FIRST CUSTOMER SHIPMENT	4Q90	1987	1990	1989	1990
COMMENTS		Sold as militarized subsystem			

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HO SHIN
DRIVE	FDD 412 FDD 413B	HFD 516C	FDD 441	FDD 541	HS-550
DISK/TREND GROUP	13	14	16	16	14
MARKET	Captive, OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	8"	5.25"	8"	5.25"	5.25"
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .8/1.6	U: .8/1.6	U: 9.6	U: 6.5	U: .250
Capacity per track (Bytes)	U: 5,208/10,416	U: 5,208/10,416	U: 31,250	U: 31,250	U: 6,250
Data surfaces per spindle	2	2	2	2	1
Tracks per surface	77	77	154	104	40
Track density (TPI)	48	96	96	125	48
Maximum linear density (BPI)	3408/6816	4823/9646	20560*	29560	5536
Rotational speed (RPM)	360	360	360	720	300
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	2	2	6
Settling time (msec)	35	15	15	37	15
Head load time(msec)	50	50	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	83.3	83.3	41.7	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	187.5	375	31.25
SIZE (Inches: H x W x D)	2.24 x 8.54 x 13.0	1.625 x 5.75 x 8.0	2.24 x 8.54 x 12.9	1.625 x 5.75 x 8.6	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	2/82	4/83	2/84	1Q85	12/87
COMMENTS			*2,7 RLL Code		For use with Apple II

MANUFACTURER	HO SHIN	HO SHIN	HO SHIN	HYUNDAI ELECTRONICS	HYUNDAI ELECTRONICS
DRIVE	HS-551	HS-552	HS-553	HMF-311	HMF-321
DISK/TREND GROUP	14	14	14	15	15
MARKET	OEM	OEM	OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	3.5"	3.5"
Recording medium	Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5	U: 1.0	U: 1.6	U: 1.0	U: 1.6
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 10,416	U: 6,250	U: 10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	80	77	80	77
Track density (TPI)	48	96	96	135	135
Maximum linear density (BPI)	5876	5922	9646	8717	14528
Rotational speed (RPM)	300	300	360	300	360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	6	3	3	3	3
Settling time (msec)	15	15	15	20	20
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	83.3
Data transfer rate (KBytes/sec)	31.25	31.25	31.25	31.25	62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	3/88	3Q88	3Q88	10/88	10/88
COMMENTS	For use with IBM PC XT	For use with IBM PC XT	For use with IBM PC AT		

MANUFACTURER	HYUNDAI ELECTRONICS	HYUNDAI ELECTRONICS	IBM	IBM	INSITE PERIPHERALS
DRIVE	HMF-331	HMF-341	4956 4965	4964	I325VM
DISK/TREND GROUP	15	15	13	13	16
MARKET	Captive, OEM	Captive, OEM	Captive	Captive	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	8"	8"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: 1.0/2.0	F: .985088 or F: 1.136640 or F: 1.212416	F: .492544 or F: .568320 or F: .606208	F: 20.8
Capacity per track (Bytes)	U: 6,250/10,416	U: 6,250/12,500	F: 6,656/7,680/ 8,192	F: 3,328/3,840/ 4,096	F: 13,824
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	74/3	74/3	755
Track density (TPI)	135	135	48	48	1250
Maximum linear density (BPI)	8717/14528	8717/17434	3408/6816	3408	23980 BPI* 17985 FCI
Rotational speed (RPM)	300/360	300	360	360	720
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Crs:Step. Motor Fine:Voice Coil
POSITIONING:Track to track(msec)	3	3	5	5	1
Settling time (msec)	20	20	35	35	15
Head load time(msec)	Continuous Contact	Continuous Contact			Continuous Contact
Average rotational delay (msec)	100/83.3	100	83.3	83.3	41.6
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25	200
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	--	--	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	10/88	10/88	8/81	11/76	4/91
COMMENTS			Series/1	Series/1	*1,7 RLL Code 65 msec average position. time Optical servo track system. SCSI interface Downward comp. with 1 & 2 MB (Read & Write)

MANUFACTURER	IOMEGA	IOMEGA	IOMEGA	IOMEGA	IOMEGA
DRIVE	A110H/A210H Bernoulli Box	A120H/A220H Bernoulli Box	Alpha-10H	Alpha-20H	B120/B220 Bernoulli Box II
DISK/TREND GROUP	16	16	16	16	16
MARKET	PCM	PCM	PCM, OEM	PCM, OEM	PCM
MEDIA: Nominal disk diameter	8"	8"	8"	8"	5.25"
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: 10.0	F: 21.4	F: 10.027 or 10.497	F: 21.4	F: 21.4
Capacity per track (Bytes)	F: 32,768	F: 32,768	F: 32,768 or 34,304	F: 32,768	F: 16,128
Data surfaces per spindle	1	1	1	1	2
Tracks per surface	306	654	306	654	677
Track density (TPI)	300	641	300	641	570
Maximum linear density (BPI)	24000 BPI 18000 FCI	24000 BPI 18000 FCI	24000 BPI 18000 FCI	24000 BPI 18000 FCI	23511 BPI* 17633 FCI
Rotational speed (RPM)	1500	1500	1500	1500	1845.7
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil
POSITIONING:Track to track(msec)	10 (including settling)	10 (including settling)	10 (including settling)	10 (including settling)	6.2 (including settling)
Settling time (msec)	--	--	--	--	--
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	20	20	20	20	16.25
Data transfer rate (KBytes/sec)	1130	1130	1130	1130	666
SIZE (Inches: H x W x D)	6.32 x 12.5 x 15.25	6.32 x 12.5 x 15.25	2.32 x 8.54 x 12.0	2.32 x 8.54 x 12.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	8/85	10/85	4Q84	3Q85	9/87
COMMENTS	Subsystem for IBM PC A210H is 2 drive version priced at $1,999	Subsystem for IBM PC A220H is 2 drive version priced at $2,299	1st drive $840 2nd drive $464	1st drive $900 2nd drive $550	2nd drive $900 External Single $1,450 Dual $2,350 40 msec average positioning time *1,8 RLL Code

MANUFACTURER	IOMEGA	IOMEGA	JIN TECH ELECTRONICS	JIN TECH ELECTRONICS	JIN TECH ELECTRONICS
DRIVE	B144/B244 Bernoulli Box II/44	Beta-20	OB-1	OC-118 OC-118N	OH-2
DISK/TREND GROUP	16	16	14	14	14
MARKET	PCM	OEM	OEM, PCM	OEM, PCM	OEM, PCM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	5.25"
Recording medium	Barium Ferrite	High Density Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 44.5	F: 21.4	U: .5	U: .174	U: .143
Capacity per track (Bytes)	F: 20,480	F: 16,128	U: 6,250	U: 4,833	U: 3,972
Data surfaces per spindle	2	2	2	1	1
Tracks per surface	1088	677	40	36	36
Track density (TPI)	1095	570	48	48	48
Maximum linear density (BPI)	28541 BPI* 21405 FCI	23511 BPI* 17633 FCI	5536	2768/5536	2768/5536
Rotational speed (RPM)	2027	1845.7	300	300	300
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track (msec)	3.7	6.2 (including settling)	4	6	4
Settling time (msec)	--	--	20	15	15
Head load time (msec)	Continuous Contact	Continuous Contact	Continuous Contact	35	35
Average rotational delay (msec)	14.8	16.25	100	100	100
Data transfer rate (KBytes/sec)	692.5	666	31.25	15.63	15.63
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8	1.57 x 5.67 x 7.95	1.57 x 5.67 x 7.95	1.65 x 5.75 x 7.05
FIRST CUSTOMER SHIPMENT	2/89	3Q86	9/86	1984	1985
COMMENTS	2nd drive $1099 External Single $1,799 Dual $2,799 32 msec average positioning time *1,8 RLL Code	1000 quantity: 1st drive $995 2nd drive $723 38 msec average positioning time SCSI interface *1,8 RLL Code		For Commodore	For Apple II

MANUFACTURER	KONICA	MAGYAR OPTIKAI MUVEK	MAGYAR OPTIKAI MUVEK	MAGYAR OPTIKAI MUVEK	MAGYAR OPTIKAI MUVEK
DRIVE	KT-510	MF 54D	MF 54S	MF 58D	MF 58S
DISK/TREND GROUP	16	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	5.25"
Recording medium	High Density Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 10.76	U: .5	U: .250	U: 1.0	U: .5
Capacity per track (Bytes)	F: 15,360	U: 6,250	U: 6,250	U: 6,250	U: 6,250
Data surfaces per spindle	2	2	1	2	1
Tracks per surface	350	40	40	80	80
Track density (TPI)	480	48	48	96	96
Maximum linear density (BPI)	17827	5876	5536	5922	5576
Rotational speed (RPM)	600	300	300	300	300
PERFORMANCE					
Actuator type	Linear, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	20	3	3	3	3
Settling time (msec)	--	15	15	15	15
Head load time(msec)	Continuous Contact	35	35	35	35
Average rotational delay (msec)	50	100	100	100	100
Data transfer rate (KBytes/sec)	200	31.25	31.25	31.25	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.3	1.625 x 5.75 x 8.3	1.625 x 5.75 x 8.3	1.625 x 5.75 x 8.3
FIRST CUSTOMER SHIPMENT	11/87	1987	1987	1987	1987
COMMENTS	Embedded Servo 75 msec average positioning time SCSI, with 1200 KB/second transfer rate				

MANUFACTURER	MANTEC TECHNOLOGY	MANTEC TECHNOLOGY	MANTEC TECHNOLOGY	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	MTL-FD102E/C	MTL-FD128	MTL-FD228	JA-751	JU-455 JA-551*
DISK/TREND GROUP	14	14	14	13	14
MARKET	PCM	PCM	PCM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	8"	5.25"
Recording medium	Oxide Coated	Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .125/.250	U: .5	U: 1.6	U: .8/1.6	U: .5
Capacity per track (Bytes)	U: 3,125/6,250	U: 6,250	U: 10,416	U: 5,208/10,416	U: 6,250
Data surfaces per spindle	1	2	2	2	2
Tracks per surface	40	40	77	77	40
Track density (TPI)	48	48	96	48	48
Maximum linear density (BPI)	2768/5536	5876	9646	3408/6816	5876
Rotational speed (RPM)	300	300	360	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	4
Settling time (msec)	16	16	16	25	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	50	Continuous Contact
Average rotational delay (msec)	100	100	83.3	83.3	100
Data transfer rate (KBytes/sec)	15.63/31.25	31.25	31.25	31.25/62.5	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	2.2 x 8.6 x 12.1	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1987	1987	6/88	1987	1982
COMMENTS	For use with Apple IIC and Apple IIE				*Sold only in Japan

