

NEW HARDWARE ECONOMICS

INPUT

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PLUG COMPATIBLE MAINFRAMES:
THE NEW HARDWARE ECONOMICS

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PLUG COMPATIBLE MAINFRAMES:
THE NEW HARDWARE ECONOMICS

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I. INTRODUCTION

I INTRODUCTION

- This report is produced by INPUT as part of the Market Analysis Service (MAS).
- Research carried out for this report included interviews with:
 - 7 users of Amdahl equipment
 - 7 users of large Burroughs business systems
 - 7 users of large Honeywell business systems
 - 7 users of IBM medium size business systems
 - 7 users of IBM large business systems
 - 7 users of Univac large business systems
- Interviews were carried out in April and May 1977, by telephone.
- The benchmarks quoted in this study were performed by a consultant affiliated with INPUT.
- Research included visits to Amdahl and Itel and in-depth discussions carried out with their management, technical and marketing personnel.
- Discussions were also held with two foreign computer manufacturers and a foreign trading company.

- Actions in the market place which have occurred since the study started, and are not otherwise analyzed, are presented in Addendum 1.
- Two reports were delivered to clients in 1976 which contained forecasts related to the developments analyzed in this report. These reports were:
 - "Economics of Computer/Communications Networks and Their Impact"
 - "Amdahl as a Viable Alternative to IBM"
- Addendum 2 to this report contains an analysis of the previous forecasts. It is INPUT's policy to provide this tracking of forecasts wherever possible.
- Inquiries and comments on the information presented in the report are requested from clients.

II. EXECUTIVE
SUMMARY

II EXECUTIVE SUMMARY

A. ASSESSMENT OF NEW HARDWARE ECONOMICS

- Advancing technology, represented by the emergence of the plug compatible large mainframes and IBM's response, has established new processor price-performance standards.
- IBM's announcement of the 3033 processor, coupled with the 370/158 and 168 price cuts, were a major surprise with respect to the extent to which these announcements drastically changed the price-performance characteristics.
- These dramatic moves represent a recognition by IBM that they must transfer improvements in performance, made possible by advancing technology, to the marketplace.
- INPUT considers that the success of Amdahl's plug compatible mainframe was a major factor in the announcement of the 3033, and the lowering of prices on the 370/158 and 168; the objective being to slow down Amdahl's incursion into the IBM customer base.
- Amdahl responded within 72 hours to IBM's new mainframe and aggressive price cuts. This response consisted of two new mainframes:

- 470 V/7 with performance above the 3033
- 470 V/5 which is competitive down to the 370/158
- As a result of the announcements, the effective price-performance ratios of large scale IBM and IBM compatible processors has improved by a factor of four! Exhibit II-1 shows a price-performance comparison of the Amdahl 470 V/7 and the 370/168 at its old price (pre March 1977).
- The New Hardware Economics impacts the value of future shipments of large business systems. When INPUT published the study "Amdahl as a Viable Alternative to IBM", IBM's portion of large business systems shipments from 1976 to 1980 was projected as \$9 billion, at 1976 prices. The recent price-performance improvement has theoretically cut the potential backlog in half.

B. USER REACTIONS TO RECENT ANNOUNCEMENTS

- Half the 14 users of large and medium scale IBM systems surveyed by INPUT have changed their installation plans as a result of the announcements. IBM users are taking advantage of the improved price-performance available now, or expected to be made available through future announcements.
- Several current Amdahl users are "hedging their bets". They are placing letters of intent for both new IBM and Amdahl processors, waiting for a clearer picture of IBM's long term intentions and evaluating Amdahl's response to IBM strategies.

EXHIBIT II-1

COMPARISON OF PRICE-PERFORMANCE
 CHARACTERISTICS OF LARGE SCALE IBM
 AND AMDAHL MAINFRAMES

PROCESSOR	INTERNAL PERFORMANCE	PRICE-PERFORMANCE
370/158-3 (OLD PRICES)	1	1
370/158-3 (NEW PRICES)	1	1.4
370/168-3 (OLD PRICES)	2.9	1.8
370/168-3 (NEW PRICES)	2.9	2.3
470V/5	3.3	4.3
470V/6 (OLD PRICES)	4.6	3.6
470V/6-II (OLD PRICES)	5.1	3.8
470V/6-II (NEW PRICES)	5.1	5.4
3033	4.9	5.0
3033 (EF)*	4.9	5.6
470V/7	7.4	7.4

*WITH SYSTEM/370 EXTENDED FACILITY AND THE MVS/SYSTEM EXTENSIONS PROGRAM PRODUCT.

- INPUT's survey of Honeywell, Univac, and Burroughs users shows them to be content with their present vendors primarily because they perceive the non-IBM software as being superior. However, 90% indicated they did expect some price adjustment as a result of IBM's repricing. (The survey was taken before Univac and Burroughs adjusted prices.)

C. RESIDUAL VALUES OF LARGE IBM PROCESSORS

- Residual values on installed large IBM systems dropped immediately by 30% and this drop will continue until the 3033 deliveries commence.
- INPUT believes the 370/158 and 168 residual values will stabilize in the 30%-35% range near the end of 1978.
- These residual values will decrease again early 1980 due to a new processor family announcement by IBM.
- The Amdahl 470 and 3033 processor residual values will decline sharply at the same time.
- The residual value of the 370/168 in 1981 will be approximately 10% of its 1976 value giving the ten times price-performance gain predicted by INPUT.

D. JAPANESE COMPUTER INDUSTRY STRATEGIES

- On a world wide basis, a major challenge to IBM will come from the rapidly expanding Japanese computer industry. Directed by the Japanese government

through the Ministry of International Trade and Industry (MITI), the Japanese computer industry is marshalling its combined resources for an organized all-out assault on IBM's customer base.

- The Japanese expect to obtain a 12%-15% share of the world's medium-large scale systems market by the mid-1980s.
- Japanese computer manufacturers will vary their tactical planning strategies by geographic markets to attain market share. In the North American (N.A.) market, for example, Japanese computer manufacturers will achieve market share through product/market alliances with N.A. firms.
- Outside N.A. the Japanese computer companies will assume a more direct market approach. Here, they will compete aggressively with their own products and using their own nomenclature.

E. FUTURE DEVELOPMENTS AND STRATEGIES

- An immediate problem for IBM is the price-performance pressure on the 370/158 and 168 due to the IBM 3033 and Amdahl announcements.
- Also, IBM will continue to espouse the concept of tightly coupled systems.
- As a result, IBM will announce several more processor configurations in the 3033 family through 1977 and 1978 as detailed in Exhibit II-2.
- IBM will continue to unbundle operating system functions using hardware, firmware and program products in a manner similar to System/370 Extended Function.

EXHIBIT II-2

ANTICIPATED LARGE SCALE IBM MAINFRAME ANNOUNCEMENTS,
1977-78

PROCESSOR	INTERNAL PERFORMANCE	PRICE RANGE (\$ MILLIONS)	PRICE-PERFORMANCE
370/158-3 (OLD PRICES)	1		1.0
3031*	1.1	1.2-1.5	2.7 <i>.912/333</i>
3032*	3.0	2.2-2.5	4.5 <i>1.504/1.2</i>
3033 TC1**	9.5	4.8-5.3	6.5
3033 TC2**	10.6	5.0-5.5	7.0

*INPUT'S PROJECTIONS OF NEW PRODUCT OFFERINGS

**TIGHTLY COUPLED ALTERNATIVES OF THE 3033 (EITHER AP OR MP)

- This strategy of continually shifting functions among hardware/firm-ware/software has two important benefits to IBM:
 - Additional revenue from functions previously bundled.
 - It makes it increasingly difficult and expensive for other vendors to maintain compatibility with IBM.

- The long range potential market for random access storage is virtually unlimited. IBM strategy in this will include:
 - Interim IBM announcements will encompass improvements and extensions to current systems including the provision of storage systems processors.
 - In the mid-1980s costs of storage on magnetic media will fall below those of paper as IBM announces systems based on new technology.

- By the early 1980s, IBM will be in a position to support distributed processing networks. However, IBM will continue to offer users the choice of degree to which they wish to distribute the function.

- IBM will also offer services as a computer/communications utility.

- In order for Amdahl to sell mainframes, it must have a clear price-performance advantage over comparable IBM systems.

- When the projected 3032 is announced, Amdahl could respond by adjusting the price of its 470 V/6-II to that of the V/5 and lowering the V/5 price to approximately \$2 million. This would result in a more reasonable price spread for the 470 line and establish clear price-performance advantages over the IBM line.

- The most serious current issue to be addressed by Amdahl is the IBM System/370 Extended Facility announcement to which Amdahl has not yet adequately responded. Amdahl can certainly respond in some manner. However, any deviation from compatibility will result in an adverse customer reaction out of all proportion to its true significance.
- As a long term strategy, Amdahl must at some time deviate from total compatibility with IBM. The economic impossibility of constantly reacting to all the hardware/firmware/software tactical announcements from IBM, in the large systems area, makes this strategy mandatory.
- The most promising areas for Amdahl to expand its product line between now and 1980 appears to be in mass storage systems and communications processors. Conceivably, this market opportunity would be attractive to Amdahl's partner Fujitsu. Here, Fujitsu has product offerings which not only fulfill Amdahl's needs but allow Fujitsu to achieve market goals in the U.S.
- Intel will be confronted with some unique challenges. The most important, however, will be the effective management of its inventory of IBM equipment. This single issue will have the greatest impact on Intel's profitability - even more than any of its own products.
- Depending upon project margins and user acceptance, Intel will substitute other manufacturers' products for those of IBM in a basically "IBM" systems package; this substitution will include mainframes where appropriate.

F. IMPLICATIONS FOR PLUG COMPATIBLE MANUFACTURERS

- The plug compatible mainframe manufacturers, like their peripheral supplier counterparts, are going to find out just how expensive it is to keep up with IBM.
- As IBM continues to price its products aggressively, the profit margins of the plug compatible manufacturers will be squeezed.
- At the same time, these manufacturers must be able to retain IBM compatibility until they achieve a significant user base. This means they must be able to respond to the hardware/firmware/software announcements of IBM, particularly announcements such as the System/370 Extended Facility.

G. IMPLICATIONS FOR ALL MAINFRAME MANUFACTURERS

- The price-performance pressure exerted by the large scale systems at the top of the line and from the minicomputers at the bottom of the line results in an unsatisfactory competitive situation for medium and small scale standalone systems.
- As IBM implements its System Network Architecture (SNA), minicomputer and terminal manufacturers, interfacing with IBM networks, will experience severe compatibility problems.
- All mainframe manufacturers will be affected by IBM's emerging hardware/firmware/software strategy. This strategy will provide price-performance improvements in storage, operating systems, communications and

applications. The impact of these improvements, on the overall systems performance, may be greater than that of the recent processor price-performance improvements.

H. IMPLICATIONS FOR PROCESSING SERVICES COMPANIES

- The availability of mainframes with increased capacity and better price-performance is both a potential benefit and a potential threat to the processing services.
- There is a substantial market opportunity for processing services firms in replacing small to medium scale standalone systems.
- Processing services companies must consider both price-performance and straight performance improvements available under the New Hardware Economics.
- Because of the projected price-performance improvements in storage and other areas, the processing services vendors must consider the question of IBM compatibility.
- Competition for the processing services vendors will emerge from two sources:
 - IBM's entry into computer/communication services
 - Other, very large companies using their computer and communications capacity to enter this fast growing market.

I. IMPLICATIONS FOR SOFTWARE COMPANIES

- IBM's hardware/firmware/software strategies will make it difficult for companies providing IBM's systems software packages to develop and maintain viable products.
- There will be opportunities for systems software products but these products must be priced and sold on the basis of a short life cycle.
- IBM will emphasize the elimination of, or at least reduction of, applications programming. This will change the nature of the professional services market by putting more emphasis on systems designers and consultants, as opposed to programmers or coders.

J. IMPLICATIONS FOR USERS

- The chief result of the recent announcements has been turmoil in the industry. Based on the analysis contained in this report, INPUT does not foresee a settling down through the remainder of this decade!
- Immediate price-performance benefits will be obtainable by all medium and large systems users.
- There are major considerations, especially related to computer/com-
munications networks, which indicate that fundamental changes in processing modes or methods should not be undertaken until IBM's long range strategy becomes clearer.

- The major exception to this is the accepted movement towards on-line systems using intelligent terminals for data entry and information output.
- Few users have the resources to evaluate the complex options available now and in the immediate future.
- By the time computer/communications utilities are established, most users will be ready to purchase their computer power and let someone else worry about the technology. In the interim period, they should enjoy the most economical processing in the history of the industry.

III. LARGE SCALE
SYSTEMS
PERFORMANCE

III LARGE SCALE SYSTEMS PERFORMANCE

A. MARKET VALUE SHRINKS

- When INPUT projected the demand for large scale IBM mainframes in its report on "Amdahl as a Viable Alternative to IBM", it estimated a cumulative market value for new shipments of \$9.0 billion through 1980. Recent announcements by IBM and Amdahl have had the effect of seriously reducing the value of this market, assuming the same number of shipments, by providing the user with substantial improvements in price-performance of large scale systems.
- The purpose of this chapter is to analyze the impact of these announcements on price-performance and examine IBM's motives for its recent announcements. To do that, it is necessary to obtain some historical perspective on the performance of large scale commercial systems.

