March 22, 1971

To: File

From: J. D. Hutcheson

Subject: Evaluation of Automated Testers for LSI Production Operation

The availability, cost, and technical parity of automated testers for MOS LSI production operations has fluctuated widely during the past 18 months. The situation does not yet appear to have stabilized. Machines have been introduced that range as low as $33,000, such as the General Radio model 1790, to over $250,000, such as the Macrodata model MD200. At the time of this writing, Teradyne is preparing to introduce still another machine, the J-277, designed exclusively for MOS LSI. Fairchild has plans to upgrade the Sentry 400 to make it more compatible, from a functional testing viewpoint, with MOS. Consequently, it is somewhat difficult to make an evaluation that will remain valid beyond late 1971. This evaluation is directed to that time frame.

In order to more properly compare these testers it is assumed that the machine must operate as a stand-alone function in a small MOS production operation. That no additional technical assistance is available, other than field support, and that the machine must be brought up to full operating performance from a dead start, business wise. It is further assumed that all operating costs, both fixed and recurring, must be borne as direct production costs. Operating costs are based upon one 8 hour shift operation. Acquisition costs are based upon a two station, 60 pin, test capability with 50 program storage capacity. The cost of a wafer probe station is not included, but can be factored in for an additional fixed cost of approximately $20,000.

Seven machines were initially compared for technical performance. The bases of this performance is shown in Table I. Three machines were quickly eliminated. These were the General Radio 1790, Adar Doctor 64, and Datatron 4400. They do not have the requisite performance characteristics. The remaining four machines have approximate technical parity with the single exception that the Sentry 400 tends to out-perform in DC tests while the other three machines out-perform in functional tests. When Fairchild improves the functional capability of the Sentry 400, then all four machines should be at parity. Consequently, the evaluation can be focused on operating costs.

Detailed operating costs of the remaining four machines are shown in Table II. In summary, by descending cost, they are:

Type of Machine	Basic System Cost	Estimated Start-up Cost	Estimated Monthly Operating cost
Macrodate MD 200	$250,000	$329,600	$22,214
Fairchild, Sentry 400	$251,000	$306,200	$22,630
Teradyne, J-277	$165,000	$238,050	$17,026
LSI Testing 4024	$148,000	$209,300	$17,655

The basic system cost was obtained from the manufacturer. Total start up costs were derived, as outlined in Table II, by considering additional system contingency costs, installation costs, maintenance costs, and training costs necessary to bring the machine to full operational capability. Estimated monthly operating costs include depreciation, maintenance, and operations labor for one 8 hour shift. It is estimated that in order to operate any of these machines on second or third shift will require an additional monthly cost of $2,965 and $4,685 respectively.

Cost versus performance indicates that the LSI testing model 4024 machine should be the one to purchase; that the Teradyne J-277 would be the best alternate. However, it is to be recommended that both of these machines be examined by a qualified engineer prior to making a decision to buy.

Other things being equal, either machine should give adequate performance. Teradyne has a long successful history in building automated testers, despite the fact that their experience in MOS is somewhat light. LSI testing corporation should have more experience in building MOS testers than any other supplier. They have been building MOS testers for General Instrument for several years.

TABLE I

TECHNICAL PERFORMANCE REQUIREMENTS

Performance Requirements	Sentry 400	Teradyne J-277	Macrodata MD-200	LSI Testing 4024	Gen. Radio 1790	Adar Doctor 64	Datatron 4400
Prime							
4 phase clocks	Yes	Yes	Yes	Yes	No	Yes	No
30-40 volt drivers	Yes	Yes	Yes	Yes	Yes	No	Yes
10 KHZ minimum speed	Yes	Yes	Yes	Yes	No(4KHZ)	Yes	Yes
Over 1 MHZ top speed	No (256KHZ)	Yes (5MHZ)	Yes (8MHZ)	Yes (2MHZ)	No(4KHZ)	Yes (10MHZ)	No (50KHZ)
Rise/fall times 1/20 of 1/fo, 1/5 phase time	Yes	Unknown	Yes	No	-	?	Yes
Pin capacity	30-120	24-?	16-64	70	240	64	100-256
DC parameters							
10 uA current resolution	Yes	Yes	No-20nA	Yes	?	None	Yes
0.1 V voltage resolution	Yes	Yes	Yes	No (0.25V)	?	None	Yes
70V break down tests	with difficulty	Yes	Yes	Possibly	?	None	Yes
Simple easy setup	Reasonable	Unknown	Reasonable	Unevaluated	Yes	None	Yes
Secondary							
Variable strobe	No	Unknown	Apparently	Yes		Yes	No
Phase adjustable clocks	No	Unknown	Yes	Yes		No	No
Hardware counters	No	Unknown	No	Yes		No	Yes
Simple software	No	Somehwat	No	Unknown		Unknown	Yes
Datalogging capability	Yes	Yes	Yes	Yes		Unknown	Yes
Desirable							
Versatile load board	Yes		Yes	Unknown			No
Fast program loading	No		No	Yes			Yes
Simple device interface	Yes		Yes	Yes			Reasonable
Local memory at test station	No	Yes	Yes	Yes			No
Units built beyond prototype	15 or more	2	2(?)	3			?

TABLE II

OPERATING COSTS

	Sentry 400	Teradyne J-277	Macrodata MD 200	LSI Testing 4024
Fixed Initial Costs				
Initial system cost	251,000	165,000	250,000	148,000
Initial system contingencies		30,000	20,000	20,000
Installation costs (@10% OEC)	25,150	19,500	27,000	16,800
Initial maintenance spare parts (@5% OEC)	12,550	9,250	14,500	8,400
Maintenance equipment costs	12,000	12,000	12,000	12,000
Total hardware acquisition costs	300,700	235,750	323,500	205,200
Fixed training costs	5,500	2,300	6,100	4,100
Total start up costs	306,200	238,050	329,600	209,300
Recurring Monthly Costs (8 hour shift)				
Hardware				
Fixed costs depreciated over 60 months	5,100	3,900	5,400	3,400
Tester interface boxes	1,000	500	300	300
Spare parts replacement (0,1% OEC)	300	236	324	205
Maintenance equipment calibration	50	50	50	50
Unburdened Staffing				
2 operators @ $2.90/hr.	975	975	975	975
1 device programmer @ $7.00/hr.	1,175	1,175	1,175	1,175
1 systems programmer @ $7.00/hr.	1,175	0	1,175	560
1 electronic tech. @ $6.00/hr.	1,010	1,010	1,010	1,010
1/4 systems manager @ $10.00/hr.	420	420	420	420
Total unburdened labor	4,755	3,580	4,755	4,140
Labor burdening @ 150%	7,125	5,360	7,125	6,200
Subtotal of estimated recurring costs:	18,330	13,626	17,954	14,295
Other monthly contingencies	900	700	900	700
G & A @12.5%	3,400	2,700	3,360	2,660
Estimated actual monthly operating costs	22,630	17,026	22,214	17,655