MANUFACTURER	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	JU-475 JU-595*	JU-202	JU-233A	JU-235A	JU-237A
DISK/TREND GROUP	14	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	2.0"	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)	U: .5/1.0 or U: .8/1.6	U: 1.0	U: 1.0	U: 1.0/1.6	U: 1.0/2.0
Capacity per track (Bytes)	U: 6,250/10,416	U: 6,250	U: 6,250	U: 6,250/10,416	U: 6,250/12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	77/80	80	80	77/80	80
Track density (TPI)	96	254	135	135	135
Maximum linear density (BPI)	5922/9646	14000	8717	8717/14184	8717/17434
Rotational speed (RPM)	300/360	300	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	6	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100	100	100/83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25	31.25	31.25/37.5/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	.79 x 2.5 x 3.6	.67 x 4.0 x 5.2	.67 x 4.0 x 5.2	.67 x 4.0 x 5.2
FIRST CUSTOMER SHIPMENT	1983	1Q89	3Q90	3Q90	3Q90
COMMENTS	*Sold only in Japan		Direct drive motor	Direct drive motor	Direct drive motor

MANUFACTURER	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	JU-239A	JU-253	JU-253A	JU-255	JU-255A
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0/4.0	U: 1.0	U: 1.0	U: 1.0/1.6	U: 1.0/1.6
Capacity per track (Bytes)	U: 6,250/12,500 25,000	U: 6,250	U: 6,250	U: 6,250/10,416	U: 6,250/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80/77	80/77
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/34868	8717	8717	8717/14184	8717/14184
Rotational speed (RPM)	300	300	300	300/360	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	6	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100/83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5/125	31.25	31.25	31.25/37.5/62.5	31.25/37.5/62.5
SIZE (Inches: H x W x D)	.67 x 4.0 x 5.2	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1Q91	1987	1986	1987	1987
COMMENTS	Direct drive motor				

MANUFACTURER	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	JU-257	JU-257A	JU-259A	JU-263A*	JU-351X
DISK/TREND GROUP	15	15	15	15	16
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	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: 1.0/2.0	U: 1.0/2.0/4.0	U: 1.0	U: 1.0/2.0/4.0 28.5
Capacity per track (Bytes)	U: 6,250/12,500	U: 6,250/12,500	U: 6,250/12,500 25,000	U: 6,250	U: 36,500/ 53,000
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80/320
Track density (TPI)	135	135	135	135	135/541
Maximum linear density (BPI)	8717/17434	8717/17434	8717/34868	8717	52620
Rotational speed (RPM)	300	300	300	300	750
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	6	--
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	100	100	100	40
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5/125	31.25	1500
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.625 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1987	1987	4Q90	1987	2Q91
COMMENTS		5V (single)	SCSI interface option	*Sold only in Japan	50 msec. average positioning time SCSI interface Downward comp. with 1,2 & 4 MB (Read & Write)

MANUFACTURER	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS
DRIVE	EME-156	EME-232	EME-112	EME-212	EME-213 EME-214
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3"	3"	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)	U: .250	U: 1.0	U: .5	U: 1.0	U: 1.0
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 6,250	U: 6,250	U: 6,250
Data surfaces per spindle	1	2	1	2	2
Tracks per surface	40	80	80	80	80
Track density (TPI)	100	200	135	135	135
Maximum linear density (BPI)	8946	9891	8187	8717	8717
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)	12	12	3	6	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	100	100	100	100
Data transfer rate (KBytes/sec)	31.25	31.25	31.25	31.25	31.25
SIZE (Inches: H x W x D)	1.5 x 3.5 x 5.9	1.5 x 3.5 x 5.9	1.0 x 3.8 x 5.9	1.0 x 3.8 x 5.9	1.0 x 4.0 x 5.75
FIRST CUSTOMER SHIPMENT	1987	1987	3/87	3/87	1989
COMMENTS	Replaces EME-155	Replaces EME-231			

MANUFACTURER	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MILTOPE	MILTOPE
DRIVE	EME-262	EME-263	EME-264	DD 400	DD 450
DISK/TREND GROUP	15	15	15	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	8"	8"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.6	U: 2.0	U: 1.0	U: .401/.802	U: .8/1.6
Capacity per track (Bytes)	U: 10,416	U: 12,500	U: 6,250	U: 5,208/10,416	U: 5,208/10,416
Data surfaces per spindle	2	2	2	1	2
Tracks per surface	80	80	80	77	77
Track density (TPI)	135	135	135	48	48
Maximum linear density (BPI)	14528	17434	8717	3268/6536	3408/6816
Rotational speed (RPM)	300	300	300	360	360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	6	5
Settling time (msec)	15	15	15	10	10
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	16	16
Average rotational delay (msec)	100	100	100	83.3	83.3
Data transfer rate (KBytes/sec)	31.25	62.5	31.25	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	.67 x 3.8 x 5.3	.67 x 3.8 x 5.3	.67 x 3.8 x 5.3	5.44 x 8.44 x 18.0	5.44 x 8.44 x 18.0
FIRST CUSTOMER SHIPMENT	1989	1989	1989	1977	1980
COMMENTS				Sold as militarized subsystem	Sold as militarized subsystem

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION
DRIVE	MF 501C	MF 504B	MF 504C	MF 504S	MF 353BA
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)	U: .5	U: 1.0/1.6	U: 1.0/1.6	U: 1.0/1.6	U: 1.0
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,416	U: 6,250/10,416	U: 6,250/10,416	U: 6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	80/77	80/77	80/77	80
Track density (TPI)	48	96	96	96	135
Maximum linear density (BPI)	5877	5922/9870	5922/9870	5922/9870	8717
Rotational speed (RPM)	300	300/360	300/360	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Spindle Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	6	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100/83.3	100/83.3	100
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	31.25/62.5	31.25/62.5	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 7.7	1.625 x 5.75 x 7.7	1.625 x 5.75 x 7.7	1.12 x 5.75 x 7.5	1.26 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	2Q88	4Q85	2Q88	3Q89	4Q85
COMMENTS					

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION
DRIVE	MF 353C	MF 354C	MF 355BA	MF 355C	MF 355S
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)	U: 1.0	U: 1.0/1.6	U: 1.0/2.0	U: 1.0/2.0	U: 1.0/2.0
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,416	U: 6,250/12,500	U: 6,250/12,500	U: 6,250/12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717	8717/14184	8717/17434	8717/17434	8717/17434
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	100/83.3	100	100	100
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.26 x 4.0 x 5.9	1.0 x 4.0 x 5.9	.67 x 4.0 x 5.1
FIRST CUSTOMER SHIPMENT	2Q87	2Q87	4Q86	2Q87	4Q90
COMMENTS					

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE	MF 356C	D 503V	D 509V	D 509V2	D 201
DISK/TREND GROUP	15	14	14	14	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	5.25"	5.25"	5.25"	2.0"
Recording medium	Barium Ferrite	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Metal Powder
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0/4.0	U: .500	U: 1.0/1.6	U: 1.0/1.6	U: 1.0
Capacity per track (Bytes)	U: 6,250/25,000	U: 6,250	U: 6,250/10,416	U: 6,250/10,416	U: 20,000
Data surfaces per spindle	2	2	2	2	1
Tracks per surface	80	40	80	80	50
Track density (TPI)	135	48	96	96	254
Maximum linear density (BPI)	8717/34868	5876	5922/9646	5922/9646	51200
Rotational speed (RPM)	300	300	360	360	3600
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	6	3/5	3/5	4
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	100	83.3	83.3	8.3
Data transfer rate (KBytes/sec)	31.25/62.5/125	31.25	37.5/62.5	37.5/62.5	1787.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.625 x 5.75 x 7.4	1.625 x 5.75 x 7.4	1.625 x 5.75 x 7.4	1.0 x 2.5 x 3.4
FIRST CUSTOMER SHIPMENT	4Q90	3/85	1987	4Q88	2Q90
COMMENTS					Compatible with Sony 2.0" FDD

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE	D 352C	D 352T2	D 357B	D 357C	D 357P2 D 357T2
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	Barium Ferrite	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0/4.0	U: 1.0/2.0/4.0	U: 1.0	U: 1.0	U: 1.0
Capacity per track (Bytes)	U: 6,250/25,000	U: 6,250/25,000	U: 6,250	U: 6,250	U: 6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/34768	8717/34768	8717	8717	8717
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	6	6	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	100	100	100	100
Data transfer rate (KBytes/sec)	31.25/62.5/125	31.25/62.5/125	31.25	31.25	31.25/62.5
SIZE (Inches: H x W x D)	.67 x 4.0 x 6.1	1.0 x 4.0 x 6.1	1.0 x 4.0 x 6.1	.67 x 4.0 x 6.1	1.0 x 4.0 x 6.1
FIRST CUSTOMER SHIPMENT	1Q91	2Q90	4/87	1Q90	4Q88
COMMENTS					D 357P2 is in 5.25" form factor

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MULTIDIGIT
DRIVE	D 359B	D 359C	D 359P2 D 359T2	D 281 D 284 D 286	DF0511
DISK/TREND GROUP	15	15	15		14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	72 mm	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: 1.0/2.0	U: 1.0/2.0	U: .064	U: .5
Capacity per track (Bytes)	U: 6,250/12,500	U: 6,250/12,500	U: 6,250/12,500	U: 64,000	U: 6,250
Data surfaces per spindle	2	2	2	1	2
Tracks per surface	80	80	80	1	40
Track density (TPI)	135	135	135	59	48
Maximum linear density (BPI)	8717/17434	8717/17434	8717/17434	4410	5877
Rotational speed (RPM)	300	300	300	423	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	N/A	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	6	3/6	N/A	6
Settling time (msec)	15	15	15	N/A	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	N/A	50
Average rotational delay (msec)	100	100	100	N/A	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	12.63	31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 6.1	.67 x 4.0 x 6.1	1.0 x 4.0 x 6.1	1.73 x 4.6 x 4.1	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	4Q90	1Q90	4Q88	2/86	1985
COMMENTS				64,000 bytes in single spiral track Front loading QDM-02 is MSX subsystem	

MANUFACTURER	MULTIDIGIT	NEC	NEC	NEC	NEC
DRIVE	DF1622	FD 1165	FD 1157C	FD 1157D	FD 1158C FD 1158D
DISK/TREND GROUP	14	13	14	14	14
MARKET	OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	5.25"	8"	5.25"	5.25"	5.25"
Recording medium	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.6	U: .8/1.6	U: 1.0/1.6	U: 1.0/1.6	U: 1.0/1.6
Capacity per track (Bytes)	U: 10,416	U: 5,208/10,416	U: 6,250/10,416	U: 6,250/10,416	U: 6,250/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	77	80	80	80
Track density (TPI)	96	48	96	96	96
Maximum linear density (BPI)	9646	3408/6816	5922/9870	5922/9870	5922/9870
Rotational speed (RPM)	360	360	360	360	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	50	35	35	Continuous Contact
Average rotational delay (msec)	83.3	83.3	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	2.28 x 8.54 x 12.7	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.0 x 5.75 x 7.5
FIRST CUSTOMER SHIPMENT	1986	4Q81	1987	1987	2Q90
COMMENTS				With VFO	