B. PROCESSOR PERFORMANCE 1954-1978

- The fact that computers keep getting faster and cheaper seems self-evident to the most inexperienced computer industry observer. However, there has been underlying user frustration because the promised potential of large scale systems seems always to be somewhere in the future. Management sees systems growing

larger, faster than true benefits accrue. We shall first analyze how much processor performance has improved since 1954.

- Exhibit III-1 presents internal performance potential of large commercial processors starting with the IBM 650 as a base of 1. Exhibit III-2 shows the performance ratios of the processors plotted. Although processors are getting faster, other parameters influencing system productivity must be analyzed to understand "real" price-performance available to the user.
- When the Amdahl 470V/7 is delivered in 1978, it will have 10,000 times the power of the 650 which was delivered in 1954. Raw speed for an add instruction has increased by 100,000 times and main memory size has increased one thousand fold.
- Overall performance potential has been improving at a compound rate of approximately 1.47 per year.
- Each "generation" appears to give roughly an order of magnitude improvement over the previous generation.
- With each new generation new markets for computers have been created. Thus, instead of each "new" system replacing ten "old" systems, a proliferation of computers has been taking place. In actual practice, IBM 705s did not replace the equivalent of 10 IBM 650s; this is understandable because new applications were being developed and running IBM 650 programs on an IBM 705 required extensive reprogramming.
- IBM 7074s and 7080s did not replace the equivalent of 10 IBM 705s and this was due to the implementation of new applications, main memory constraints and effective program migration.

EXHIBIT III-1

HISTORICAL PROCESSOR PERFORMANCE 1954-1978
GENERAL PURPOSE SYSTEMS-LARGE SCALE

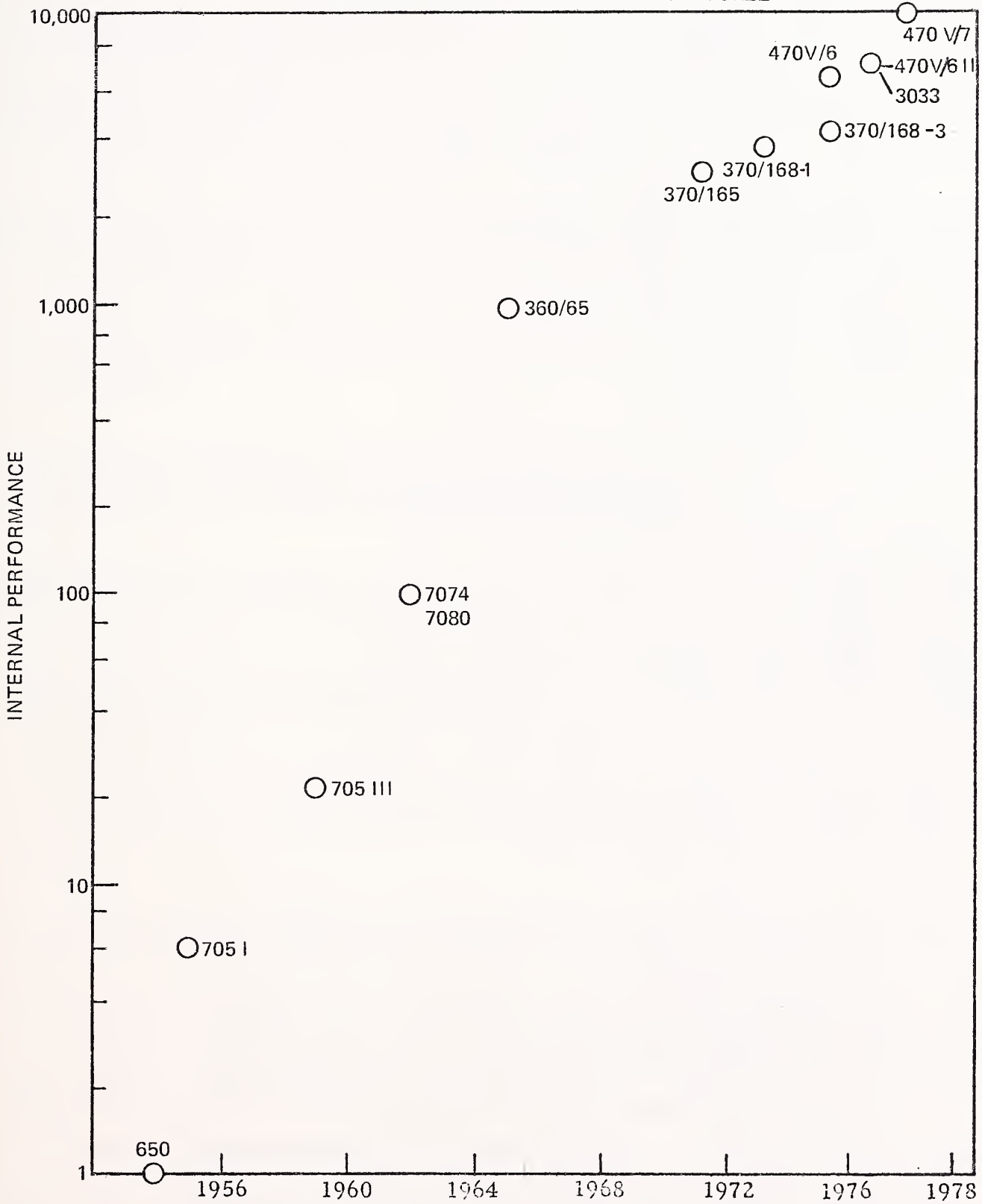


EXHIBIT III-2

LARGE SYSTEM PROCESSOR RATIOS, 1954-1978

PROCESSOR	PROCESSOR												
	705		7074	360/	370/		470		3033	470/ V/7			
	I	III	7080	165	168-1	168-3	V/6	V/6-II					
650	1	6.0	23.0	100.0	2800	3600	4000	6300	6900	6800	10,000		
705I	1	1	3.8	167	467	600	667	1050	1150	1147	1,667		
705III			1	43.5	122	157	174	274	300	299	435		
7074				10.0	28.0	36.0	40.0	63.0	69.0	68.8	100		
7080													
360/ 65				1	2.8	3.6	4.0	6.3	6.9	6.9	10.0		
370/ 165					1	1.3	1.4	2.3	2.5	2.5	3.6		
370/ 168-1						1	1.1	1.8	1.9	1.9	2.8		
370/ 168-3							1	1.6	1.7	1.7	2.5		
470/ V/6								1	1.1	1.1	1.6		
470/ V/6-II									1	1.0	1.5		
3033										1	1.5		

- The 360/65 did not replace the equivalent of 10 IBM 7074s or 7080s based on direct conversion of existing applications. In fact, a 360/65 seldom replaced two such systems and the main reason is the emergence of complex operating systems. This will be analyzed in detail in a later chapter.
- The high end of the 370 line has been successful in replacing systems in proportion to its performance improvement. Thus a single 370/165 or 168 may replace the equivalent of three 360/65s. This is significant and it will also be discussed in a later chapter.

C. POTENTIAL VS ACTUAL PROCESSOR PERFORMANCE

- The IBM 705 was a "data processing machine". It said so on the console. This was done so that it would not be confused with computers which were called Univacs. In many ways, it was designed exclusively for commercial work. Even a modest engineering problem could cause it to run for hours. However, it had more than enough capacity for batch commercial work because peripheral devices were so slow.
- As the IBM 7080 and 7070 series equipment was developed, the problem became clear - commercial work was "I/O bound". It was impossible to get enough data into memory to keep the CPU busy. This condition was caused by small memories (50-100K) and failure to understand contention problems in the early I/O channels. Users put both input and output on the same channel and wondered why the system was slow. Although IBM announced four channels with the 7074, it didn't really understand how to support them under its input/output control system.

- Regardless of what caused the I/O bound problem, IBM decided that improved operating systems software would provide the "solution". If one commercial program couldn't keep the CPU busy maybe two could, or three, or four concurrent programs could. With the advent of operating systems, the world of computing would never be the same. After the introduction of operating systems, user management and computer architects began to wonder where all the potential processing power was disappearing. This provides part of the answer why the 360/65 never replaced more than 2 large scale equivalent 2nd generation systems.
- In 1963, IBM surveyed its 275 domestic large scale commercial users (7080, 7070 series) on the important features of systems software support. (As a matter of interest, based only on internal processing and memory size, those 275 large scale commercial systems could be replaced by three Amdahl 470V/7s.) At that time fewer than 5% of commercial programs were written in Cobol.
- Users were asked to rank important features of software systems. "Ease of use" was the unanimous choice as the most important software characteristic on all system components (compilers, operating system, RPG, etc.) except for sorting, where speed of operation was deemed most important.
- With "ease of use" as the primary design criterion, OS/360 was developed. Whether or not this objective was met is left to the judgment of the reader and experience of the user.
- Since that time, however, all processor times must be adjusted to reflect the burden of systems software. Exhibit III-3 shows processor performance adjusted for systems overhead. Exhibit III-4 shows the values used in those adjustments.

EXHIBIT III-3

HISTORICAL PROCESSOR PERFORMANCE 1954-1978
 ADJUSTED FOR PROGRAMMING SYSTEMS OVERHEAD

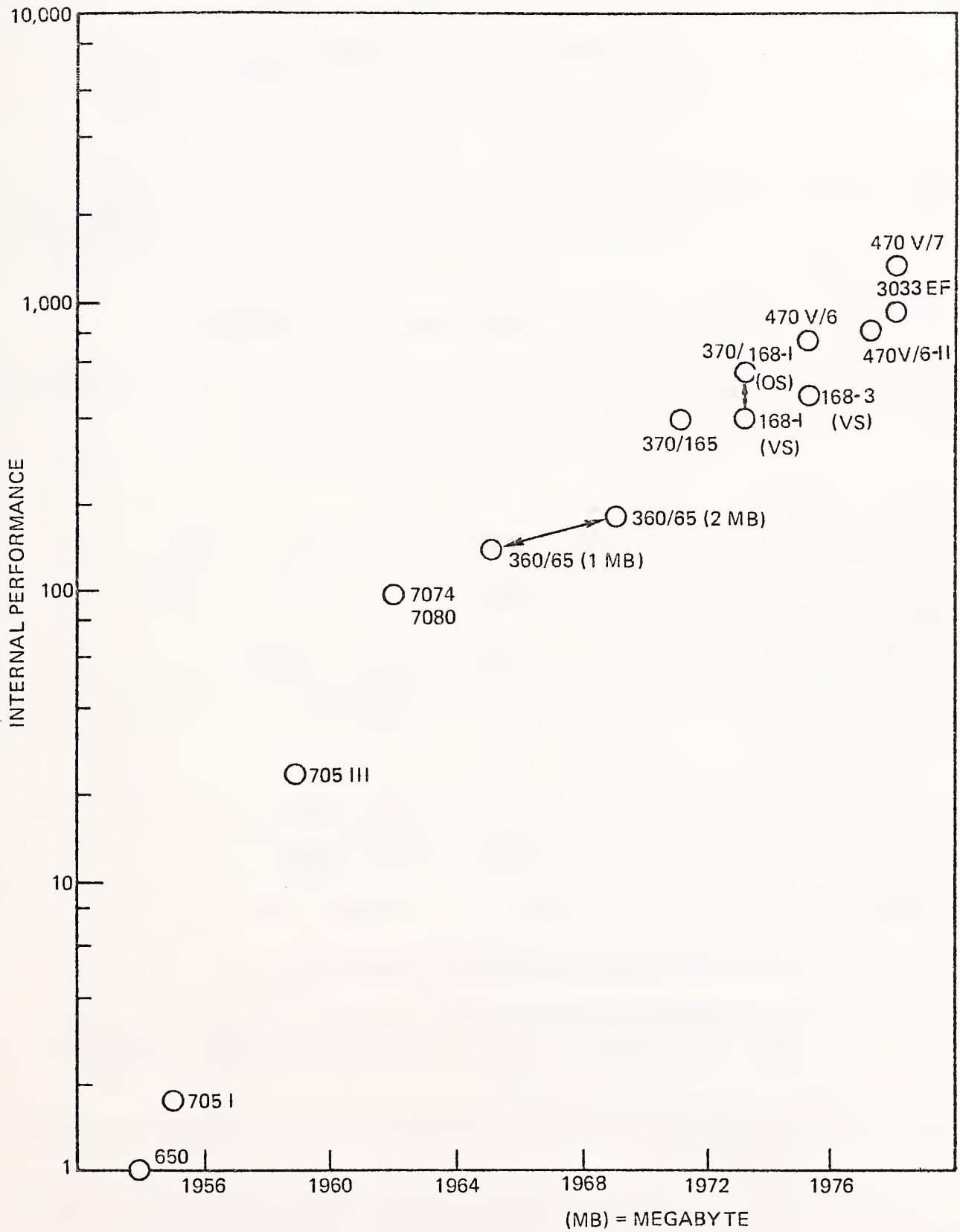


EXHIBIT III-4

RATING FACTORS USED IN ADJUSTING
SELECTED PROCESSOR PERFORMANCE

	360/65	370/165	370/168-1
RATED POWER ¹	1000	2800	3600
MINUS OS OVERHEAD	500(50%)	1680 (60%)	--
MINUS VS OVERHEAD			2520(70%)
MINUS LANGUAGE OVERHEAD ² (60%)	500 300	1120 672	1080 648
MINUS EMULATION DEGRADATION ³	200 20(10%)	448 45(5%)	432 --
MINUS MEMORY CONSTRAINTS ⁴	180 54	403 --	432 --
EFFECTIVE RATING	126	403	432

NOTE:

1. THE POWER RATING PLOTTED ON EXHIBIT III-1
2. CONSERVATIVE ESTIMATE THAT HIGH LEVEL LANGUAGES GENERATE CODE WHICH RUNS 2-4 TIMES AS LONG AS ASSEMBLY LANGUAGE FOR COMPARABLE PROBLEMS.
3. ESTIMATED PERCENT OF EVALUATION (OR OTHER CONVERSION AIDS') DEGRADATION.
4. THE 360/65 WAS ANNOUNCED WITH A MAXIMUM MEMORY OF 1 MEGABYTE WHICH WAS NOT SUFFICIENT TO PERMIT FULL UTILIZATION OF THE CPU UNDER OS. IT IS ALSO PLOTTED WITH 2 MEGABYTES OF MEMORY, PERMITTING IMPROVED PERFORMANCE.