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	FD 1037A	FD 1038A	FD 1135C	FD 1135D	FD 1137C
DISK/TREND GROUP	15	15	15	15	15
MARKET	Captive, 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	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5/1.0	U: 1.0	U: 1.0/1.6	U: 1.0/1.6	U: 1.0/1.6
Capacity per track (Bytes)	U: 3,125/6,250	U: 6,250	U: 6,250/10,416	U: 6,250/10,416	U: 6,250/10,416
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)	4359/8717	8717	8717/14528	8717/14528	8717/14528
Rotational speed (RPM)	300	300	300/360	300/360	300/360
PERFORMANCE					
Actuator type	Linear, Stepping Motor	Linear, Pulse Motor	Band, Stepping Motor	Band, Stepping Motor	Linear, Stepping Motor
POSITIONING:Track to track(msec)	3	2	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	35	35	Continuous Contact
Average rotational delay (msec)	100	100	100/83.3	100/83.3	100/83.3
Data transfer rate (KBytes/sec)	15.63/31.25	31.25	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.1	.75 x 4.0 x 5.12	1.625 x 4.0 x 5.3	1.625 x 4.0 x 5.3	1.0 x 4.0 x 5.1
FIRST CUSTOMER SHIPMENT	1987	1Q90	11/85	1/86	1987
COMMENTS					

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	FD 1137D	FD 1137H	FD 1138C FD 1138D	FD 1138H	FD 1335C
DISK/TREND GROUP	15	15	15	15	16
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	OEM	Captive, OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Metal Powder
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: 1.0/2.0	U: 1.0/1.6	U: 1.0/2.0	F:1.0/1.6/10.18
Capacity per track (Bytes)	U: 6,250/10,416	U: 6,250/12,500	U: 6,250/10,416	U: 6,250/12,500	F: 19,968
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	255
Track density (TPI)	135	135	135	135	431
Maximum linear density (BPI)	8717/14528	8717/17434	8717/14528	8717/17434	8717/36595
Rotational speed (RPM)	300/360	300	300/360	300	360
PERFORMANCE					
Actuator type	Linear, Stepping Motor	Linear, Stepping Motor	Linear, Pulse Motor	Linear, Pulse Motor	Linear, Pulse Motor
POSITIONING:Track to track(msec)	3	3	3	2	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	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/1250
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.1	1.0 x 4.0 x 5.1	.75 x 4.0 x 5.0	.75 x 4.0 x 5.0	1.0 x 4.0 x 5.12
FIRST CUSTOMER SHIPMENT	1987	1987	1Q90	1Q90	1/90
COMMENTS	With VFO				Downward comp. with 1 & 1.6 MB (Read & Write)

MANUFACTURER	NEC	ORIENTAL PRECISION	ORIENTAL PRECISION	ORIENTAL PRECISION	ORIENTAL PRECISION
DRIVE	FD 1335H	OFD-506R	OFD-516R	OFD-546R	OFD-596R
DISK/TREND GROUP	16	14	14	14	14
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	3.5"	5.25"	5.25"	5.25"	5.25"
Recording medium	Metal Powder	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F:1.0/2.0/10.18	U: 1.0/1.6	U: 1.6	U: .250/.5	U: .5/1.0
Capacity per track (Bytes)	F: 19,968	U: 6,250/10,416	U: 10,416	U: 3,125/6,250	U: 3,125/6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	255	77/80	77	40	80
Track density (TPI)	431	96	96	48	96
Maximum linear density (BPI)	8717/36595	5922/9870	9646	2938/5876	2961/5922
Rotational speed (RPM)	360	300/360	360	300	300
PERFORMANCE					
Actuator type	Linear, Pulse Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	100/83.3	83.3	100	100
Data transfer rate (KBytes/sec)	31.25/1250	62.5/37.5	62.5	15.63/31.25	15.63/31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.12	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1/90	6/89	6/89	1983	1983
COMMENTS	Downward comp. with 1 & 2 MB (Read & Write)			Licensed by TEAC	Licensed by TEAC

MANUFACTURER	PERIPHERAL DATA SYSTEMS	PERIPHERAL DATA SYSTEMS	PERIPHERAL DATA SYSTEMS	PROLOGICA	QUME
DRIVE	BD-101	BD-120	MFDD-110	D 500SL	HF24
DISK/TREND GROUP	14	14	14	14	16
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	5.25"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .250/.5	U: .250/.5	U: .125/.250	U: .250/.5	F: 20.2
Capacity per track (Bytes)	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250	F: 19,968
Data surfaces per spindle	2	2	1	2	2
Tracks per surface	40	40	40	40	506
Track density (TPI)	48	48	48	48	666
Maximum linear density (BPI)	2938/5876	2938/5876	2788/5576	2936/5876	24000
Rotational speed (RPM)	300	300	300	300	720
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Rotary, Stepping Motor	Voice Coil
POSITIONING:Track to track(msec)	5	5	5	6	25
Settling time (msec)	15	15	15	20	N/A
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	42
Data transfer rate (KBytes/sec)	15.63/31.25	15.63/31.25	15.63/31.25	15.63/31.25	330
SIZE (Inches: H x W x D)	3.25 x 5.75 x 8.0	1.625 x 5.75 x 8.0	2.2 x 5.86 x 9.68	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1986	1987	4Q86	9/85	8/88
COMMENTS			Subsystem for Apple II system		Embedded Servo SCSI interface 60 msec average positioning

MANUFACTURER	ROBOTRON	ROBOTRON	ROCTEC	ROCTEC	SAMSUNG ELECTRONICS
DRIVE	K 5600.10	K 5600.20	RF501A	RF501R	SFD-500P
DISK/TREND GROUP	14	14	14	14	14
MARKET	Captive, OEM	Captive, OEM	OEM	OEM	Captive, OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	5.25"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .125/.250	U: .250/.5	U: .250	U: .250	U: .5
Capacity per track (Bytes)	U: 3,250/6,250	U: 3,250/6,250	U: 6,250	U: 6,250	U: 6,250
Data surfaces per spindle	1	1	1	1	2
Tracks per surface	40	80	40	40	40
Track density (TPI)	48	96	48	48	48
Maximum linear density (BPI)	2768/5536	2788/5576	5576	5576	5876
Rotational speed (RPM)	300	300	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	10	8	6	6	6
Settling time (msec)	12	10	20	20	15
Head load time(msec)	40	40	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	100
Data transfer rate (KBytes/sec)	15.63/31.25	15.63/31.25	31.25	31.25	31.25
SIZE (Inches: H x W x D)	2.36 x 5.55 x 7.87	2.36 x 5.55 x 7.87	1.625 x 5.75 x 8.5	2.67 x 5.8 x 10.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1984	1984	4Q87	3Q87	3Q88
COMMENTS			For Apple II	External drive for Atari systems	

MANUFACTURER	SAMSUNG ELECTRONICS	SAMSUNG ELECTRONICS	SANKYO SEIKI	SANKYO SEIKI	SANKYO SEIKI
DRIVE	SFD-560D	SFD-321K	FDU-370 FDU-380	FDU-480	FDU-580
DISK/TREND GROUP	14	15	15	15	15
MARKET	Captive, OEM	Captive, 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)	U: 1.6	U: 1.0/2.0	U: 1.0	U: 1.0/1.6	U: 1.0/2.0
Capacity per track (Bytes)	U: 10,416	U: 6,250/12,500	U: 6,250	U: 6,250/10,416	U: 6,250/12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80	80/77	80
Track density (TPI)	96	135	135	135	135
Maximum linear density (BPI)	9870/9642	8717/17434	8717	8717/14184	8717/17434
Rotational speed (RPM)	360	300	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)	83.3	100	100	100/83.3	100
Data transfer rate (KBytes/sec)	62.5	31.25/62.5	31.25	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.1	1.0 x 4.0 x 5.1	1.0 x 4.0 x 5.1
FIRST CUSTOMER SHIPMENT	4Q87	2Q89	12/86	2Q87	2Q87
COMMENTS					

MANUFACTURER	SANKYO SEIKI	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
DRIVE	FDU-583	SD-621L	SD-680L	SD-340	SMD-1020
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	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 2.0	U: .5	U: 1.0/1.6	U: 2.0	U: 1.0/1.6
Capacity per track (Bytes)	U: 12,500	U: 6,250	U: 6,250/10,416	U: 12,500	U: 6,250/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	40	80	80	80
Track density (TPI)	135	48	96	135	135
Maximum linear density (BPI)	17434	5876	5922/9870	17434	8717/14528
Rotational speed (RPM)	300	300	300/360	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	4	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	35	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100/83.3	100	100
Data transfer rate (KBytes/sec)	62.5	31.25	37.5/62.5	62.5	37.5/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.1	1.625 x 5.75 x 7.7	1.625 x 5.75 x 7.7	1.0 x 4.0 x 5.75	0.71 x 4.0 x 5.1
FIRST CUSTOMER SHIPMENT	3Q87	2Q86	3Q86	--	1Q90
COMMENTS					Direct drive motor

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
DRIVE	SMD-1040	SMD-320	SMD-340	SMD-380	SMD-440L
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)	U: 2.0	U: 1.0/1.6	U: 1.0/2.0	U: 1.0	U: 1.0/2.0
Capacity per track (Bytes)	U: 12,500	U: 6,250/10,416	U: 6,250/12,500	U: 6,250	U: 6,250/12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	17434	8717/14528	8717/17434	8717	8717/17434
Rotational speed (RPM)	300	300/360	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, 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)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100	100	100
Data transfer rate (KBytes/sec)	62.5	37.5/62.5	31.25/62.5	31.25	31.25/62.5
SIZE (Inches: H x W x D)	.71 x 4.0 x 5.1	1.0 x 4.0 x 5.75	1.0 x 4.0 x 5.75	1.0 x 4.0 x 5.75	1.0 x 4.0 x 5.87
FIRST CUSTOMER SHIPMENT	1Q90	1/89	1/89	1/89	11/87
COMMENTS	Direct drive motor				

MANUFACTURER	SEIKO EPSON	SONY	SONY	SONY	SONY
DRIVE	SMD-480	MP-F11W	MP-F17W	MP-F40W	MP-F52W
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	Captive, OEM	Captive, OEM	OEM	Captive, OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0	U: 1.0	U: 1.0/2.0	U: 1.0/2.0/4.0	U: .5/1.0
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 6,250/12,500	U: 6,250/25,000	U: 3,125/6,250
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	8717	8717/17434	8717/34868	4359/8717
Rotational speed (RPM)	300	300	300	300	600
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	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	100	100	100	50
Data transfer rate (KBytes/sec)	31.25	31.25	31.25/62.5	31.25/62.5/125	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.87	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.18 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	4Q86	2Q87	2Q87	1Q91	2Q85
COMMENTS					

MANUFACTURER	SONY	SONY	SONY	SONY	TEAC
DRIVE	MP-F53W MP-F53W-00D	MP-F63W-00D MP-F63W-01D	MP-F73W-00D MP-F73W-01D	PDD-110	FD-55BR
DISK/TREND GROUP	15	15	15	15	14
MARKET	Captive, OEM	OEM	OEM	Captive, OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	2.0"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Metal Powder	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5/1.0	U: 1.0	U: 1.0/2.0	U: 1.0	U: .5
Capacity per track (Bytes)	U: 3,125/6,250	U: 6,250	U: 6,250/12,500	U: 20,000	U: 6,250
Data surfaces per spindle	2	2	2	1	2
Tracks per surface	80	80	80	50	40
Track density (TPI)	135	135	135	254	48
Maximum linear density (BPI)	4359/8717	8717	8717/17434	51200	5876
Rotational speed (RPM)	300	300	300	3600	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	6	3	3	4	4/6
Settling time (msec)	15	15	15	--	10/15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	50
Average rotational delay (msec)	100	100	100	8.3	100
Data transfer rate (KBytes/sec)	15.63/31.25	31.25	31.25/62.5	1787.5	31.25
SIZE (Inches: H x W x D)	1.18 x 4.0 x 5.9	1.18 x 4.0 x 5.9	1.18 x 4.0 x 5.9	.79 x 2.5 x 3.5	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	3Q85	1Q86	1Q86	3Q88	1987
COMMENTS				Data version of 2" still video disk	

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-55FR	FD-55GFR	FD-55GR	FD-55GS	FD-235F
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)	U: 1.0	U: 1.0/1.6	U: 1.6	U: 1.0/1.6	U: 1.0
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,416	U: 10,416	U: 6,250/10,416	U: 6,250
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
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
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.7 x 5.7 x 8.0	1.0 x 4.0 x 5.71
FIRST CUSTOMER SHIPMENT	1987	1987	1987	1990	2Q88
COMMENTS		Dual speed		SCSI interface	

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-235G	FD-235GF	FD-235HF	FD-235HS	FD-235J
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.6	U: 1.0/1.6	U: 1.0/2.0	U: 1.0/2.0	U: 1.0/2.0/4.0
Capacity per track (Bytes)	U: 10,416	U: 6,250/10,416	U: 6,250/12,500	U: 6,250/12,500	U: 6,250/25,000
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)	14528	8717/14528	8717/17434	8717/17434	8717/34868
Rotational speed (RPM)	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)	83.3	100/83.3	100	100	100
Data transfer rate (KBytes/sec)	62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5/125
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.71	1.0 x 4.0 x 5.71	1.0 x 4.0 x 5.71	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.71
FIRST CUSTOMER SHIPMENT	2Q88	2Q88	2Q88	1990	1Q89
COMMENTS				SCSI interface	

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-235JS	FD-334F	FD-334G	FD-334GF	FD-334HF
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0/4.0	U: 1.0	U: 1.666	U: 1.0/1.6	U: 1.0/2.0
Capacity per track (Bytes)	U: 6,250/25,000	U: 6,250	U: 10,416	U: 6,250/10,416	U: 6,250/12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/34868	8717	14528	8717/14528	8717/17434
Rotational speed (RPM)	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	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
Data transfer rate (KBytes/sec)	31.25/62.5/125	31.25	62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	.75 x 4.0 x 5.32	.75 x 4.0 x 5.32	.75 x 4.0 x 5.32	.75 x 4.0 x 5.32
FIRST CUSTOMER SHIPMENT	1990	1Q90	1Q90	1Q90	1Q90
COMMENTS	SCSI interface				

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-335F	FD-335GF	FD-335HF	FD-335J	FD-335JG
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)	U: 1.0	U: 1.0/1.6	U: 1.0/2.0	U: 1.0/2.0/4.0	U: 1.0/1.6/2.0
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,416	U: 6,250/12,500	U: 6,250/12,500 25,000	U: 6,250/12,500
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	8717/14528	8717/17434	8717/34868	8717/17434
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	100/83.3	100	100	100
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	31.25/62.5	31.25/62.5/125	31.25/62.5
SIZE (Inches: H x W x D)	.75 x 4.0 x 5.3	.75 x 4.0 x 5.3	.75 x 4.0 x 5.3	.75 x 4.0 x 5.3	.75 x 4.0 x 5.3
FIRST CUSTOMER SHIPMENT	9/90	9/90	9/90	9/90	9/90
COMMENTS	Direct drive motor	Direct drive motor	Direct drive motor	Direct drive motor	Direct drive motor

MANUFACTURER	TECMATE	TECMATE	TECMATE	TECMATE	TOSHIBA
DRIVE	MT-501A NPH-501A NPH-501AC	MT-502 NPH-502A	MT-503A	MT-504 NPH-504A	ND-0401 ND-04DT-A
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	Captive, OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	5.25"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .218	U: .500	U: 1.0	U: 1.6	U: .5
Capacity per track (Bytes)	U: 3,125	U: 6,250	U: 6,250	U: 10,416	U: 6,250
Data surfaces per spindle	1	2	2	2	2
Tracks per surface	35	40	80	80	40
Track density (TPI)	48	48	96	96	48
Maximum linear density (BPI)	5162	5876	5922	9646	5876
Rotational speed (RPM)	300	300	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)	6	6	3	3	6
Settling time (msec)	15	10	10	10	15
Head load time (msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continous Contact
Average rotational delay (msec)	100	100	100	83.3	100
Data transfer rate (KBytes/sec)	31.25	31.25	31.25	62.5	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.6 x 5.7 x 8.2
FIRST CUSTOMER SHIPMENT	1983	8/86	9/86	9/86	1Q88
COMMENTS	Apple compatible				

MANUFACTURER	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA
DRIVE	ND-06D/DT	ND-0801 ND-08DE-A	ND-3521 ND-352SH/TH-A	ND-3531	ND-355S/T-A
DISK/TREND GROUP	14	14	15	15	15
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	OEM	Captive, OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	3.5"	3.5"	3.5"
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5/1.0	U: 1.0/1.6	U: .5/1.0	U: 1.0/2.0	U: 1.0/1.6
Capacity per track (Bytes)	U: 3,125/6,250	U: 6,250/10,416	U: 6,250	U: 6,250/12,500	U: 6,250/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77	80	80	80/77
Track density (TPI)	96	96	135	135	135
Maximum linear density (BPI)	2961/5922	5922/9646	8717	8717/17434	8717/14184
Rotational speed (RPM)	300	360	300	300	300/360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100	100	100/83.3
Data transfer rate (KBytes/sec)	15.63/31.25	31.25/62.5	31.25	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.3	1.6 x 5.7 x 8.2	1.0 x 4.0 x 5.9	.67 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	2Q82	1Q88	1Q88	4Q90	1Q88
COMMENTS					

MANUFACTURER	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA
DRIVE	ND-3561 ND-356S/T-A	PD-210	PD-211	PD-212	PD-401
DISK/TREND GROUP	15	15	15	15	16
MARKET	Captive, 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)	U: 1.0/2.0	U: 1.0/4.0	U: 1.0/2.0/4.0	U: 1.0/1.6/4.0	U: 16.0
Capacity per track (Bytes)	U: 6,250/12,500	U: 6,250/25,000	U: 6,250/25,000	U: 6,250/25,000	U:
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	320
Track density (TPI)	135	135	135	135	542
Maximum linear density (BPI)	8717/17434	8717/34768	8717/34768	8717/34768	35080
Rotational speed (RPM)	300	300	300	300	1500
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Linear, Voice Coil
POSITIONING:Track to track(msec)	3	3	3	3	
Settling time (msec)	15	15	15	15	
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	
Average rotational delay (msec)	100	100	100	100	20
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/125	31.25/62.5/125	31.25/62.5/125	625
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1Q88		1988		
COMMENTS					50 msec average head positioning Embedded Servo

MANUFACTURER	VERBATIM	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	20 Plus	YD-180	YD-380B-1710B	YD-380B-1711B	YD-380B-1714B
DISK/TREND GROUP	16	13	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	8"	5.25"	5.25"	5.25"
Recording medium	Barium Ferrite	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 20.2	U: .8/1.6	U: 1.6	U: 1.0/1.6	U: 1.0/1.6
Capacity per track (Bytes)	F: 19,968	U: 5,208/10,416	U: 10,416	U: 6,250/10,416	U: 6,250/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	506	77	77	80	80/77
Track density (TPI)	666	48	96	96	96
Maximum linear density (BPI)	24000	3408/6816	9646	5922/9870	5922/9646
Rotational speed (RPM)	720	360	360	360	300/360
PERFORMANCE					
Actuator type	Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	25	3	3	3	3
Settling time (msec)	N/A	15	15	15	15
Head load time(msec)	Continuous Contact	50	50	50	50
Average rotational delay (msec)	42	83.3	83.3	83.3	100/83.3
Data transfer rate (KBytes/sec)	330	31.25/62.5	62.5	37.5/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	2.25 x 8.55 x 12.6	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1989	9/81	4/86	4/86	4/86
COMMENTS	Embedded Servo SCSI interface 60 msec average positioning				

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	YD-380B-1736B	YD-380D	YD-580B-1354B YD-580B-1355B	YD-580B-1376B	YD-801 YD-802
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: 1.0/1.6	U: .5	U: .5	U: 3.333
Capacity per track (Bytes)	U: 6,250/10,416	U: 6,250/10,416	U: 6,250	U: 6,250	U: 20,832
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	40	40	80
Track density (TPI)	96	96	48	48	96
Maximum linear density (BPI)	5922/9870	5922/9870	5876	5876	19740
Rotational speed (RPM)	360	720	300	300	180
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	5	5	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	50	Continuous Contact	50
Average rotational delay (msec)	83.3	41.6	100	100	166.7
Data transfer rate (KBytes/sec)	37.5/62.5	75/125	31.25	31.25	62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	2Q87	6/90	4/86	2Q87	1Q87
COMMENTS	Also sold as YD-380B-PC			Also sold as YD-580B-PC	Compatible with 1.0 and 1.6 MB formats

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	YD-645C YD-646C	YD-646F	YD-665C	YD-686C	YD-686F
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)	U: 1.0	U: 1.0	U: 1.6	U: 1.0/1.6	U: 1.0/1.6
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 10,416	U: 6,250/10,416	U: 6,250/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	77	80/77	80/77
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717	4358/8717	14184	8717/14184	8717/14184
Rotational speed (RPM)	300	300	360	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)	6	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	83.3	100/83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25	15.63/31.25	62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	.68 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	.68 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1986	12/89	1986	1Q87	1/90
COMMENTS					