- Additional observations concerning the information on Exhibit III-3:
 - All systems on Exhibit III-3 are adjusted by the same factors as applied to the 370/168. It appears that systems are currently running at approximately 12% of the potential due to software overhead and object code inefficiency.
 - There is one exception to this. The 3033 had its potential rating adjusted because of the Extended Facility. The ramifications of this facility will be discussed in more detail later.
 - The 360/65 never achieved its potential because of arbitrary memory constraints and software limitations. At most, it was capable of replacing two large scale 2nd generation systems, even though its theoretical potential was much higher.
 - A real performance breakthrough came with the 370/165 which, while only 2.8 times the 360/65 in potential, actually achieved more by having sufficient memory and stable software. The 370/165 could replace at least three 360/65 equivalents when combined with reasonably efficient remote job entry software (OS/MVT HASP).
 - Increased performance of the 370/168 over the 370/165 was effectively absorbed by the additional software burden of VS.
 - Operating systems software has evolved to the point where commercial systems are now CPU bound forcing migration to larger scale systems. This is especially noticeable in "mixed environments" which include batch work and interactive systems.
 - There exists a substantial spread between "potential" internal hardware performance and that achieved under today's systems software burden. While it may not be possible to operate at 100% of potential, considerable

- performance improvement is possible by eliminating software overhead. The range of improvement possible is represented between the performance plotted on Exhibit III-3 and that plotted on Exhibit III-1.
- The spread between potential and real systems performance is too significant to be ignored and will probably receive increased attention by users and manufacturers alike.
- The 3033 hardware and Extended Facility announcement takes a step in that direction. This causes some difficulty in keeping hardware performance numbers pure, but must be taken into consideration in comparing effective processor performance. Therefore, the 3033 is plotted on hardware performance alone on Exhibit III-1 and with Extended Facility on Exhibit III-3.
- When the 470V/6 was announced, direct performance comparisons could be made with IBM systems because such comparisons were independent of the operating system being used. These comparisons were easily understood and difficult to refute.
- As the line between hardware and software performance becomes less clear, direct comparisons will be more difficult to make.
- While it is not contended that operating systems do not do useful work, it is a fact that most large scale users have little control over the way their processor is being used.

D. PROCESSOR PRICE-PERFORMANCE 1954-1978

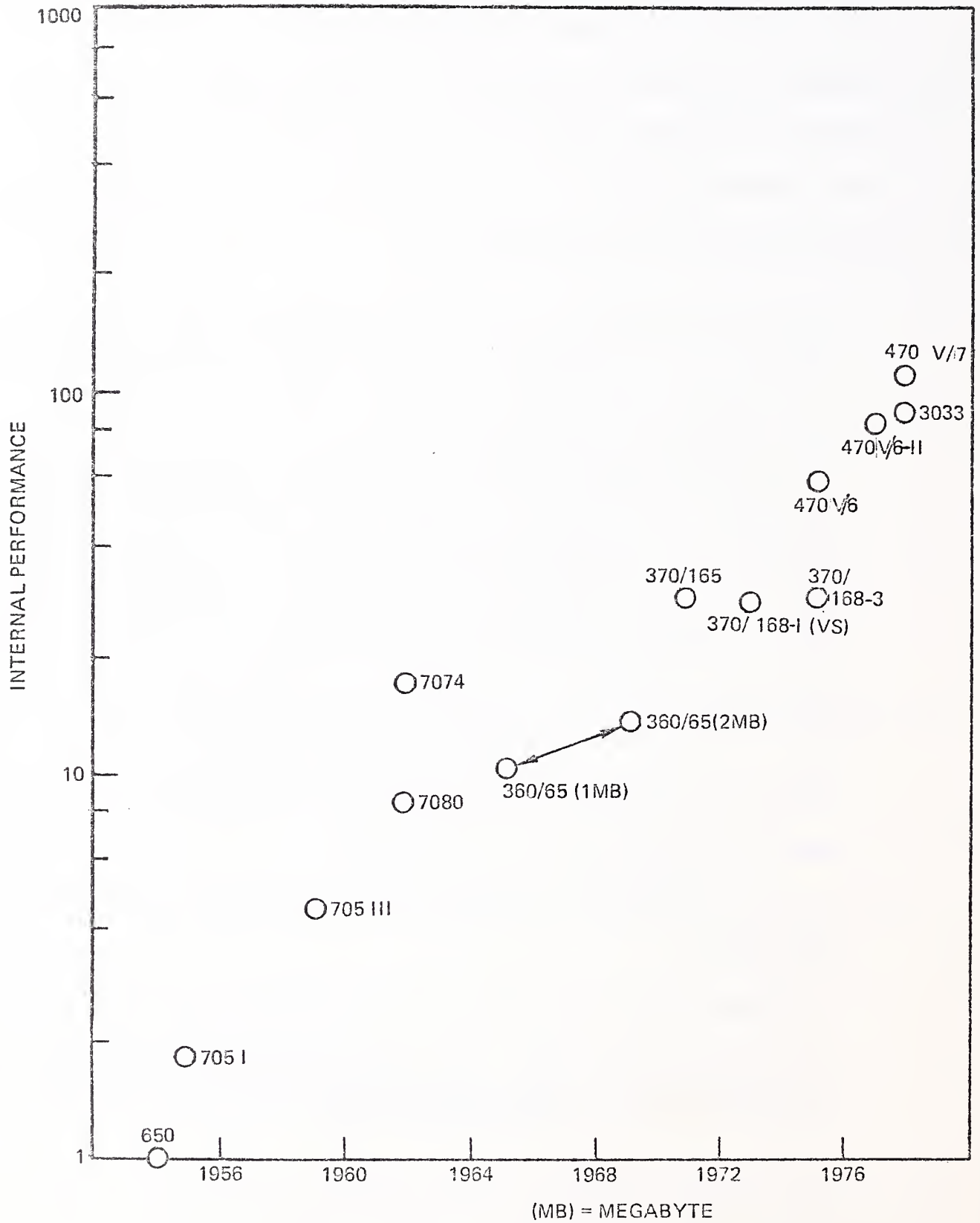
- Processor performance means little to the user without relating it to cost. Even adjusted for software overhead, processor performance has increased 1000 times

in less than twenty-five years. The record from a price-performance point of view is not nearly so impressive, but sufficient improvement has been made to justify the general feeling that computing power still represents a bargain compared to most other expenses such as personnel costs. A cynic may add, however, that processor performance ultimately depends a great deal on how this power is applied. Exhibit III-5 plots price-performance on an historical basis, with prices shown at time of introduction.

- Price-performance from 1954 to 1972 tripled about every six years. It is almost as if someone planned it that way. What cost \$100 on the 650 costs approximately \$3.7 on the 370/165-168. 20%/yr
- The IBM 7074 appears to be out of line with normal price-performance improvement. It was the top of the IBM 7070 line and provided the performance of the IBM 7080 at about half the cost. While this may seem odd, the IBM 7074 was aimed at the RCA 601 which was designed to give similar price-performance in relationship to the IBM 7080. Rather than cut prices on the 7080, IBM targetted the 7074 against the RCA 601. Price cutting on existing equipment has not been IBM's historical reaction to competition in processor price-performance.
- The 370/165, 370/168-1, and 370/168-3 are all roughly equivalent in price-performance.
- The Amdahl 470V/6 effectively enabled IBM users to double the price-performance of the 370 line. Some user management are sensitive to such savings, which accounts for Amdahl's success.

EXHIBIT III-5

LARGE SYSTEM PROCESSOR PRICE-PERFORMANCE, 1954-1978

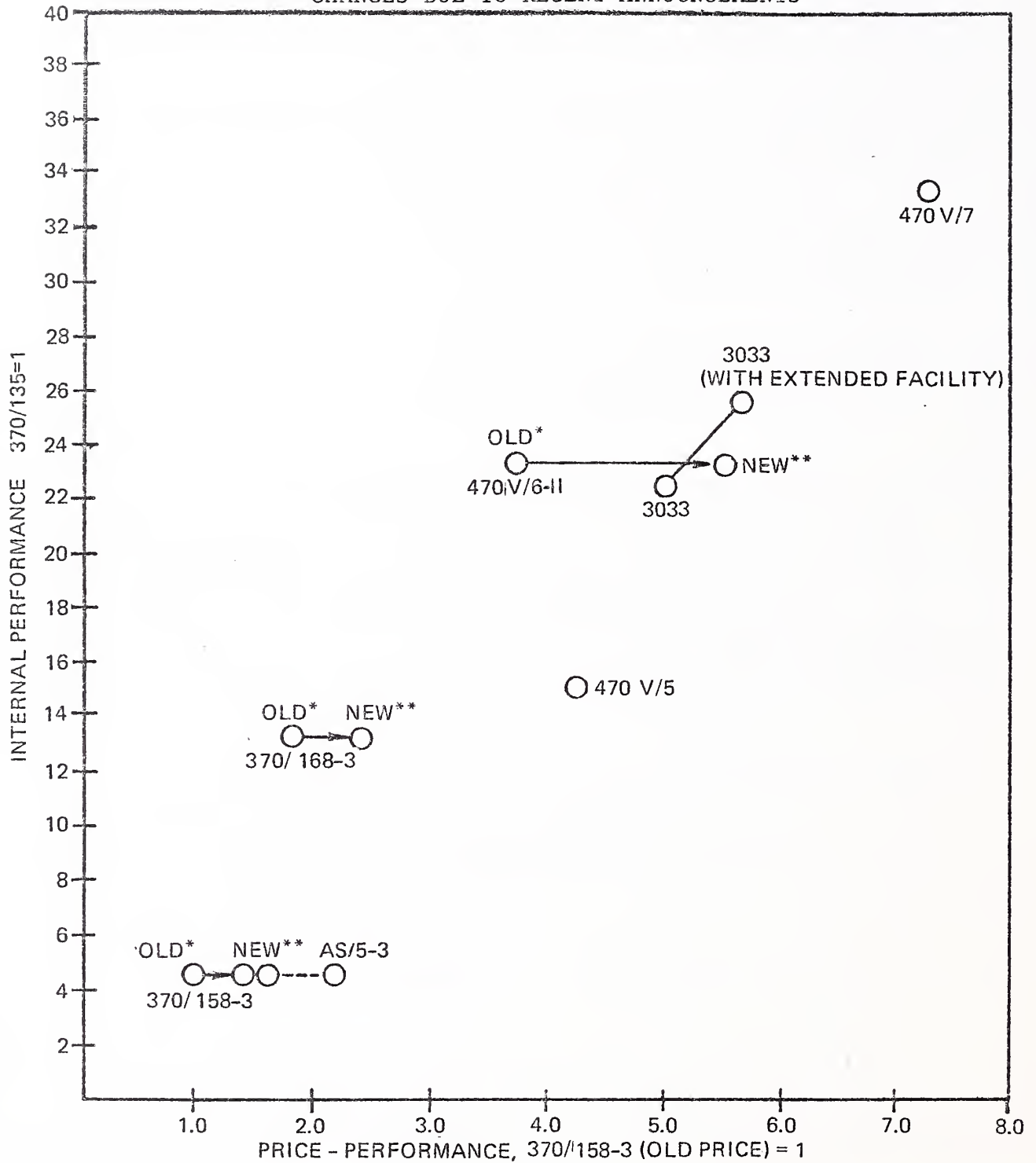


- IBM is also sensitive to such obvious price-performance advantages on the part of competition and the announcement of the 3033 was a response to this competitive threat.
- The announcement of the Amdahl 470V/7 has put the ball back in IBM's court and has produced a quadrupling of price-performance in a little over six years. This is much better than the price-performance improvements experienced in the past.

E. THE CURRENT COMPETITIVE ENVIRONMENT

- Exhibit III-6 plots internal performance and price-performance for large scale systems before and after the recent announcements. Internal performance is based on the 370/135, and price-performance is based on the 370/158-3 prior to the announced reductions in price. Exhibit III-7 presents the price-performance ratios for the processors plotted.
- An analysis of Exhibit III-6 demonstrates that the target of the 3033 announcement was the Amdahl 470V/6 price/performance slot. The new IBM processor has roughly the same performance as the 470V/6. With the Extended Facility, however, the 3033 has a clear performance advantage.
- With the reduced price of the 3033 IBM had a clear price-performance advantage over the Amdahl 470V/6. Thus it seems the 3033 was brought in to do the job the 370/168AP had failed to do: stem Amdahl's inroads into the IBM customer base.
- The IBM price-performance advantage lasted for only three days until Amdahl announced two new products and a price reduction on the 470V/6-II.