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA		
DRIVE	YD-701 YD-702	YD-702F	YD-742		
DISK/TREND GROUP	15	15	15		
MARKET	OEM	OEM	OEM		
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"		
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite		
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: 1.0/2.0	U: 1.0/2.0/4.0		
Capacity per track (Bytes)	U: 6,250/12,500	U: 6,250/12,500	U: 6,250/25,000		
Data surfaces per spindle	2	2	2		
Tracks per surface	80	80	80		
Track density (TPI)	135	135	135		
Maximum linear density (BPI)	8717/17434	8717/17434	8717/34868		
Rotational speed (RPM)	300	300	300/150		
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor		
POSITIONING:Track to track(msec)	3	3	3		
Settling time (msec)	15	15	15		
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact		
Average rotational delay (msec)	100	100	100/200		
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5/125		
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	.68 x 4.0 x 5.9	1.0 x 4.0 x 5.9		
FIRST CUSTOMER SHIPMENT	1Q87	1/90	1990		
COMMENTS					

MANUFACTURER PROFILES

1990 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 "1989 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. "1989 total net sales" covers the fiscal year ending in 1989 for each firm unless noted otherwise, or for the parent company if the disk drive manufacturer is a subsidiary. The fiscal year of listed firms ends on December 31, 1989, 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 1989 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
Brazil	Cruzeiro	2.81
Hong Kong	Dollar	7.80
India	Rupee	16.2
Japan	Yen	138.00
South Korea	Won	674.00
Taiwan	Dollar	26.4

U.S Manufacturers

BRIER TECHNOLOGY, INC.
2363 Bering Drive
San Jose, CA 95131

Incorporated in April, 1986, Brier was founded by managers from Data Technology and other data storage firms to develop high capacity 3.5 inch floppy disk drives. The initial product was a 21.4 megabyte drive originally scheduled for 1989 shipment with a 43.2 megabyte version announced for later delivery. Both models employ embedded servo, using preformatted diskettes with barium ferrite media. In the Spring of 1988, an interest in Brier was purchased by Intelligent Systems, which also owns Peachtree Software, Princeton Graphics Systems, Quadram, and other PC oriented peripherals companies. Limited shipments of the 21.4 megabyte drive began in late 1989, but full production has been deferred pending the development of a version of the drive with full read/write downward compatibility with 1 and 2 megabyte drives. Brier has licensed Irwin Magnetics, since purchased by Cipher, as a second manufacturing source. In late 1989, Brier announced a manufacturing and investment agreement with National Computer Ltd. of Japan, whereby NCL would manufacture Brier products under license and act as Brier's exclusive distributor in Asia. In return, Brier received an equity investment from NCL.

DATA TECHNOLOGY CORPORATION (See Qume Corporation)

DIGITAL EQUIPMENT CORPORATION
146 Main Street
Maynard, MA 01754

1989 total net sales: $12,741,956,000 (FY ending 6/30/89) Net income: $1,072,610,000

DEC started production of 8 inch one sided floppy drives in 1976, originally under a Calcomp license. All of these drives were produced for captive use with its own systems, and the last shipments were made in 1986. DEC introduced its first 5.25 inch floppy, the RX50, along with the company's personal computer systems in late 1982 -- and at one time produced large quantities. The RX50 used a single stepping motor to position heads on two 96 TPI one sided diskettes, and was adapted from a product acquired originally from T & E Engineering, a late 1970's floppy drive start-up that never achieved large scale production. RX50 production ended in 1989.

EASTMAN KODAK COMPANY
343 State Street
Rochester, NY 14650

1989 total net sales: $18,398,000,000 Net income: $529,000,000

Although the Spin Physics operation of Eastman Kodak had previously introduced flexible disk media using isotropic particulate coatings, Kodak's action in licensing the Drivetec embedded servo 5.25 inch drive was the firm's first step into flexible disk drive hardware. Production started in 1984 at Rochester, New York. Following an earlier OEM sales program by Data Technology Corporation (now Qume), a Santa Clara controller manufacturer in which Kodak had an investment, marketing responsibility was turned over to Kodak's Verbatim subsidiary, which distributed the Eastman Kodak high capacity drives under its own brand name. Qume still manufactures the 5.25 inch 12 and 24 megabyte versions on a contract basis for Verbatim. In 1990, Verbatim was sold to Mitsubishi Kasei, including the floppy drive program.

GENISCO TECHNOLOGY CORPORATION
14930 Alondra Boulevard
La Mirada, CA 90638

Genisco produces ruggedized and militarized peripherals. The firm purchased rights to the Shugart Associates 3.5 inch microfloppy program, which was aborted when Xerox lost interest in the disk drive business. Limited quantities of a 1.0 megabyte microfloppy have been used in a militarized subsystem since 1987.

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

Insite's announcement of a 20 megabyte 3.5 inch microfloppy, combining an optical head positioning scheme with magnetic recording, has aroused widespread interest in the industry. Trademarked as the "floptical", the drive uses an LED on the head assembly to follow optically reflective servo tracks on the surface of 3.5 inch barium ferrite media. A version that is downward compatible with standard 3.5 inch 1 and 2 megabyte drives in both read and write mode was announced at the 1989 Fall Comdex show. Insite is attempting to achieve mainstream status for the "floptical" through licensing of established drive and media manufacturers, with Iomega as the first announced licensee, and is aggressively seeking additional strategic relationships. High volume production has been deferred until early 1991 in order to complete tooling and chip development for read/write compatibility with 1 and 2 megabyte drives.

INTERNATIONAL BUSINESS MACHINES CORPORATION
Route 22
Armonk, NY 10504

1989 FDD sales: $16,500,000
1989 total net sales: $62,710,000,000 Net income: $3,758,000,000

IBM introduced the original one and two sided 8 inch flexible disk drives, and has used them on a wide variety of business systems, word processing systems, terminals and specialized equipment. After years of neglecting the minifloppy product area, IBM emerged as the world's largest buyer of OEM floppy drives, when it used two sided 48 TPI 5.25 inch drives for the successful PC program. This choice established the two sided 48 TPI format as a mainstream minifloppy configuration. Later, the IBM blessing was given to 1.6 megabyte 5.25 inch drives and to 3.5 inch microfloppies, and these configurations are now industry standards. The 1987 introduction of the PS/2 series of personal computers using both 1 and 2 megabyte microfloppies reinforced the 3.5 inch trend and gave the 2 megabyte format a major boost. It is now expected that IBM will use the 4 megabyte barium ferrite 3.5 inch drives pioneered by Toshiba for applications to be introduced within the next year. IBM's preparations for this move have already prompted many Japanese floppy drive manufacturers to prepare for production of 4 megabyte barium ferrite drives. IBM made extensive preparations to design and manufacture its own 5.25 inch and microfloppy drives, but abruptly cancelled the program in mid-1985 -- choosing to rely on the low cost floppy drives available from numerous suitable vendors. Internal production of 8 inch floppy drives continued in order to support older product families, but is now at end of life.

IOMEGA CORPORATION
1821 West 4000 South
Roy, UT 84067

1989 FDD sales: $71,500,000
1989 total net sales: $108,991,000 Net income: $11,172,000

Iomega, founded in 1980 by former IBM managers, was successful in establishing production capability for its unique 8 inch drive, which maintains control of head/disk contact with the Bernoulli effect, and a 5.25 inch version was added in mid-1983. The products were originally intended as OEM drives, but Iomega had much better luck with subsystems sold in the personal computer add-on market. The 8 inch subsystem for the IBM PC market began shipping in 1983 and provided most of the company's early revenue growth until surpassed by the 20 megabyte half high 8 inch drives introduced in 1985. However, half high 5.25 inch models in production since 1987 have largely displaced 8 inch drives. The 5.25 inch product line includes drives offering 21.4 megabytes capacity and a 44.5 megabyte model added in mid-1989. These are also marketed in subsystems. Iomega has licensed the Insite Peripherals 'floptical' drive, but has not yet announced a production start-up date.

MILTOPE CORPORATION
1770 Walt Whitman Road
Melville, NY 11747

1989 total net sales: $94,439,000 Net income: ($2,311,000)

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

QUME CORPORATION
500 Yosemite Drive
Milpitas, CA 95035

1989 total net sales: $222,266,000 (FY ending 2/29/90) Net income: $8,671,000

Qume is a manufacturer of storage controllers, storage controller chip sets, flexible disk drives, printers and video displays. Floppy disk drives represented 2% of fiscal 1990 revenues.

Qume's floppy drive operations started in 1979, with a manufacturing license from Y-E Data. Except for some confusion when the firm reorganized its marketing and manufacturing programs in 1981, Qume maintained continuous growth in the OEM market -- and received a big boost in 1983 by being selected as a vendor for half high 5.25 inch floppy drives to IBM for the PC Junior. However, Qume's management didn't care for today's floppy drive prices, and after licensing production in China, closed down floppy drive manufacturing. A significant number of already completed drives were sold in 1986, and a small remainder was sold in 1987. In June, 1988, Qume's parent sold the operation to Data Technology Corporation (DTC), which adopted the Qume name for the combined operation, and which now makes printers, terminals and data storage products. DTC now operates as a manufacturing subsidiary, along with Qume Taiwan.

DTC, founded in 1979, operated for several years as a controller manufacturer and subsystem vendor, with founders originally from Xebec. Eastman Kodak had a minority investment in the firm, and arrangements were made to manufacture and market the 12 megabyte 5.25 inch floppy drive developed by Kodak, which was also being marketed by that firm's Verbatim subsidiary. A 24 megabyte version began shipping in mid-1988. Both drives are currently manufactured in Taiwan by DTC Technology, a subsidiary firm in which Qume has a 24.05% interest.

SHUGART CORPORATION
9292 Jeronimo
Irvine, CA 92718

The original Shugart Associates became the world leader in OEM floppy drives before being acquired by Xerox in the late 1970's. Within a few years of the acquisition, the spark was gone and the company was in trouble. Product reliability problems and a failure to keep the product line up to date left Shugart Associates in bad shape when confronted by increasing competition. In the end, Xerox management decided to stop the bleeding, and most Shugart Associates operations were closed down in 1985. U.S. distribution rights to the half high 5.25 inch floppy products were sold to Matsushita. 8 inch floppy drives remained in production until the end, but were sold to the Narlinger Group in early 1986, along with rights to use of the Shugart Corporation name. The new Shugart Corporation continued to manufacture the 8 inch product line until 1989, along with additional models acquired from Control Data and Tandon. When inventories are exhausted, which may take a year or two, the firm plans to discontinue floppy drive sales operations. Shugart Corporation also makes tape drives (acquired from Kennedy) and terminals (acquired from TEC).

Asian Manufacturers

(All fiscal years for Japanese companies end in March, 1989, unless otherwise noted.)

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

1989 FDD sales: $99,300,000
1989 total net sales: $2,728,015,000 Net income: $39,719,000

Alps Electric is a high-growth manufacturer of electronic components and subassemblies for television, audio, instruments and computer applications. Production of captive 5.25 inch floppy drives for use with Alps systems started several years ago, but has not been emphasized. The firm's big increase in floppy drive shipments came in 1981, with a rapid build-up of shipments to Apple Computer. Printers, keyboards, mice and disk drives together account for approximately 27% of Alps revenues. Alps' shipments have topped all other floppy drive manufacturers' deliveries of one sided 5.25 inch drives since 1981. Alps also started shipping 3.5 inch microfloppy drives in mid-1984, and enjoyed a major increase in shipments in 1987 as a vendor to IBM for the PS/2 personal computer family. Alps has also announced a product line of rigid disk drives. In the spring of 1987, Alps became the first Japanese company to manufacture floppy drives in the U.S., with 5.25 inch drives made in Garden Grove, California. Alps also manufactures floppy drives in Ireland. In 1989, Alps announced a 2 inch floppy drive for use with video camera systems, but has not announced a similar product for use as a computer peripheral.

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

Asia Commercial, founded in 1968 as a watch manufacturer, has been an aftermarket supplier of floppy drives for IBM, Apple, MSX and other microcomputers since 1985. The firm also manufactures a variety of other computer related products. Shipments of 5.25 inch one sided drives began in 1985, and two sided drives were added in 1986. A 3.5 inch drive was added in 1987. Manufacturing is done by Manhattan Electronics, a closely associated firm at the same location.

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

1989 total net sales: $1,561,208,000 (FY ending 11/30/89) Net income: $26,313,000

Brother is Japan's largest manufacturer of sewing machines, knitting machines and typewriters, with rapid growth in recent years in printers

and other office equipment. Brother began shipping a 100 kilobyte 3.5 inch microfloppy drive in 1984 and added one inch high 1, 1.6, and 2 megabyte versions in 1986. The firm was unable to achieve a high enough production volume to remain competitive in the OEM market, and at the present time, Brother's floppy disk drive production is dedicated to use in Brother products.

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

1989 FDD sales: $51,900,000
1989 total net sales: $9,784,291,000 (FY ending 12/31/89) Net income: $277,345,000

Canon Electronics produces electronic subassemblies for Canon cameras, as well as other electronic components, including magnetic heads, and systems. Floppy disk drives represent 14% of Canon Electronics revenues, down from 27% in 1987. One and two sided 5.25 inch floppy drives have been in production since 1979, originally under a BASF license for one third high drives.

Canon also developed its own unique microfloppy using a 97 mm disk, but these drives were dropped, and the firm began shipments of 3.5 inch microfloppies in late 1984. Floppy drives are produced for both captive applications and for sale to the OEM market, both domestic and export. One inch high 3.5 inch drives began production in mid-1986, and in 1988 Canon commenced production of a 2 megabyte 3.5 inch drive. 19.5 millimeter high 3.5" drives were introduced in late 1989.

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

1989 FDD sales: $130,500,000
1989 total net sales: $379,829,000 Net income: $3,035,000

Chinon is a manufacturer of cameras and auto radios, with worldwide distribution. Eastman Kodak is a minority shareholder in the firm, holding about 12.7% ownership. The company produces scanners, CD-ROM drives and printers as well as floppy disk drives. During 1984, the firm introduced its flexible disk drive product line, consisting of half high 5.25 inch drives and 3.5 inch microfloppies. In 1984, data products accounted for less than 10% of company revenues, but grew to 34% in 1989, with a major proportion contributed by floppy drive shipments.

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

1989 FDD sales: $71,300,000
1989 total net sales: $2,178,286,000 Net income: $61,194,000

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 60% of sales, machine tools hold 11% and electronic equipment the balance. In addition to printers, displays, and small computers, Citizen introduced 3.5 inch microfloppies in 1984, offering the first one inch floppy drive, and began an aggressive sales program in the U.S. and Europe, aimed at the OEM market.

Citizen intended to manufacture a 10 megabyte 5.25 inch drive under an agreement with Konica, but this plan has been suspended due to the small size of the market. In 1989, Citizen again led the industry in drive packaging, this time with the first introduction of 3/4 inch high 1 and 2 megabyte 3.5 inch floppy disk drives. A 20.6 megabyte (formatted) floppy drive using metal powder media was announced in late 1989, but is unlikely to be in production prior to 1991. A 4 megabyte drive was introduced in 1990.

COPAL CO., LTD.
2-16-20, Shimura
Itabashi-ku, Tokyo 174
Japan

1989 total net sales: $449,873,000 Net income: ($9,966,000)

Starting with camera shutters, still the firm's largest product, Copal has diversified into a wide range of electronic components, photographic equipment, clocks, machine tools and printers. Electronic information systems products accounted for about 31% of revenues in 1989. After experience in contract manufacturing for floppy drives, Copal introduced its own 5.25 inch floppy drives in 1985, later adding 3.5 inch models. Fujitsu, Ltd. has a 13% ownership position in Copal and has supplied key personnel to assist in joint product development efforts.

Until recently, Copal manufactured the floppy drives sold by Fujitsu in the U.S. and Europe. However, the firm is now closing down its floppy drive manufacturing operation, due to the small market share held by its own label and the low profitability experienced in contract manufacturing.

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

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

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

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

FUJITSU, LTD.
6-1, Marunouchi 2-chome
Chiyoda-ku, Tokyo 100
Japan

1989 total net sales: $17,291,533,000 Net income: $506,613,000

Despite its role as Japan's leading computer manufacturer and a major participant in the worldwide market for OEM rigid disk drives, Fujitsu was not a participant in the flexible disk drive industry until 1984, except as a buyer of OEM drives for use with its systems. After a short-lived internal manufacturing program, an investment was made in Copal, which until recently produced Fujitsu's floppy drives sold in the U.S. and in Europe. The 3.5 inch microfloppy manufacturing program, which was discontinued in the mid-1980s, was later sold to Hyundai.

GOLDSTAR TELECOMMUNICATION CO., LTD.
20, Yoido-dong
Youngdungpo-gu, Seoul 150
South Korea

1989 total net sales: $233,933,000 Net income: ($18,922,000)

A member of the Lucky-GoldStar Group, one of Korea's major industrial families, GoldStar Telecommunication is a diversified manufacturer of

telecommunication equipment, automation systems and computer peripherals. Computer peripherals account for about 14.2% of sales. A 20% ownership is held by Siemens, the largest shareholder. In an effort to expand beyond existing terminal and printer products, the company markets half high 5.25 inch floppy drives with distribution limited, so far, to Korea. Sales in the U.S. were delayed due to a lawsuit by Tandon Corporation, since settled, claiming improper use of Tandon product designs by ex-employees.

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

1989 total net sales: $46,363,562,000 Net income: $1,344,152,000

Hitachi is Japan's largest electric and electronics manufacturer, with about 46% of its total sales generated by the computer and communications industry. Hitachi has been making 8 inch floppy drives since 1976 for both captive and OEM applications. In 1982, the firm entered the 5.25 inch market, and also joined in the 3.0 inch microfloppy standard with Matsushita Electric Industrial, but has since dropped production of 3.0 inch floppy drives. In early 1986, the firm began shipping a 1.6 megabyte 3.5 inch drive, but manufacturing ceased in 1987. Hitachi has taken something of a leadership role in introducing high capacity flexible disk drives designed to use high density particulate media developed by Maxell, including a 9.6 megabyte 8 inch drive and a 6.5 megabyte 5.25 inch drive. The firm has also made technology announcements concerning vertical recording. However, in recent years floppy drive activity has dwindled and production is now mostly directed at filling internal needs.

HO SHIN SUB-SYSTEM CO., LTD.
3-5 Lane 145
Hsien Sheng S. Road, Section 1
Taipei 106
Taiwan

Founded in 1983, Ho Shin originally produced 8 inch drives, but later switched to production of 5.25 inch drives. Current products include half high drives for IBM and Apple systems. Ho Shin has moved its production facilities to the People's Republic of China. About half of current production is consumed in the PRC.

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 agree-

ment with Fujitsu to take over the 3.5 inch microfloppy program which Fujitsu was preparing for market introduction at the time it acquired control of Copal, which then was chosen as the Fujitsu floppy drive manufacturing arm. Using the Fujitsu products as a starting point, Hyundai has now established its own microfloppy drive manufacturing program at the large electronics complex at Ichon.

JIN TECH ELECTRONICS CORP.
40-42 Lane 166, Li-San Street
Nei Hu, Taipei
Taiwan

Jin Tech was founded as Oceanic Electronics. The firm began to ship one sided 5.25 inch floppy drives in 1985. The product line now includes one and two sided drives for Apple, Commodore and IBM compatible personal computers. In late 1989, Oceanic was split into two organizations, Jin Tech, which is responsible for marketing, and Oceanic, which retains manufacturing responsibility. Current production emphasizes two sided half high drives used with Commodore equipment.

KONICA CORPORATION
1-26-2, Nishi-Shinjuku
Shinjuku-ku, Tokyo 163
Japan

1989 total net sales: $3,447,331,000 (FY ending 4/30/89) Net income: $14,674,000

Konica announced a formatted 10 megabyte, half high 5.25 inch floppy disk drive in 1986, but production did not begin until the fourth quarter of 1987. The drive uses standard media with pre-written servo tracks and is downward compatible with standard 48 TPI and 96 TPI formats. Citizen also has rights to manufacture the drive, but only Konica had an active program in 1989.

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

Mantec was founded in 1985 as a producer of floppy disk drives and modems. The drives produced are two sided 5.25 inch 360 kilobyte models and a one sided drive which is Apple compatible. The company is a spinoff from Manhattan Electronics, which is associated with Asia Commercial, another Hong Kong producer of floppy disk drives.

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

1989 FDD sales: $194,900,000
1989 total net sales: $2,620,439,000 Net income: $87,021,000

Matsushita Communication Industrial is a member of the Matsushita Electric Industrial group, a worldwide giant in appliances and electronics. MCI manufactured most of the Shugart floppy drive line under license for the Japanese OEM market. MCI later added floppy drives of its own design, including half high 5.25 inch and 3.5 inch microfloppy drives. The firm made half high 5.25 inch drives on a contract manufacturing basis for Shugart and in 1985 acquired the rights to market them in the United States, which has resulted in significant sales by the firm's U.S. Panasonic subsidiary. MCI has a joint venture with a manufacturer in the Philippines, Precision Electronics Corporation, to manufacture 5.25 inch floppy disk drives and other computer components.

The firm's product line includes a 1 megabyte 2 inch floppy drive that was adopted by Zenith in 1989 for use in a notebook computer but was otherwise shunned by the computer industry. In 1987, MCI became one of several firms that licensed the barium ferrite technology used in the Toshiba 4 megabyte 3.5 inch floppy drive. MCI has also announced high capacity 3.5 inch drives and 17 millimeter high 3.5 inch drives with 1,2, and 4 megabyte capacities.