EXHIBIT III-6
 LARGE SCALE UNIPROCESSOR PRICE-PERFORMANCE
 CHANGES DUE TO RECENT ANNOUNCEMENTS



*OLD PRIOR TO IBM & AMDAHL ANNOUNCEMENTS - 3/77
 **NEW AFTER IBM & AMDAHL ANNOUNCEMENTS - 3/77

EXHIBIT III-7

CURRENT PRICE-PERFORMANCE RATIOS FOR LARGE SCALE UNIPROCESSORS

370/158-3		370/168-3		470 V/5	3033	470 V/6-II		3033	470 V/7
OLD	NEW	OLD	NEW	NEW		OLD	NEW		
1	1.4	1.8	2.3	4.3	5.0	3.8	5.4	5.6	7.4
	1	1.3	1.6	3.1	3.6	2.7	3.9	4.0	5.3
		1	1.3	2.3	2.8	2.1	2.9	3.1	4.0
			1	1.8	2.2	1.6	2.2	2.4	3.2
				1	1.2	.9	1.2	1.3	1.7
					1	.7	1.0	1.1	1.5
						1	1.4	1.5	2.0
							1	1.0	1.4
								1	1.3

"OLD" REPRESENTS RATIO AT PRE 3/77 ANNOUNCEMENT PRICES.

"NEW" REPRESENTS RATIO AT POST 3/77 ANNOUNCEMENT PRICES.

- The big question still remains, however - why did IBM drop prices so drastically since IBM has never felt the necessity for having a clear price-performance advantage in the past? Perhaps it was done in anticipation of Amdahl's response, but there may be more subtle implications. Price-performance five times the 370/158 has ramifications for minicomputer manufacturers as well. Interdata recently advertised: "Interdata's 8/32 Computer Processes Data at One-Half the Speed of the IBM 370/158, for About One-Tenth the Cost". This works out to be precisely five times the price-performance of the 370/158.
- Regardless of the cause, the announcement of the 3033 changed the economics of large scale data processing. Thus, even with the recent price reductions, on a price-performance curve, the 370/168 and 370/158 are no longer competitive with the new systems. An IBM spokesman reportedly made the statement that both the 3033 and the 370/168 are in the IBM product line and the choice was up to the user. Based on price-performance alone, there will be no choice in the future. Both the 370/168 and 370/158 have effectively been obsoleted.
- The 370/158 price adjustment had the additional advantage of making the processor competitive with the Intel AS5-3 which is equal in performance to the 370/158-3 and was being marketed at 65% of the IBM price.
- The Amdahl response to the IBM announcement should receive an award for the fastest major business decision of 1977. Most companies couldn't get the memos out to arrange a meeting to analyze the situation much less announce two new computers and reduce prices on another product - all over a weekend.
- By its rapid response to the long rumored IBM announcement, Amdahl not only gave the impression it knew what it was doing, it also gave the impression it knew

what IBM was going to do. The price adjustment on the 470V/6-II will provide early delivery, by 9/77, of systems which will have competitive price-performance with the 3033 while the 470V/7 will still provide significant price-performance advantages over the 3033 (even with the Extended Facility).

- It should be noted that the 0.3 price-performance difference between the top of the line Amdahl processor (470V/7) and the top of the line IBM processor (3033) is equivalent in computing power to two 370/158s.
- The 470V/5 on the other hand, offers a high price-performance alternative with growth potential to the 470V/6-II for 370/158 and 168 users who do not need the power of the 3033-470V/6 class of processors.
- Itel is primarily a financial services company. It prefers not to quote prices on processors only but to make bids on total systems involving not only plug compatible processors, but also plug compatible peripherals. This business strategy allows individual bids tailored to individual customer requirements and allows Itel a maximum of flexibility.
- Itel management has indicated that prices have been approximately 65% of IBM's. This gave them a 1.5 price-performance advantage. If Itel is to maintain this advantage against the new 158 prices, it would mean that an AS5-3 with 2M bytes of main memory and 5 channels would have to sell for approximately \$1,000,000.

F. THE NEW PRICE-PERFORMANCE ECONOMICS

- It was noted in the previous discussion that price-performance improvements since the announcement of the 370 line have been better than the previous historical

trend. The way in which this improvement was achieved is even more significant. Until the announcement of the 3033, IBM had never announced a compatible processor with substantially greater power for less money. The range of processor costs have always been extended upwards as performance improved. It is now evident that a lower price level has been established on uniprocessors. The effect is to compress prices within the overall range of processors and to make a confused competitive situation. The pricing umbrella has been lowered!

- The lowering of prices at the high end puts additional pressure on the concept of "stepping stone" systems. We predicted a year ago in our report on "Economics of Computer/Communications Networks and their Future Impact" that there would be little justification for medium scale standalone systems. Recent developments, by putting a squeeze on the medium priced systems, reinforce the previously stated forecast.
- For purposes of analysis it may be convenient to think of large scale systems in terms of their "replacement ratios" of smaller systems. Exhibit III-8 shows the number of smaller scale systems which can theroretically be replaced by each recently announced system. Since the larger processors can obviously replace the smaller processors, the smaller processors' prices must be reduced in order to be justified as alternatives. In the System/370 product line there is now an obvious imbalance between the price-performance of the medium and the very large systems.
- Exhibit III-9 shows what current systems would have to cost in order to be cost justified. The impact on the current concept of medium scale standalone systems is large. In fact, the table demonstrates that the current System/370 line is

EXHIBIT III-8

REPLACEMENT RATIOS OF NEW, LARGE SYSTEMS TO SMALLER SYSTEMS

REPLACING SYSTEM	NUMBER OF SYSTEMS REPLACED										
	470 V/6	SYSTEM/370									135
		168-3	168-1	165	158-3	158	155	148	145	138	
470 V/7	1.6	2.6	2.8	3.6	7.4	8.1	9.7	15.4	21.2	25.5	33.9
3033	1.1	1.7	1.9	2.4	4.9	5.3	6.4	10.2	14.0	16.8	22.4
470 V/6-II	1.1	1.7	1.9	2.5	5.1	5.5	6.7	10.6	14.6	17.5	23.3
470 V/5	-	1.1	1.2	1.6	3.3	3.6	4.3	6.9	9.4	11.4	15.1

EXHIBIT III-9

PRICING REQUIRED FOR SMALLER SYSTEMS TO BE COMPETITIVE
WITH THE NEW LARGE SYSTEMS IN PRICE-PERFORMANCE

LARGE SYSTEM	REQUIRED PRICE (\$000)										
	470 V/6	168-3	168-1	165	158-3	158	155	148	145	138	135
470 V/7	2,175	1,338	1,243	967	470	430	359	226	164	136	103
3033	3,073	1,988	1,779	1,408	690	638	528	331	241	201	151
470 V/6-II	2,982	1,929	1,726	1,312	643	596	490	309	225	187	141
470 V/5	—	2,409	2,208	1,656	803	736	616	384	282	232	175

obsolete which does not bode well for the used computer market. The question, however, of whether such replacements are really possible will be addressed in Chapter V.

G. MARKETING CONSIDERATIONS

- IBM's market power, market coverage and financial strength are well known.
- Amdahl's total sales force consists of 15 salesmen in the U.S. plus a few in Europe and Canada. It is a very small sales force concentrating on a selected, narrow segment of the market.
- Amdahl's marketing management is not planning to increase the size of the sales force despite the fact that the 470 V/5 is capable of reaching down to the 370/155 and the 370/158 replacement level which adds almost 3,000 more mainframes as potential replacement targets.
- Itel is the interesting element in the market. Until the announcement of the AS 5, Itel was a leasing company which had obtained:
 - Over 50% of the independent disk drive market
 - 35% of the independent IBM System/370 add-on memory market
 - Over \$1 billion in IBM System/370 full payout leases
- Itel has 100 marketing representatives familiar with IBM installations (mostly former IBM salesmen), 635 field engineers (560 U.S. based), 45 sales offices, and 120 service locations.

- All Itel contracts are non-recourse, full payout leases which gives the company a clean balance sheet and minimizes its risks.
- Itel's OEM contracts appear very favorable. For example, it purchases 3330-type disk drives from ISS at \$8K to \$10K, depending on features. Even though Itel is unwilling to disclose its agreement with National Semiconductor, a similar ratio may be presumed leaving Itel with enough room to adjust prices on the AS/5 and still make a reasonable profit.
- According to Itel management, the AS/5 is aimed at the markets shown in Exhibit III-10.
- In fact, the focus is narrower and is centered on the 370/145, 155 and 158 models, which have a combined installed base of about 6,000 systems.
- Itel's original contract called for 30 systems. Production has been sold out until year end 1977, giving Itel exclusive distribution until the 1979-1980 time-frame by virtue of orders signed to date.
- Competition from the Japanese firms is going to be discussed in a separate chapter since we believe that ultimately, in the 1980s and beyond, they may be the source of the most serious challenge to IBM's dominance of the computer industry.

EXHIBIT III-10

TARGET MARKET FOR ITEL AS 5

IBM MODEL	WORLDWIDE INSTALLED BASE
360/50	960
360/65	650
370/135	4,060
370/145	3,525
370/155	1,055
370/158	1,750
TOTAL (APPROX.)	12,000
TOTAL (U.S. & CANADA)	7,500

(NUMBER OF SYSTEMS)

IV. TECHNICAL
ASSESSMENT
OF THE
ANNOUNCED
PRODUCTS

IV TECHNICAL ASSESSMENT OF THE ANNOUNCED PRODUCTS

A. THE IBM 3033 PROCESSOR

- The 3033 is not a new system irrespective of IBM's change in nomenclature. In fact, the nomenclature appears to be causing as much speculation as the processor itself. What is important to this report, however, is to provide a measure of analytical perspective between the IBM 3033 and the Amdahl 470 V/7.
- At the time of the 3033 announcement, IBM stated a performance improvement between 1.6 and 1.8 times the 370/168-3 under MVS Release 3, the low side (1.6) representing a scientific job mix and the high side (1.8) reflecting a commercial and/or interactive mix. INPUT will use an average of 1.7 in its overall price/performance calculations.
- The performance improvement will probably be achieved as follows:

- Improved cycle time 80NS to 58NS	38%
- 64K high speed buffer	10%
- Improved storage interface	10%
- Instruction and microcode enhancements	<u>10%</u>
- Total improvement	68%

- The total improvement figure approaches the center of the range and variations can be explained by a smaller improvement from the high speed buffer in a scientific environment, and heavier use of SS instructions in a commercial environment.
- The 3033 CPU does not represent the application of new technology but rather the repackaging and optimization of that used in the 370/168. While improved density of "44 circuit sides per chip" has been reported, it seems doubtful that this has been achieved except in specialized portions of the processor.
- The power, space, and cooling requirements have been reduced but chilled water is still required.
- The 3033 is microprogrammed, permitting flexibility in modifying the instruction set for diverse operating environments which tends to improve the high speed buffer hit ratio. It should also be noted that the 3036 console and 3037 power and coolant distribution unit are priced separately at \$150,000 and \$160,000 respectively.
- Cost of main memory continues to decline, but technology remains unchanged. The memory on the 3033 is still the MOSFET chip, first introduced in 1971-1972. It is economical for IBM to produce this memory and it has been able to compete with more advanced technology by lowering prices.
- In May 1976, the memory purchase price was reduced from \$263,000 to \$170,000 per megabyte on 370/158 and 168 memories and in March 1977 the price went to \$112,500 on the 3033 (\$225,000 per 2 megabyte increment). This represents substantial price-performance improvement by cutting prices on old technology. Presently up to 8 megabytes are available on the 3033.

- Channels on the 3033 represent an approach we may see more of in the future. They can be thought of as bolting two 370/158's onto the 3033 and using special microcode to provide two "integrated" channel groups. Each group consists of a byte multiplexor channel which operates at 40-75 KB per second and five block multiplexor channels capable of 1.5 megabyte-per-second data transfer rate. An optional channel group consisting of either four block multiplexors or one byte multiplexor and three block multiplexors is available for \$320,000. Channel-to-channel adapters are available at \$15,000 and the two byte interface at \$1,400 purchase.

B. IMPROVING PROCESSOR EFFICIENCY THROUGH FIRMWARE

- Perhaps the most important portion of the IBM announcement is the Extended Facility and the MVS Systems Extensions program product which provides additional performance benefits to MVS users. The projected improvement is 14% in throughput and a 20% reduction in control program execution time in "certain uniprocessor environments".
- The Extended Facility incorporated in the 3033 processor and the MVS Systems Extensions are available for \$1,200 per month. These options are a price-performance bargain. For \$1,250 per month the user gets the equivalent of 3.2 I35s (assuming throughput is roughly equivalent to internal performance). To obtain this improvement the assumption is made that MVS has already made the installation CPU bound.
- In its latest announcement, IBM has used hardware, firmware, and software to improve processor throughput. From now on the hardware, firmware, and

software must all be considered to obtain an accurate measurement of system performance.