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

1989 FDD sales: $43,800,000
1989 total net sales: $39,865,648,000 Net income: $1,546,042,000

Matsushita's Panasonic, National, Technics and Quasar brand names are among the most widely known in the world for appliances, consumer electronics and communications equipment. Matsushita Electric, the parent company, joined with Hitachi in attempting to establish a 3.0 inch microfloppy standard, and is now the sole manufacturer of 3.0 inch microfloppy drives, which have widest acceptance in the European market. In addition, production of one inch high 3.5 inch microfloppies began in 1987.

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

1989 FDD sales: $243,400,000
1989 total net sales: $19,677,106,000 Net income: $385,573,000

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. Captive 8 inch drives have been used with the firm's Melcom systems for several years, and the firm also participates in the domestic OEM market. A family of half high two sided 5.25 inch floppy drives was introduced in 1982, with capacities up to 2.0 megabytes. Mitsubishi also started shipping a 3.5 inch microfloppy drive in 1983 and introduced a 2.0 megabyte version as early as 1985.

Production of flexible disk drives has been moved to expanded facilities at Mitsubishi's Koriyama Works. A new joint venture for the manufacture of floppy disk drives has been established in Thailand with Kang Yong Electric Manufacturing Co., a firm 80% owned by Mitsubishi. Production of one inch high 3.5 inch drives at Koriyama began in 1987, and Mitsubishi has become a major supplier of flexible disk drives to IBM.

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

1989 FDD sales: $73,000,000
1989 total net sales: $952,000,000 (FY ending 1/31/89) Net income: $268,000

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

In 1984, Mitsumi introduced a very low cost 2.8 inch drive using a special Maxell disk under the name "Quick Disk", which uses a single spiral track with 64,000 kilobytes capacity. It is used primarily in low-end home systems, including games. One inch high 3.5 inch drives went into production in 1987, and at the 1989 Comdex conference Mitsumi displayed a 3.5 inch floppy drive with 3/4 inch height, a 4 megabyte drive 3.5 inch drive, and a 2 inch Sony compatible drive. Mitsumi has established a manufacturing facility in Malaysia for floppy disk drives.

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

1989 FDD sales: $395,800,000
1989 total net sales: $22,327,805,000 Net income: $466,988,000

About 47% of NEC's revenues are generated by computer mainframes, small business systems, minicomputers and desktop systems -- and the firm remains the clear leader in the growing Japan domestic personal computer market. Since 1978 the company has manufactured two sided 8 inch floppy drives, and was one of the earliest firms to offer half high 8 inch drives, with shipments starting in late 1981. 3.5 inch microfloppy drives and half high 5.25 inch drives were introduced in 1984. The majority of NEC's floppy drive shipments have been for captive applications, making the company the world leader in total DISK/TREND revenues for flexible disk drives.

NEC moved into the high capacity floppy drive market with the 1988 introduction of a 3.5 inch 9.4 megabyte (formatted) drive for sale with its microcomputer systems. A 10 megabyte version was introduced in 1990. In 1989, NEC announced that it was establishing a subsidiary in Hong Kong to oversee procurement and manufacturing in southeast Asia, including production of floppy disk drives in the Philippines.

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

1989 total net sales: $143,269,000 Net income: ($14,246,000)

OPC, established in 1953, is a diversified producer of electronic products and systems including terminals, telecommunication products, small computers and radio products. Computer equipment accounts for about one fifth of annual sales. The firm manufactures a line of 5.25 inch floppy drives under license from Teac, and also does contract manufacturing of small rigid disk drives.

RICOH CO., LTD.
1-15-5 Minami-Aoyama
Minato-ku, Tokyo 107
Japan

1989 total net sales: $5,282,907,000 Net income: $128,884,000

Copiers, sensitized papers and photographic equipment provide the major part of Ricoh's revenues, but the firm has been investing in the growing line of data processing equipment which now accounts for about 30% of

Ricoh sales. Since 1979, Ricoh has made 8 inch floppy drives, in both one and two sided versions, originally under a Calcomp manufacturing license. The firm has introduced half high 5.25 inch drives intended for both captive and OEM applications. All of Ricoh's floppy drives are made by Ricoh Elemex, a subsidiary, but recent production rates have been very low.

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

Roctec was established in 1986 when a group of engineers approached the parent organization and proposed establishing floppy drive manufacturing. There was no significant production in 1986, but substantial shipments of 5.25 inch drives, mostly two sided, were made in 1987. Roctec has its assembly facilities in Hong Kong, and also makes use of manufacturing facilities in the People's Republic of China, working with an organization which provides manufacturing on a contract basis. Roctec is emphasizing externally mounted diskette add-on products for various personal computers including Apple, Commodore, Compaq, IBM, and Toshiba.

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

1989 total net sales: $5,942,261,000 Net income: $235,035,000

Samsung Electronics is the leading manufacturer of consumer electronics and appliances in Korea. About 21% of sales are computer or communications products. In 1988, the firm merged with Samsung Semiconductor and Telecommunications, with Samsung Electronics the surviving organization.

Samsung got started in floppy drive production in 1983 when Shugart granted a license to manufacture and market the Shugart 5.25 inch floppy drives in South Korea, but consumer electronics and appliances are the firm's major sources of income. Samsung is currently making half high 5.25 inch drives with capacities up to 1.6 megabytes, and has initiated an export program. Production of 3.5 inch 2 megabyte one inch high drives began in 1989.

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

1989 total net sales: $437,901,000 Net income: $5,613,000

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

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

1989 FDD sales: $137,000,000

Seiko Epson is owned by the privately held Suwa Seikosha/Epson group held by members of the Hattori family, who also control Japan's Seiko companies active in watches and electronics. Epson is best known for matrix printers, now used worldwide with personal computers. Epson also manufactures line printers, LCDs, paper tape equipment, watch components, and its own portable computer. The first Epson floppy drive was a captive 5.25 inch one third high unit first shipped in 1982 and used with the Epson portable computer. Starting in October, 1983, Epson added an OEM floppy drive product line of 5.25 and 3.5 inch models, including 3.5 inch drives with very low power requirements. At the 1985 Fall Comdex, Seiko Epson showed a 2.5 inch floppy disk drive prototype for which no manufacturing program has ever been announced. As of 1990, the product line included half high 5.25 inch drives and 25.4 millimeter and eighteen millimeter high 3.5 inch drives.

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

1989 FDD sales: $294,000,000
1989 total net sales: $15,944,608,000 (FY ending 10/31/89) Net income: $524,871,000

As it becomes more difficult to meet Sony's growth objectives in the consumer electronics market, several portions of which appear saturated, the firm's management has made it clear that expansion in office products

markets is a major company objective. About 17% of sales are now in non-consumer products. Included are word processing and personal computer equipment -- both of which use the Sony 3.5 inch microfloppy which has been shipping since late 1981.

After initially taking a somewhat stiff posture on granting licenses, Sony demonstrated flexibility in working with the U.S. manufacturers concerned with establishing common standards. The result was agreement on the 3.5 inch media standard by Sony and several U.S. drive and media manufacturers -- and a growing number of Japanese firms rushing to make 3.5 inch micro-floppy drives. After a big early boost when Hewlett-Packard selected Sony's drive for a variety of personal computers, there was a two year period of attack from contentious sponsors of rival standards, but the industry consensus on the Sony 3.5 inch drive has been in place for several years. 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 2 megabyte, 3.5 inch media standard in 1985, which has become a de facto industry standard, with a little help from IBM. In 1987, Sony responded to the growing industry support for one inch high 3.5 inch drives by introducing its own model. The firm has been pioneering the sub-microfloppy field with a very high bandwidth 1 megabyte, 2 inch floppy based upon a design used in the Mavica video camera storage device. Sony is also an active producer of CD-ROM, erasable and write-once optical disk drives, and has also entered the 3.5 inch rigid disk drive market as a supplier to Apple.

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

1989 FDD sales: $340,100,000
1989 total net sales: $622,923,000 (FY ending 9/30/89) Net income: ($4,295,000)

Teac is a leading manufacturer of consumer and professional audio recorders, but digital recording equipment is a major portion of the firm's product mix, now accounting for about 69% of total revenues. Shipments of 5.25 inch floppies for the OEM market started in 1978, and rapid growth made Teac the leader in 1986 worldwide OEM floppy drive revenues. Major products today are half high 5.25 inch drives and microfloppy drives. In 1985, Teac announced its line of 3.5 inch drives, including a 2.0 megabyte model and subsequently added one inch high models. The firm joined Toshiba in 1987 in announcing 4 megabyte 3.5 inch floppy drives using barium ferrite media. 1 megabyte and 2 megabyte 3/4 inch high 3.5 inch drives were introduced at the Fall 1989 Comdex. A 4 megabyte model was introduced in 1990. Teac has made manufacturing and licensing arrangements with a number of other firms in Japan, Korea, and other countries.

TECMATE ELECTRONIC INC.
30 Section 3, Chung-Shan N. Road
Taipei
Taiwan

Tecmate, also known under its NPH brand name, was founded in 1982 and has become one of Taiwan's largest floppy disk drive producers. The firm produces 5.25 and 3.5 inch floppy disk drives and other electronic products for small computers. Current production has shifted strongly to two sided 5.25 inch models but has declined to low levels.

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

1989 FDD sales: $101,400,000
1989 total net sales: $27,528,478,000 Net income: $864,793,000

Toshiba is one of Japan's major diversified electric and electronics manufacturers, with products ranging from heavy electric machinery to home appliances and communications equipment. Toshiba has a major share of the Japanese minicomputer and small business system markets. 8 inch floppy drives for both captive and OEM markets have been produced since 1977. Half high two sided 5.25 inch drives were added in 1982, with the more recent addition of microfloppy drives. Although now de-emphasizing internal production of standard floppy drives, Toshiba has actively promoted advanced technology, including optical drives. High capacity barium ferrite media has been developed by the firm for 4 megabyte 3.5 inch floppies, with initial production of drives and media underway in 1988. Several other firms have licensed the drive and media. Toshiba is also working on 3.5 inch drives with 15-20 megabyte capacity, and displayed a 16 megabyte 3.5 inch drive using barium ferrite media at the Japan Business Show in May, 1989.