- IBM also indicated that it expected improvement in throughput for AP and MP installations to be even greater when the Extended Facility feature and program product are applied to the 370/158 and 168. Although the 3033 is strictly a uniprocessor at this time similar improvements are likely in AP and MP configurations.
- IBM, it seems, would like all users to migrate to VS and more specifically MVS; it is offering strong incentives to do so. The recalcitrant OS users have been warned - the wave of the future is soon going to leave them stranded on the beach.
- VM system extensions are made available on all 370 models from the 370/135 up for a fee of \$1,200 per month but IBM does not estimate throughput improvements. This is understandable because of the wide variety of complex operating environments which are possible.
- At present, compatibility features with other IBM mainframes are not available on the 3033, or on the 370/158 and 168, if the Extended Facility feature is installed. IBM probably concluded that those users who haven't converted after 12 years probably aren't too interested in performance at this stage.

C. THE AMDAHL 470 V/7 AND V/5

- In the Amdahl announcement the performance ratios of the 470 V/7 and V/5 were referenced to different bases. The V/7 was based on the 470 V/6 and the 470 V/5 on the 470 V/6-11. Using the V/6 as a common base of 1, this provides the following announced performance characteristics:

Amdahl Processor Performance Characteristics

470V/5	470V/6	470V/6-11	470V/7
0.66-0.77	1.0	1.1	1.5-1.7

- The performance improvement of the 470V/7 over the 470V/6 was achieved as follows:

- Enlarged high speed buffer 16-32K 10%
(previously announced for V/611)
- Instruction improvement 17-35%
- Additional storage unit enhancements 6%
- Improved cycle time 12%
- Total improvement (approx.) 60%

This is within the announced performance improvement range, and as with the 3033, the high end will be approached by a commercial job mix because of improvements to SS instructions.

- The Amdahl 470 incorporates air-cooled LSI technology throughout the CPU and channels. Density of integration ranges from 75 to 100 circuits per chip. The system is hardwired and there are no current plans to change this. The

470 V/5 can be upgraded to the 470 V/6-11 for \$780,000 and 470 V/6 systems can be upgraded to the V/6-11 for \$100,000.

- Compared to IBM, the Amdahl 470 prices include the console and power distribution unit.
- Up to 16 megabytes of main memory is available on the 470 V/7 and up to 6 megabytes is available on the 470 V/5. Amdahl continues to match IBM memory prices with additional modules available at \$220,000 per 2 megabyte increment.
- The 470 V/6 includes 12 integrated channels which can be used in any combination of byte multiplexor, block multiplexor or selector channel. Data transfer rates are quoted as being 110 KB as a byte multiplexor and 2 megabytes operating as either a block multiplexor or a selector channel operating in burst mode. Four additional channels are available for \$150,000 with channel-to-channel costing \$32,500 and the two byte interface selling for \$1,400.
- Amdahl is dependent on IBM software; being vulnerable, it is sensitive to changes in this area. The provision of improved performance through the combined use of the System/370 Extended Facility and MVS/System Extensions program product has not been addressed in the Amdahl announcement. To maintain true compatibility, Amdahl must be able to run IBM program products and achieve comparable results.
- Amdahl indicates that it will continue to support MVT in addition to MVS, VS, and VM on the 470 V/7. This may be of some significance to the remaining OS users and may even prompt additional sales.

V. USER REACTIONS
TO THE RECENT
ANNOUNCEMENTS

V USER REACTIONS TO THE RECENT ANNOUNCEMENTS

- INPUT surveyed 42 users to determine the effect of the announcements on their installations and plans.

- The survey was organized as follows:

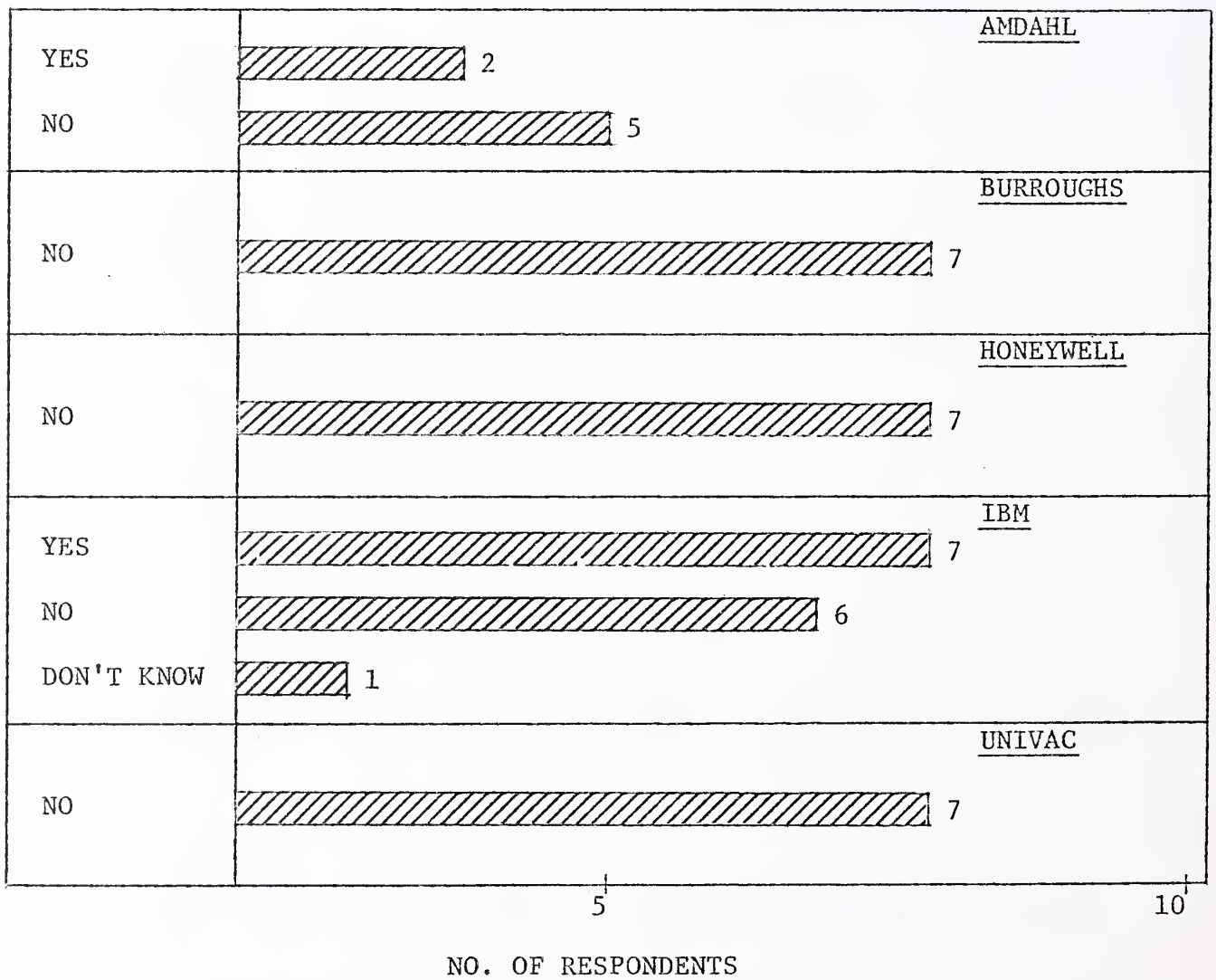
- Amdahl	7 users
- Burroughs	7 users of large systems
- Honeywell	7 users of large systems
- IBM	7 users of large systems
- IBM	7 users of medium systems
- Univac	7 users of large systems
Total	<u>42</u>

A. IBM IS THE VENDOR MOST AFFECTED BY THE ANNOUNCEMENTS

- As shown in Exhibit V-1 none of the Burroughs, Honeywell or Univac users surveyed has changed their installation plans as a result of the announcements.
- However, 2 out of 7 Amdahl users and half the IBM users have changed their installation plans.

EXHIBIT V-1

IMPACT OF THE IBM ANNOUNCEMENT ON
 INSTALLATION PLANS
 RESPONSES TO THE QUESTION 'HAS THE IBM ANNOUNCEMENT
 CHANGED ANY OF YOUR INSTALLATION PLANS?'



- The two Amdahl users have reacted as follows:
 - placed letters of intent for an Amdahl 470/V/5 and a V/7 as well as an IBM 370/148 and 3033, final selection will be made later
 - placed an order for a 3033 and a 470 V/7: also deciding between an 8 Megabyte (MB) 370/168 and a 6 MB 470 V/6

- Responses of IBM users changing their plans were:
 - "too early to tell; probably have to do something" (2 MB 370/158 user)
 - was planning to replace his 370/158 with a "Honeywell Multics" system; found his 370/158 suddenly drop in value by \$500K-less than happy with the instant "loss"
 - had been waiting for the announcements and is now going to decide between IBM and Amdahl
 - re-evaluating commitments to see "how flexible they are" to take advantage of the new announcements
 - sent a letter of intent for "half-a-dozen" 3033s
 - considering switching an order from a 370/148 to a 370/158 "to take advantage of the price reduction"
 - ordered 2 3033s and would have placed a 370/168 order if the 3033 had not been announced
 - considering getting a smaller, less expensive processor with a larger memory

- Amdahl users are protecting themselves and are placing letters of intent for next year for both the new IBM and the new Amdahl processors. This reflects

a continuing healthy respect for IBM's ability to pull a surprise out of one of its many R&D facilities.

- IBM users are simply attempting to take advantage of the improved price-performance available. The larger users are reacting first, as would be expected.

B. USERS' EVALUATIONS OF IBM'S ANNOUNCEMENTS

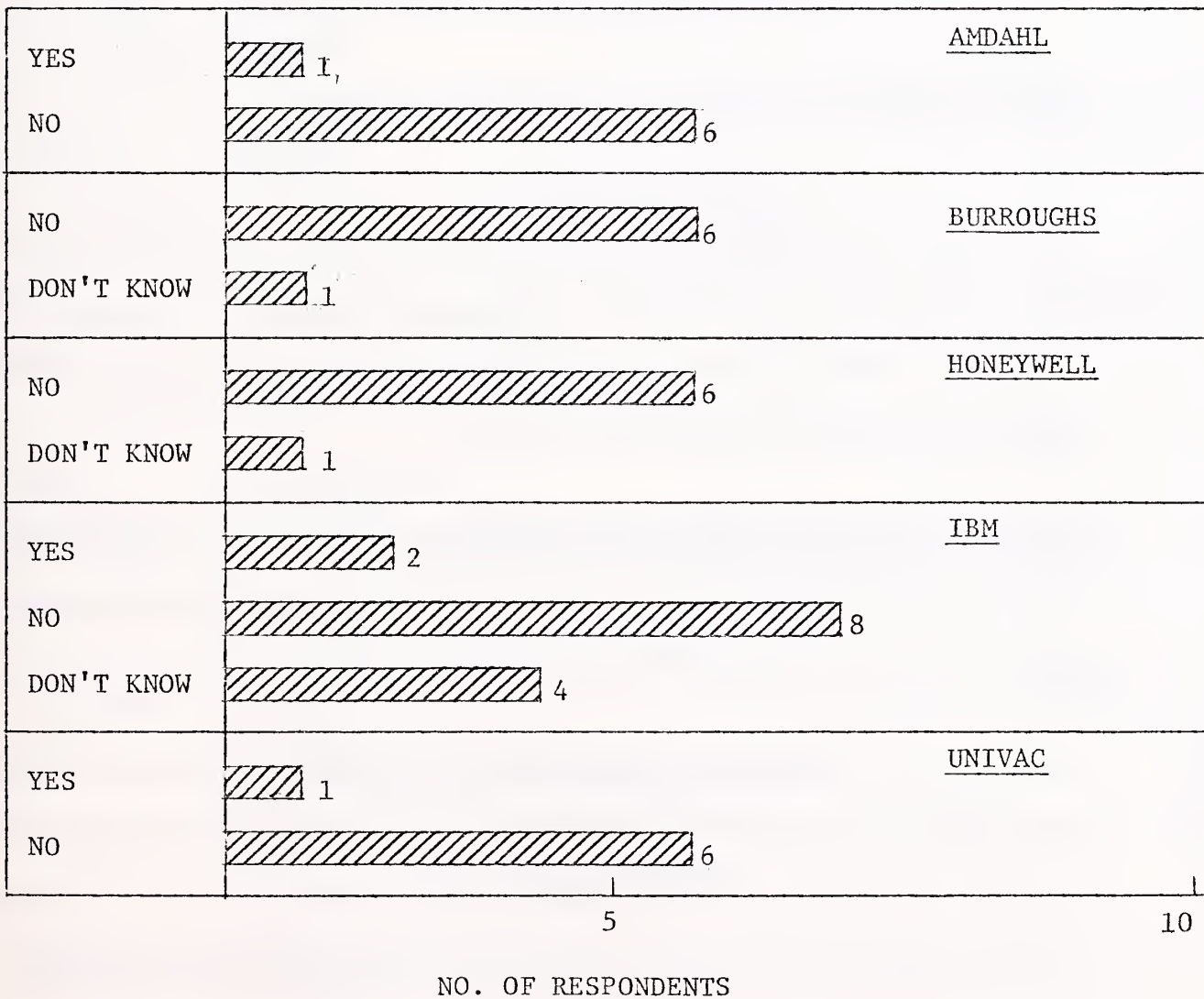
- As shown in Exhibit V-2, only 4 of the 36 respondents who were aware of the announcement considered the 3033 a major breakthrough.
- There were 6 Burroughs, Honeywell, or Univac users who were not aware of the announcement at the time of the interview.
- Over 50% of the respondents considered that the price-performance improvement was directly aimed at Amdahl, while another 23% felt that 'someone' had forced them (IBM) to act.
- Other relevant comments obtained were:
 - "Long overdue" (23% of respondents)
 - "Firmware the most important part of the announcement" (10% of respondents)
 - "Dumping equipment to come out with new line"
 - "IBM still very expensive despite price reductions"
 - "IBM is no longer afraid of 'antitrust case' "
 - "Marketing ploy"
 - "IBM will be less profitable"

EXHIBIT V-2

RESPONDENTS' EVALUATION OF THE 3033

RESPONSES TO THE QUESTION:

"DO YOU THINK THE 3033 IS A MAJOR BREAKTHROUGH?"



- "More aggressive than expected"
- "Caused by minicomputer price/performance"
- Exhibit V-3 demonstrates that Amdahl users were most aware of the performance differences between the 370/168-3 and the 3033. Univac and Burroughs users were the least concerned and knowledgeable in this area.
- Only 2 out of the 42 respondents were unfamiliar with IBM's price reduction on the 370/168.

C. USERS' AWARENESS OF AMDAHL AND ITEL SYSTEMS

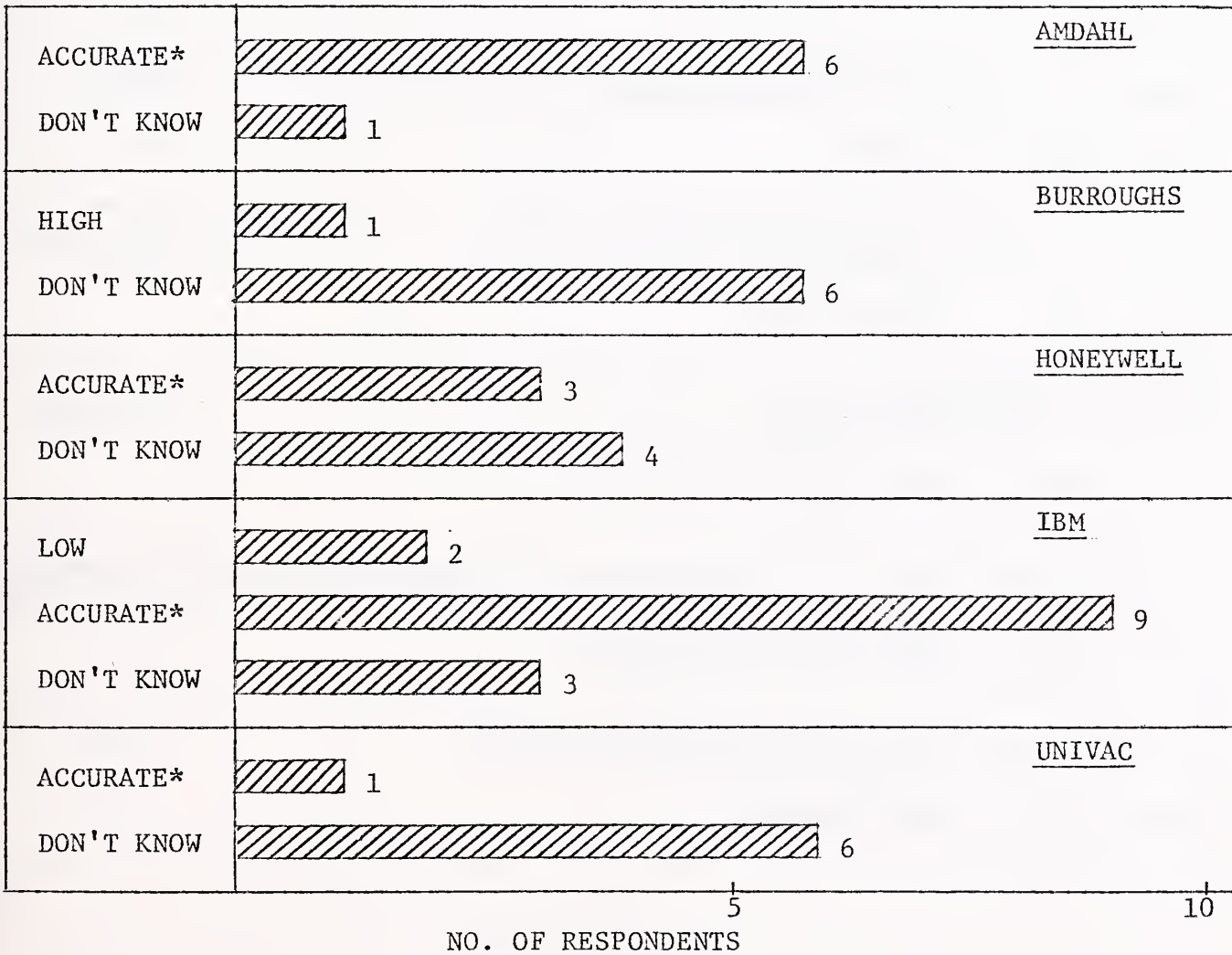
- With respect to Amdahl's activities, one each of the Burroughs, IBM, and Univac, and two of the Honeywell users were unfamiliar with the 470 V/6. Further two Burroughs and two Honeywell users were unfamiliar with the recently announced 470 V/5 and V/7 models.
- In price-performance, 70% of the respondents (including 10 out of 14 IBM users) rated Amdahl as having better price-performance than the equivalent IBM mainframes; the rest 'didn't know' as shown in Exhibit V-4.
- Compared with Amdahl, Itel has achieved far less awareness of its price comparability; 26 out of the 42 respondents could not compare the price of the Itel AS5 with the equivalent 370/158. On the other hand, 26 out of 42 reported that the Amdahl systems were priced less than the equivalent IBM systems.
- What is more significant for Itel is that 6 out of 14 IBM users could not compare Itel's prices with IBM's.

EXHIBIT V-3

RESPONDENTS' AWARENESS OF 3033 PERFORMANCE

RESPONSES TO THE QUESTION:

"WHAT IS THE PERFORMANCE INCREASE OF THE 3033 OVER THE 168-3?"



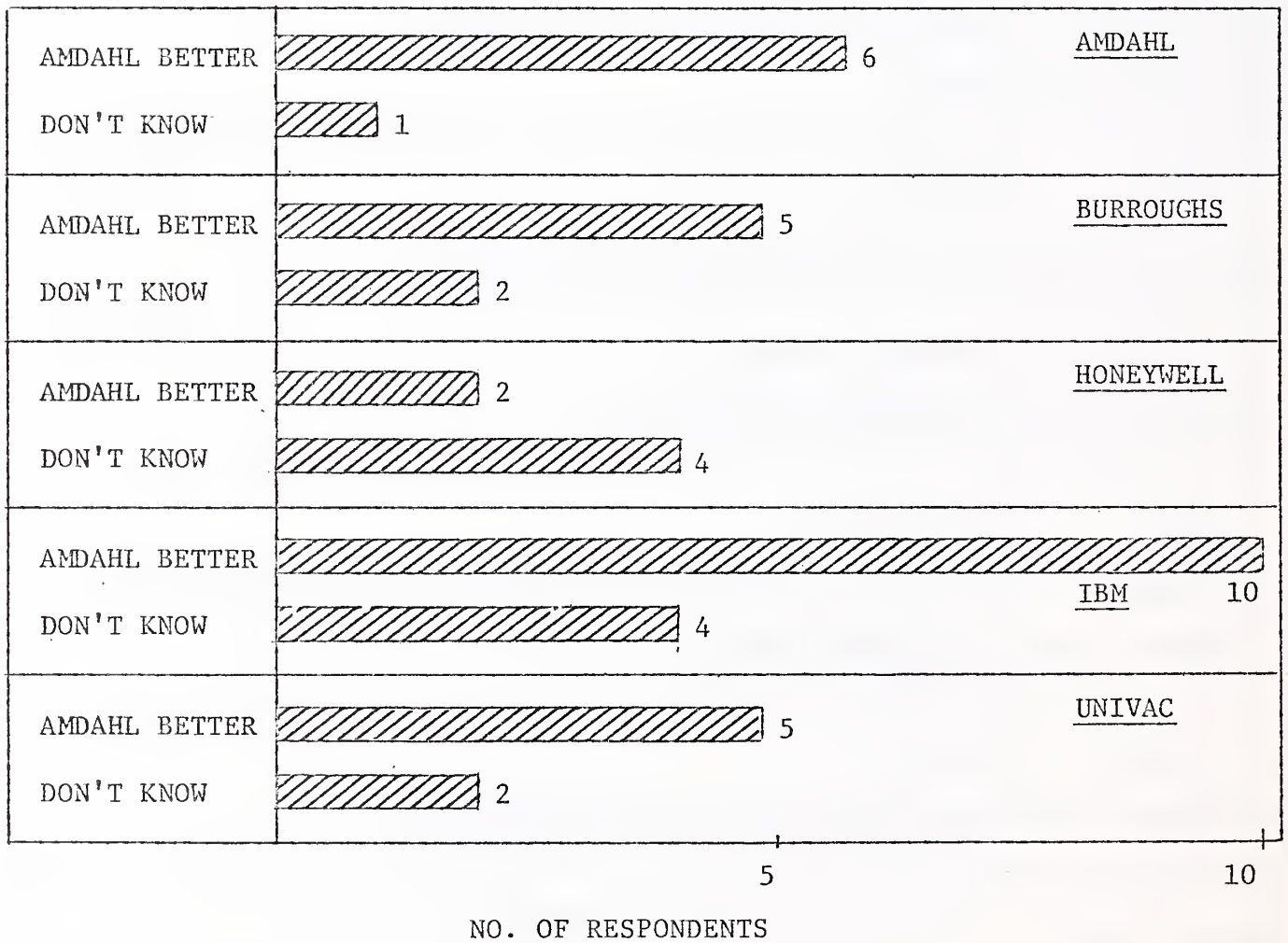
*ACCURATE WITHIN \pm 20%

EXHIBIT V-4

RESPONDENTS' COMPARISON OF AMDAHL AND IBM PRICE-PERFORMANCE

RESPONSES TO THE QUESTION:

"WHAT IS YOUR PERCEPTION OF THE PRICE-PERFORMANCE OF
THE AMDAHL 470 V/5, V/6, AND V/7 COMPARED TO
THE IBM 370/158, 168, AND 3033 RESPECTIVELY?"



D. USERS' FUTURE EXPECTATIONS FOR PRICE-PERFORMANCE CHANGES

- Over 70% (30) of the respondents considered that the other mainframe manufacturers would improve their price-performance in response to the IBM price cuts. Two Honeywell users felt this would not happen and the remaining 10 respondents did not know.
- All IBM respondents and all but 3 of the others considered IBM will further improve price-performance of its large systems over the next 3 years. However, the range of improvement expectation ranges from 10% to 100%, with the average at 30%. Their projections are relatively imprecise from a planning viewpoint.
- Also, most users expectations of price-performance improvements by IBM are quite conservative when compared to historic trends.

VI. IMPACT OF NEW
HARDWARE
ECONOMICS
ON RESIDUAL
MAINFRAME
VALUES

VI IMPACT OF NEW HARDWARE ECONOMICS ON RESIDUAL MAINFRAME VALUES

A. VARIABLES AFFECTING RESIDUAL VALUES

- Informed decisions relating to the acquisition of large scale computing systems require forecasts of residual values at future points in time. Numerous variables such as competitive pressure, tax considerations, productivity, marketing, etc. affect residual values as shown in Exhibit VI-1.
- In recent years a major industry has developed, oriented around the buying and selling of used computers. As with other brokerage operations, used computer prices are sensitive to supply and demand conditions within the market at any given time.
- These short term fluctuations fall generally within a range of "perceived value" - which is a function of the price-performance ratios of alternative equipment choices and also expectations about future technology or pricing changes.
- Historically the dominant factor influencing used computer values has been the actions of IBM. Its pricing and maintenance policies on old equipment, coupled with the price-performance of new products, have had a direct effect of used equipment values.

EXHIBIT VI-1

VARIABLES AFFECTING VALUES OF USED IBM COMPUTERS

1. IBM PRACTICES AND POLICIES

a. New Product Announcements

- Price-performance ratio relative to existing products
- Ease of conversions and transitions and lead time in obtaining new products
- Ease of installation and maintenance
- Effect on perceptions of IBM's technical direction

b. Pricing Policies

- Price increases or decreases on existing products
- Rental vs. purchase breakeven ratios
- Lease plans and penalty provisions for lease termination
- Purchase option accruals

c. Maintenance Policies

- Availability and cost
- Attitude towards other vendor modification of CPU to enhance function or speed

EXHIBIT VI-1

VARIABLES AFFECTING VALUES OF USED IBM COMPUTERS

2. ALTERNATIVE CPU SOURCES

a. Price-Performance of non-IBM manufactured CPUs

- The impact of plug compatible mainframes (Amdahl, Ite1) is significantly greater than the impact of other CPU manufacturers (e.g., CDC, Honeywell, etc.)

b. Third Party Leasing Companies

- Pricing policies for both CPUs and mixed, multivendor "systems"
- Inventory situation - many of the same companies are active in both buying and selling in the used market.