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

1989 FDD sales: $139,300,000
1989 total net sales: $188,419,000 Net income: $1,463,000

Y-E Data is a spin-off of Yaskawa Electric, a diversified manufacturer of heavy electric, factory automation and data processing equipment. Data processing products are the responsibility of Y-E Data, which first manufactured 8 inch one sided floppy drives in 1974 under an Orbis license. Disk drives represent about two thirds of current sales. Y-E Data became an early leader in the Japanese OEM markets for both 8 and 5.25 inch two sided drives. Y-E Data also cooperated with NTT on the standard for 1.6

megabyte 5.25 inch drives and has been shipping its version since early 1982. Microfloppy drives were added in 1984. Y-E Data's biggest sale of all came in 1984, with IBM's selection of the firm's 1.6 megabyte 5.25 inch drive for use with the PC AT. In 1986, one inch high 3.5 inch drives were added to the product line. In addition to its drive manufacturing activities, Y-E Data is supplying drive kits to manufacturers in India and mainland China. A 4 megabyte 3.5 inch microfloppy drive using cobalt modified oxide media was introduced in 1988 in an unsuccessful attempt to develop an industry standard, and a preliminary announcement of a 27.8 megabyte drive using metal particle media was made in 1989. 17 millimeter high 1 and 2 megabyte 3.5 inch drives were announced in 1990.

European Manufacturers

DZU
6000 Stara Zagora
Bulgaria

DZU is the new 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 produces flexible and rigid disk drives, as well as most of the components needed for disk drive fabrication, plus many other electrical and electronic devices. Isotimpex is the foreign trade organization for Bulgarian computer equipment and other electronic products. Disk drives manufactured by DZU are exported to Eastern Bloc countries, with some magnetic media products also exported to Western countries. Rigid disk drives, in several older IBM configurations, have been produced since the 1960s, later joined by 8 inch and 5.25 inch floppy drives.

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

In July, 1981, Elcomatic acquired the 8 inch flexible disk product line of MFE. These drives had been manufactured mostly in a two sided version at plants in Salem, Massachusetts, and in Livingston, Scotland. Elcomatic moved manufacturing to a Glasgow plant and is continuing to produce 8 inch two sided floppy drives for the European market. 1988 production was impacted by a shortage of suitable heads, but product redesign enabled Elcomatic to resume production.

ISOT (See DZU)

KOVO
Jankovcova 2
17088 Praha 7
Czechoslovakia

KOVO is the Czechoslovakian import/export agency with jurisdiction over that country's trade in computers and related products. Included in the current product line are computers and peripheral equipment manufactured by Zbrojovka Brno and Aritma, both diversified manufacturing operations. 8 inch floppy drives, 14 inch disk cartridge drives and disk pack drives are produced in small quantities, but manufacturing of floppy drives was discontinued in the last year.

MAGYAR OPTIKAI MUVEK
XII, Csorsz u.35
H-1525 Budapest
Hungary

Usually known by the abbreviation of its Hungarian name, MOM, or the "Hungarian Optical Works", this organization has produced 8 inch one sided floppy drives for several years, including various subsystems. A full size 5.25 inch one sided drive was added in 1980, replaced by half high one and two sided drives in 1987. MOM's extensive export program, primarily to other Eastern Bloc countries, was handled through Videoton, a state-run foreign trade organization, but MOM now relies on its own trade organization.

PERIPHERAL DATA SYSTEMS
Asenovgradsko Shose
Plovdiv
Bulgaria

Peripheral Data Systems (formerly known as Instrumentation and Automation) has the charter from the Bulgarian government for product development, and to establish high volume manufacturing facilities for peripherals used in personal computers, in order to facilitate usage of personal computers throughout the country. With assistance from ISOT, plus acquisition of tooling from outside countries, the organization started production of 5.25 inch flexible disk drives in 1985.

ROBOTRON
VEB Robotron-Buchungsmaschinenwerk Karl-Marx-Stadt
Annabergerstrasse 93
DDR-9010 Karl-Marx-Stadt
East Germany

The Robotron group is the East German organization responsible for manufacture of computing and office equipment, communication equipment, electronic instruments and consumer electronic devices. The Robotron facility for peripheral equipment initiated manufacture of 5.25 inch one sided floppy drives during 1984, after several years of buying similar drives from outside sources for Robotron equipment. With the integration of East and West Germany now in effect, the continued Robotron production of floppy disk drives in the face of Asian competition will become increasingly problematical.

South American Manufacturers

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

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

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

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

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

Originally known as Electrodigi S.A. Electronica Digital, Flexdisc has had several name changes. Its present name was adopted in mid-1986. Floppy disk drives have been produced by Flexdisc since 1979, originally under a Shugart Associates license. Current products also include rigid disk drives, controllers, and other peripheral products. The floppy disk product line began with 8 inch drives, but now includes one and two sided 5.25 inch floppy drives.

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

Multidigit was founded in 1980 with a cadre of Brazilian university students, and so qualifies as a genuinely homegrown company. Products include floppy and rigid drives, controllers, and tape drives. The floppy drives are half high 5.25 inch models using both 48 and 96 TPI.

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

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

DISK/TREND ON DISK

1990 DISK/TREND REPORT

INTRODUCTION

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

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.

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 used on the label of each 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.

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.

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.

Note: Please read the license information on the following page.

DISK/TREND ON DISK
Information License

DISK/TREND supplies diskettes containing selected information from the 1990 DISK/TREND Report as a separately purchased option to subscribers to the corresponding 1990 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 the terms and conditions provided by White Crane Systems, Inc.

Trademarks

IBM is a trademark of International Business Machines Corporation.

Lotus and Lotus 1-2-3 are trademarks of Lotus Development Corporation.

MS-DOS is a trademark of Microsoft Corporation.

AutoImport is a trademark of White Crane Systems, Inc.

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 Auto-Import 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.

STATISTICAL TABLES

Loading and Installation

1. Place the floppy disk marked 'Tables' in a floppy disk drive able to read 5.25" 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

   The utility file names are of the form FORMLIN?.PRN. The files are specific to use with Lotus 1-2-3 data parsing if you prefer not to use AutoImport for file translation.

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

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

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

4. Now you are ready to start your spreadsheet. If you are using a two floppy system, place the DISK/TREND disk in drive B and the spreadsheet

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

/FR<filename>

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

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

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

ZZ= Year of Report.

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

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

If you don't use AutoImport

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

The trickiest and most-time consuming part of using the Data Parse commands is setting up the format line. Several utility files have been provided on the tables disk to make this process easier. These are used with various table formats encountered in the DISK/TREND Reports and correspond with the precomputed masks provided for use with AutoImport:

- FORMLINA.PRN — Used with Table 1 and the Revenue and Unit Shipment tables found in the product group sections of all DISK/TREND reports.

- FORMLINB.PRN — Used with Table 2.
- FORMLINF.PRN — Used with Tables 3 and 4.
- FORMLIND.PRN — Used with Application tables.
- 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 table below which relates table types to specific masks.

MASK TABLE

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

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

TABLE NUMBER TO MASK CROSS-REFERENCE

Table Number	1990 Rigid Report	1990 Flexible Report	1990 Optical Report
1	MASKA	MASKA	MASKA
2	MASKB	MASKB	MASKA
3	MASKC	MASKC	MASKB
4	MASKC	MASKC	MASKB
5	MASKC	--	MASKC
6	MASKC	--	MASKC
7	MASKC	MASKF	MASKC
8	MASKC	MASKA	MASKC
9	--	MASKA	MASKC
10	--	MASKE	MASKC
11	MASKA	MASKD	MASKC
12	MASKA	MASKG	MASKC
13	--	MASKA	--
14	--	MASKA	--
15	MASKD	MASKE	--
16	--	MASKE	--
17	MASKA	MASKD	MASKA
18	MASKA	MASKG	MASKA
19	--	MASKA	--
20	--	MASKA	--
21	MASKD	--	MASKD
22	MASKA	--	--
23	MASKA	MASKE	MASKA
24	--	MASKE	MASKA
25	--	MASKD	--
26	MASKD	MASKG	--
27	--	MASKA	MASKE
28	MASKA	MASKA	MASKD
29	MASKA	--	MASKA
30	--	--	MASKA
31	--	MASKD	MASKD
32	MASKD	MASKG	MASKA
33	--		MASKA
34	MASKA		MASKA
35	MASKA		MASKA
36	--		--
37	--		--
38	MASKD		MASKE
39	--		MASKA
40	MASKA		MASKA
41	MASKA		--
42	--		--
43	--		MASKE
44	MASKD		MASKA
45	--		MASKA
46	MASKA		--
47	MASKA		--

Cross-reference (continued)

Mask File Name	1989 Rigid Report	1989 Flexible Report	1990 Optical Report
48	--		MASKE
49	--		
50	MASKD		
51	--		
52	MASKA		
53	MASKA		
54	--		
55	--		
56	MASKD		
57	--		
58	MASKA		
59	MASKA		
60	--		
61	--		
62	--		
63	MASKD		
64	--		

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

Translation using precomputed masks

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

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

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

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

2. Now start AutoImport. When the opening screen appears, select the 'TRANSLATE' menu item using the arrow keys or just type 'T'. (The AutoImport menu system works just like the menus in Lotus 1-2-3.)

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

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

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

   Examples: RT4 FT12 OT14

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

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

   Examples: RT4.90R FT12.90F OT14.900

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

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

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

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

Mask Generation

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

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

   Example: OT50.900

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

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

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

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

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

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

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

   - o Now place cursor in first space to the right of the left margin label column. Type /C and then adjust the column width to encompass all places in the values column you have been working with. This will restore the mask column, also.

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

   Example: OT50MSK

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

   Example: OT50. You don't need to enter the file extender.

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

Other AutoImport Functions

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

SPECIFICATION TABLES

Loading

1. Place the floppy disk marked 'Specifications' in a floppy disk drive able to read 5.25" disks. This is usually drive A, but if you are using a dual floppy only system, use drive B and put the spreadsheet system disk in drive A. Use the DOS 'DIR' command to examine the file directory on the 'Tables' disk. If there are any special instructions, they will be in a file named READ.ME. To see these instructions, at the DOS prompt type:

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

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

   TYPE A:READ.ME>PRN

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

   COPY A:?S*.*

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

   /FR<filename>

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

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

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

ZZ= Year of report.

Example: OS190 Optical disk specification table
LS190 Optical library 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 database is first loaded, you will see the top of the input range, showing the first column (manufacturer name) for the first several manufacturers. Use the arrow keys to find other manufacturers or specific product specifications. If you are not using Lotus 1-2-3, use the equivalent procedure for your spreadsheet.

Operating tips

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

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

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

- o You have selected too large an output range. Use a smaller output range or delete some of the columns that contain data not relevant to your analysis. If you delete data, be sure that if you save your spreadsheet you use a different file name, otherwise you will overwrite the original file with the modified spreadsheet.

- o If you receive a memory overflow message while loading the data base, the data base is too large for your computer's available memory. You probably will have to remove other resident programs and reload Lotus 1-2-3 and the data base. If your computer doesn't have 640K memory, you will probably get this message.

Saving time

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

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

Make sure that when you save a worksheet using the FILE SAVE command that you save it in a new file name. If you save it in the file name from which it was loaded, the original copy will be overwritten. If a file is overwritten unintentionally, it can take a long time to recreate.

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

Technical support

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

Call us at: 415-961-6209

Ask for Technical Support

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.