3. OTHER VARIABLES

a. Tax Considerations

- Income tax incentives such as investment tax credit and accelerated depreciation
- Property taxation

b. General Economic Conditions

- Cost and availability of capital
- Overall demand for new and used equipment

- As long as IBM dominates the market it is likely that these values will be predictable on the basis of prior action.
- However, the various external forces which influence IBM actions are likely to change substantially. Influencing factors may be results of:
 - Anti-trust litigation
 - The success of "plug compatible" CPU suppliers such as Amdahl and Intel
 - Foreign competition in U.S. and world markets
 - Trend toward distributed computing
 - New technological developments

B. ANALYSIS OF VARIABLES AFFECTING VALUES OF USED IBM COMPUTERS

- Some products, such as the IBM 3211 printer, have been introduced with little or no price-performance advantage over existing products. Therefore, the 1403 printer has maintained its residual value.
- The 370/138, 370/148, and 3033 processor announcements have, on the other hand, incorporated better than two-to-one price-performance ratios (Exhibit VI-2) over 370/135, 145, and 168 processors respectively. This dramatic drop in price-performance curves (relative to prior processor announcements) was largely unexpected and resulted in an immediate sharp decline in installed 370/135, 145, and 168 market values.
- Transition to newer technology requires consideration of both software and hardware factors. Although computer manufacturers strive for software compatibility between "generations", some program modifications are almost always required.

PRICE-PERFORMANCE RATIOS FOR SELECTED CPUs

CPU	PRICE	CPU	PRICE	POWER RATIO	PRICE-PERFORMANCE RATIO
370/135 512K	\$ 601	370/138 512K	\$ 350	1:1.3	2.23
370/145 1 Meg.	1,188	370/148 1 Meg.	689	1:1.3	2.24
370/145 2 Meg.	1,762	370/148 2 Meg.	859	1:1.3	2.67
370/168-3 4 Meg.	(4/1/77) 4,307. (Price)	3033 4 Meg.	3,380	1:1.7	2.17
370/168-3 4 Meg.	(3/31/77) 5,394 (Price)	3033 4 Meg.	3,380	1:1.7	2.71
	(\$000)		(\$000)		

- Trends toward more compact packaging of the CPU and related components and reduced cooling requirements have simplified physical space planning for most new hardware installations. There may, however, be special requirements, such as the 370/168's 440 cycle power and internal chilled water cooling which necessitate costly site preparation expenses.
- Lead times in obtaining new products can vary from a few months to years. There are two significant time intervals to be considered.
 - The time interval from product announcement until the first installations begin (thus when "replaced" equipment enters the used market)
 - The time interval between announcement and when a given customer is scheduled for installation. That given customer may become a buyer in the used market if the new product is not available in time to meet his expanding requirements or he may attempt to purchase an earlier delivery position from another customer, usually by paying a premium over the manufacturer's list price
- New product announcements are generally analyzed in considerable detail. Consultants and other industry experts provide opinions on what the impact of the new product will be on current markets, and when appropriate, what new technological change the product portends. This tends to define the degree of technological obsolescence applicable to existing products.
- Price increases by the manufacturer have tended to stabilize the used market, while price decreases produce an opposite effect. In any event, both generally are passed through rapidly to the used computer market. Used equipment is normally listed as a percentage of the current new price, and this percentage

has tended not to change when vendor list prices have changed. Exhibit VI-3 shows the frequency and magnitude of price changes for 370/158 and 168 processors.

- The consent decree of 1956 altered IBM's then existing rental-only policy and was the primary force in establishing the used computer industry. IBM has gradually changed the relationship between rental and purchase prices in a manner which encourages purchase, thus increasing the potential disruptive effect caused by the large number of units available to be traded in the used marketplace.

- Leasing plans offer yet another financing alternative when equipment changes are under consideration. The amount of the lease discount over short term rental rates is normally a function of:

- The lease term
- Penalties for early termination

- When contemplating early termination, it may be advantageous to sell the equipment in the used market rather than pay penalties. This depends on the amount of the penalties and the differential between the used market value and purchase cost, including accrued purchase option credits.

- The ability to sell accrued equity in equipment not needed which has been under lease or rent has substantial impact on used equipment values. The monthly percentage decline in purchase price due to purchase option accruals is shown for 370/158 and 168, and 3033 processors in Exhibit VI-4. IBM policy is to apply accruals against current price lists, normally to a maximum of 50%.

EXHIBIT VI-3

IBM PRICE CHANGES FOR 370/158-K and 168-K PROCESSORS

	INITIAL PRICE	1/1/75 PRICE	1/1/76 PRICE	5/20/76 PRICE	4/1/77 PRICE
370/158-K (2/71 1st Install) % Change	\$1,999	\$2,159 8%	\$2,245 4%	\$2,105 6%	\$1,460 (31%)
370/168-K (4/71 1st Install) % Change	2,898	3,130 8%	3,255 4%	3,162 3%	2,204 (30%)

((\$000)

MONTHLY DECLINE IN PURCHASE PRICE DUE TO PURCHASE OPTION ACCRUALS

CPU	% BEFORE 4/1/77 PRICE REDUCTIONS	% AFTER 4/1/77 PRICE REDUCTIONS	MAXIMUM ACCRUAL
370/158	1.12	1.50	50%
370/168	1.07	1.48	50%
3033-U 4	-	1.15	59%

- The recent 30% or more price reduction on 370/158 and 168 processors, immediately placed many rented and leased units at the 50% maximum accrual position and will have substantial impact on future 370/158 and 168 residual values.
- The availability of competent maintenance support at a reasonable cost is a critical factor in establishing the value of a used computer. IBM's policy of guaranteeing maintenance support, regardless of ownership, has enhanced IBM residual values relative to other vendors.
- The life (and thus value) of a used computer can be extended by capacity enhancements. Such capacity enhancements have been provided by IBM (e.g. the Model 3 upgrade for 370/158 and 168 processors) and also by the independent vendors, most notably by increasing main memory size over IBM-supported levels.
- Improvements in function or performance, made to IBM CPU's by other vendors, are viable only if IBM maintenance support to the base system is not adversely effected.
- Third party leasing companies, such as Itel, provide attractive (relative to IBM pricing) lease rates for IBM equipment. Penalty provisions normally exist and produce consequences similar to those discussed above for IBM leases. The packaging of non-IBM peripherals with an IBM CPU also provides a "total system" alternative at substantial price discounts.
- Disposal of large inventories of used processors (or the threat of this) can influence short term supply and demand conditions within the market and thus impact used equipment value.

- The investment tax credit is normally available only on new equipment. Used equipment prices are thus discounted by at least the after-tax value of this credit. Other tax implications, such as allowable depreciation, must also be considered for any given transaction.

- Property taxes are related to the assessed value of the equipment. As property tax rates increase, the lower taxation burden on used equipment alternatives may become a significant factor in the procurement decision.

- Although computers generally represent a very significant capital expenditure, the computer industry has been less sensitive to economic recessions than most other industries. Recessions will tend to dampen overall demand, but on the other hand, less costly used equipment alternatives become more attractive during periods of fiscal belt-tightening.

- Holding on to used equipment for too long has certain less tangible drawbacks. For example:

- Programmers don't like working with obsolete equipment, therefore, the best and the most productive leave
- Conversion costs, when skipping one or two a generation, can be very expensive
- 'Quantum jumps' in sophistication of systems can cause severe problems because of the lack of qualifications and capabilities of existing staff to cope with them

C. DETERMINANTS OF RESIDUAL VALUE

- The following analysis and conclusions apply specifically to large CPUs manufactured by IBM. Residual values for other kinds of computing equipment, including CPUs manufactured by other vendors, although influenced by the analyzed variables have other dependencies peculiar to each product. Thus, the market characteristics for peripherals and non-IBM CPUs can be very different from that of large IBM CPUs.
- The "plug compatible" CPUs from Amdahl and Intel will, however, parallel IBM's equipment values provided:
 - The firms remain economically and technically strong in the view of the computer industry
 - IBM software remains available and fully supported
 - Hardware reliability and maintenance support compares favorably to IBM's
- Residual value at any given point in the life of a processor is determined primarily by the ability of the device to perform useful work in current and future time periods. CPUs do not wear out in the traditional sense of physical deterioration. Instead they tend to improve in reliability as they age since marginal quality electronic components are continuously weeded out.
- The work the processor can do within a specified time interval is a function of hardware architecture, the efficiency of the software, and the maintenance support applied to both.

Historically, IBM products have had higher resale values than competitive products resulting from market dominance and a larger base of potential buyers rather than an inherent hardware or software product superiority. This relative advantage in value retention is also due to IBM's excellent maintenance policies. For example: a purchaser of IBM used equipment normally receives a guarantee that:

- The equipment is working to specifications
- IBM maintenance support will be available following transfer of title (assuming the equipment has been under continuous IBM maintenance)
- The purchaser can thus expect the used equipment to perform as well (perhaps better) than new equipment from the manufacturer

D. HISTORICAL AND CURRENT RESIDUAL VALUE PATTERNS FOR USED

IBM PROCESSORS

The residual values of IBM processors have followed fairly consistent patterns. During the first 2-4 years following introduction, used CPUs offered in the market have sold for essentially new list price. This price was discounted by 10%-15% because of tax benefits relating to new equipment purchase (the Federal investment tax credit) and also for the warranty provided on new equipment. After this initial period, values have declined at 5%-15% per year. The rate of decline has been a complex function of the many variables listed in Exhibit VI-1.

- The exact value of a processor, at any given time, is dependent on the supply/demand relationship within the market at the time the user wants to buy or sell his CPU. Sellers have in the past often created an illusion of "over supply" by listing with dozens of brokers, a practice which ultimately affected adversely their selling price.
- Used IBM large processor prices underwent a relatively steep decline during 1974, as the 370/158 and 168 with VS software entered the market. This decline in used computer prices, with systems selling for less than their intrinsic value, was reversed in early 1975. Most used computer prices then increased for a sustained period of time.
- Similarly, used prices for the 370/135 and 145 actually increased, in some cases by 15%-20%, in the months just prior to the 370/138 and 148 announcements; this was an obvious misinterpretation of IBM's intentions.
- The recent 370/138 and 148, and 3033 processor announcements have established new price-performance curves within the industry.
- Immediately after the announcement, used large IBM processors dropped in value by 30% or more. This was as a result of the IBM reductions on its current equipment: this does not take into account price-performance on equipment to be delivered in 1978.
- Therefore, these residual values will continue to decline fairly rapidly until a new equilibrium position is reached relative to the new price-performance curves.

E. FUTURE RESIDUAL VALUES OF USED IBM PROCESSORS

- The residual value curves in Exhibit VI-5, 6, and 7 show actual listing prices for selected IBM processors through March 1977, and projected values through 1981.
- The projected residual values reflect INPUT's forecast based on:
 - Anticipated actions by IBM
 - Responding strategies by the plug compatible mainframe manufacturers
 - Other mainframe manufacturer actions, both domestic and international
- The percent of list price projected for 370/158 and 370/168 processors is based on the March 1977 IBM price schedule (i.e. before the 30%+ price reductions made in conjunction with the 3033 announcement).
- The sharp decline in 370/158 and 168 residual values shown in the balance of 1977 and into 1978 is caused by the 3033 (and its smaller 370/158 replacement version projected to be announced in the second half of 1977). On a strict price-performance basis, a 4 megabyte 3033 equates to roughly \$2 million (\$3.4 million list price divided by 1.7 power factor) - or 40% of the typical \$5 million price paid for a comparable 370/168 system now installed.
- INPUT believes 370/158 and 168 residual values will stabilize in the 30%-35% range near the end of 1978.
- These residual values will dip again in early 1980 due to a new processor family announcement. This new processor family is projected to have price-performance characteristics similar to the 370/168 to 3033 ratios and will cause the sharp decline as shown on the 3033 and Amdahl 470 V/6 residual value curves.

EXHIBIT VI-5

PROJECTED VALUES BY QUARTER TO 1981 OF USED, LARGE, IBM SYSTEMS

MODEL	1977				1978				1979				1980				1981			
	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4		
370/168	HI	77	68	59	53	46	40	39	38	37	36	35	30	25	24	23½	23	22	18	
	LO	59	50	40	35	30	25	24	23	22	21	20	15	10	9½	9	8½	8	5	
370/158	HI	80	71	62	55	48	40	39	38	37	36	35	30	25	24	23½	23	22	18	
	LO	62	51	40	35	30	25	24	23	22	21	20	15	10	9½	9	8	7	3	
3033	HI			86	86	86	86	86	86	86	86	86	83	80	72	65	63	61½	60	
	LO			86	84½	83	81½	80	80	80	80	80	70	60	53	45	43	41½	40	
370/165	HI	41	37	28	25	22½	20	19	18	17	16	15	11	8	7½	7	6½	6	3	
	LO	35	25	15	12	9½	7	6	5	4	3½	3	2	1½	1½	1	1	1	½	
370/155	HI	30	25	21	18	16½	15	14½	14	14	13½	13	11	8	7	6½	5½	5	2	
	LO	20	16	12	10½	9	8	8	7½	7½	7	7	5	3	3	2½	2	2	½	
360/65	HI	10	9	8	7	6½	6	6	5½	5½	5	5	3½	2	2	1½	1	1	½	
	LO	5	4	3	2½	2½	2	2	1½	1½	1	1	1	½	½	½	½	½	-	

(% OF LIST PRICE AS OF 3/31/77)

RESIDUAL VALUES FOR 360/65, 370/155, AND 370/158 PROCESSORS

(% OF LIST PRICE BASED ON 3/77 IBM PRICE SCHEDULE)

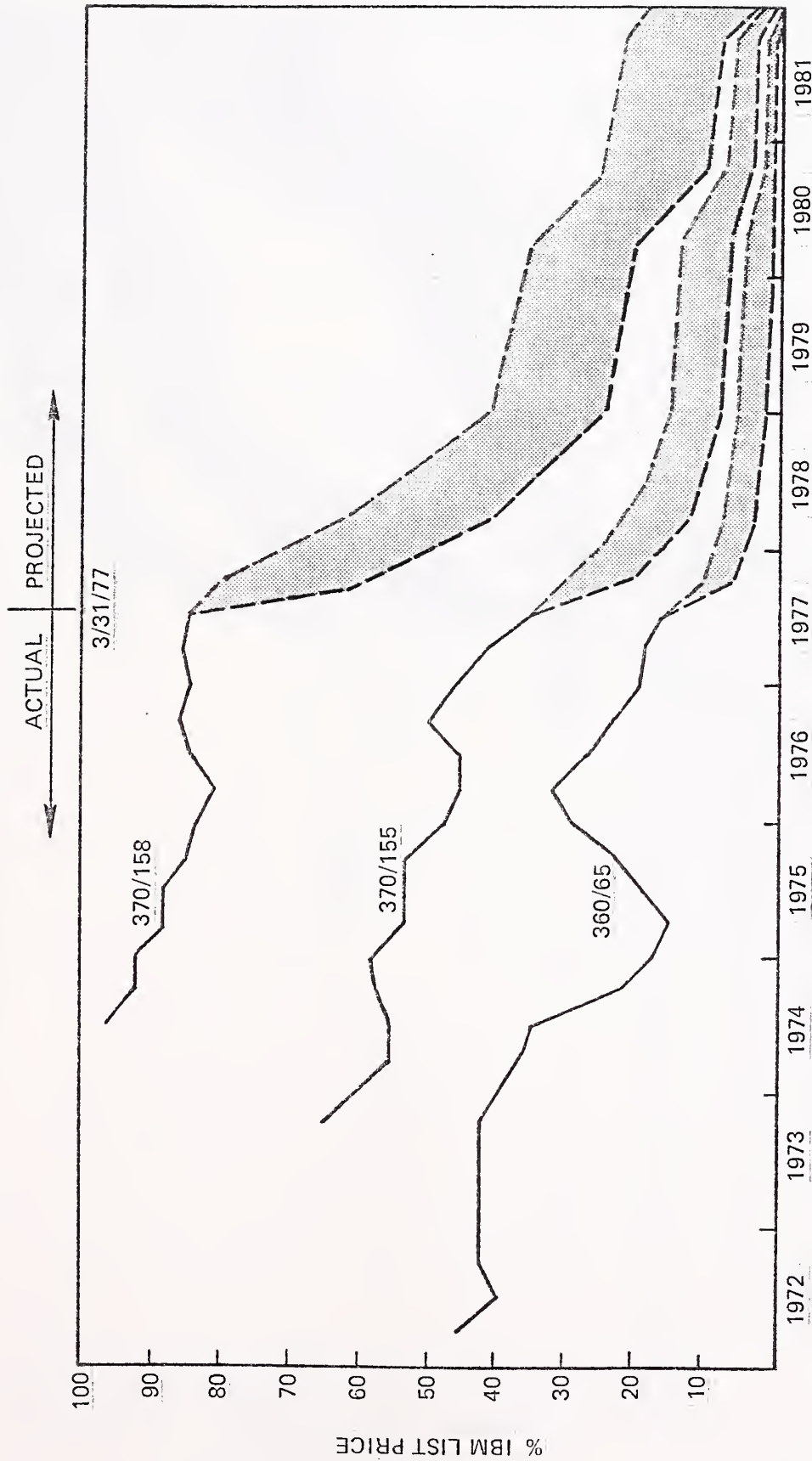
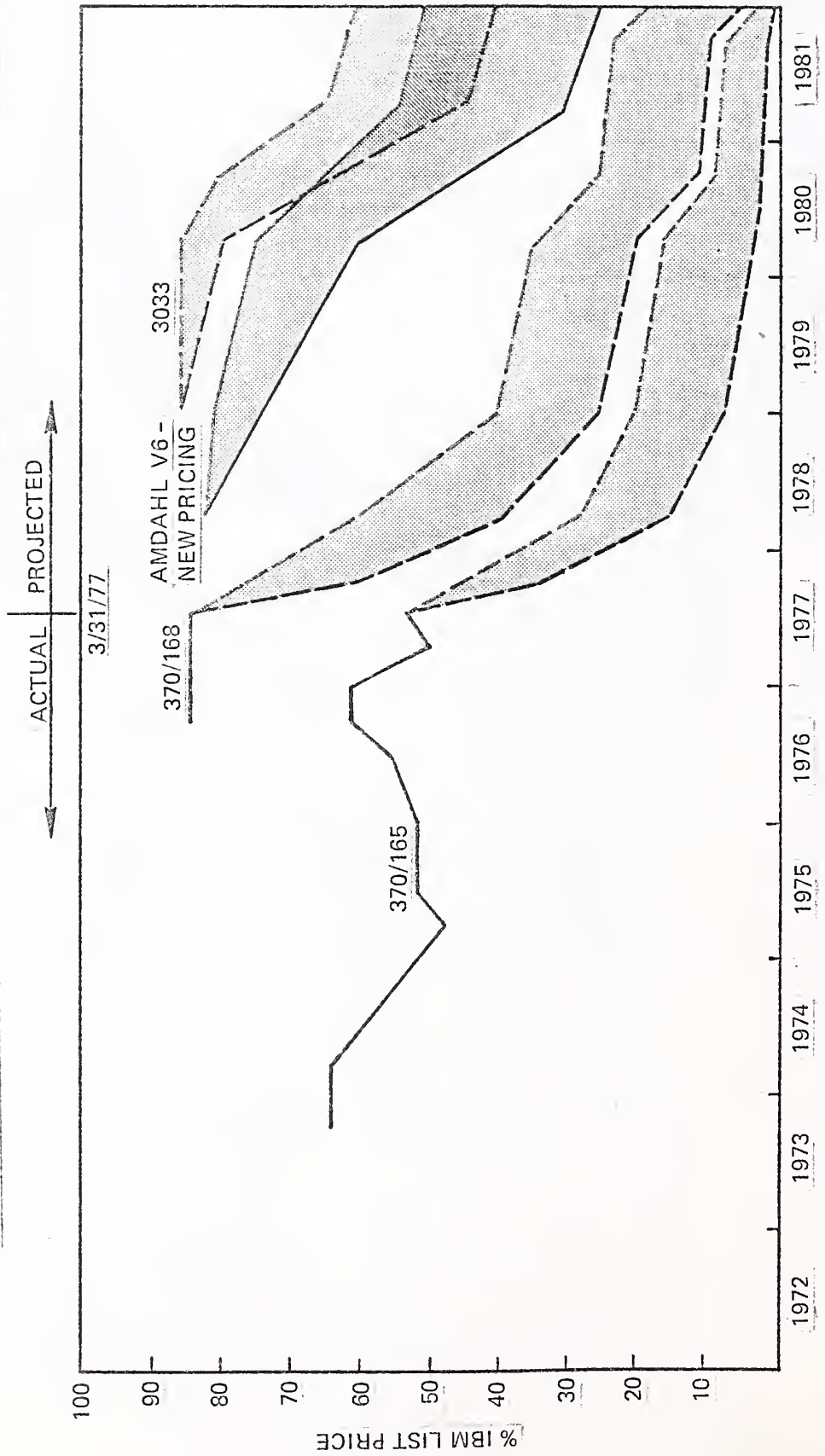


EXHIBIT VI-7

RESIDUAL VALUES FOR 370/165, 370/168, 370/168, 3033, AND 470V/6 PROCESSORS
 (% OF LIST PRICE BASED ON 3/77 IBM PRICE SCHEDULE)



- INPUT bases its Amdahl forecast on the following assumptions:
 - Amdahl maintains its financial, maintenance, support and compatibility capability
 - Actions which affect the 3033 processor will have a similar impact on the Amdahl processors

- Projections also assume that during the forecast period:
 - Current anti-trust litigation will cause no drastic changes in the structure or marketing freedom of IBM
 - U.S. economy will not enter a major recession
 - Current tax law concerning the acquisition and depreciation of computing equipment will not substantially change

VII. IMPACT OF THE
JAPANESE COM-
PUTER INDUSTRY
ON THE WORLD'S
MEDIUM-LARGE
BUSINESS SYSTEMS
MARKETS

VII IMPACT OF THE JAPANESE COMPUTER INDUSTRY ON THE WORLD'S MEDIUM-LARGE BUSINESS SYSTEMS MARKETS

A. A MATTER OF ECONOMICS: JAPANESE SUCCESSES

- The past decade has seen Japanese companies successfully penetrate, and eventually dominate, established world markets. Dedicated to the national principle that to export is to survive, Japanese industry, in league with a hierarchy of government agencies, has formed a full partnership organized to provide the total economic, political and organizational resources essential to develop targeted markets for Japanese products.
- Past efforts have led to the capture of important market shares in such diversified industries as shipbuilding, transportation and a variety of consumer markets.
- By recognizing important socio-economic trends, combining industry-government resources, initiating innovative technological improvements, and developing an extensive distribution and trade network, Japanese consumer products dominate world markets for televisions, radios, stereo components and cameras.

- In parallel with the inroads achieved in the consumer product sectors, Japanese companies are supplying 70% of the world's motorcycles and 50% of the new ships built. Further, the Japanese auto industry has captured the small auto market in the U. S. by providing quality, performance, service and price. The majority of Japanese autos exceed existing EPA mileage and emission standards while U.S. manufacturers continue to debate their merits.

B. FOR AN ENCORE: THE COMPUTER INDUSTRY!

- The Japanese are seeking new opportunities in products and markets which are synergistic with the country's strategic planning and growth goals.
- The computer industry is their targeted market. In addition to being the fastest growing industry, it will shortly become the world's largest.
- It is imperative that the Japanese achieve a 12%-15% share of the total computer market if they intend to become a recognized force in the marketplace. The market share objective could be achieved in the early 1980s if the Japanese companies continue to implement their plan.

C. HEAD-ON CONFRONTATION?

- IBM accounts for over 60% of the total installed value of computer systems. IBM's FY 1976 sales were \$16.3 billion with net earnings of \$2.4 billion.
- To achieve any significant degree of market penetration in the total computer market, the Japanese computer manufacturers have decided that they must penetrate the existing IBM customer base.

- The technological and financial resources the Japanese industry is assembling for the assault are major. The sales and earnings figures of the six major Japanese computer companies are in themselves impressive. Individual company dedication and participation in computer hardware, software and related products, varies considerably but this will change.
- As indicated in Exhibit VII-1, Fujitsu derived 74% of its 1976 revenues from computer and computer related products. On the opposite end of the spectrum, computer activities represent only 3.7% of total Oki sales. By 1985, Fujitsu, Hitachi and NEC intend to increase revenues from EDP operations significantly. These companies are resolved to become recognized competitors in the world's computer market.
- The Japanese computer industry believes it can succeed against IBM and other entrenched world mainframe manufacturers despite the fact that equally formidable opponents have failed in the past. In order to accomplish this goal, Japan's computer industry resources will be consolidated. The Japanese government is the catalyst for planning, directing and implementing the total computer strategy.

D. THE JAPANESE STRATEGY

- The Japanese computer industry combines a unique blend of strengths which include:
 - Government support and direction
 - Competitive technological base
 - Extremely high motivation level to excel in any market endeavor

EXHIBIT VII-1

JAPANESE COMPUTER MANUFACTURERS'
INCOME DERIVED FROM EDP SALES

COMPANY	1975			1976			1985
	TOTAL SALES	EDP SALES	EDP % OF TOTAL SALES	TOTAL SALES	EDP SALES	EDP % OF TOTAL SALES	EDP % OF TOTAL SALES
FUJITSU	\$ 926	\$667	72.1%	\$ 961	\$702	74.3%	91.0%
HITACHI	6,130	398	6.3	6,011	406	6.7	21.0
NEC	1,116	295	25.4	1,344	358	26.6	40.0
TOSHIBA	2,651	180	6.8	2,800	199	7.1	12.0
mitsubishi	2,113	110	5.2	2,536	147	5.8	11.0
OKI	171	62	3.6	203	75	3.7	5.0

(SALES IN \$ MILLIONS)

- Rapidly growing domestic market where industry patterns and economic growth cycles are patterned after the industrial West
- Ability to focus upon emerging market opportunities and assemble and coordinate all the resources necessary to successfully penetrate and market high technology products

● A highly disciplined strategy is being undertaken based upon the following key criteria:

- Select those markets and industries which provide the best short and long term opportunities
- Where necessary, establish local relationships where technology is interchanged, distribution paths are established, marketing experience present and manufacturing facilities available - use Japanese trade companies where appropriate
- Exercise direct control of the operation from the outset or as soon as possible - Japanese nationals will be employed in all key middle management positions
- Marshall and supply all the necessary resources in order to ensure that stated goals are met

E. NORTH AMERICAN (N. A.) STRATEGY

● Recognizing the strengths of the U. S. computer manufacturers, the Japanese computer companies have purposely avoided a direct confrontation for medium-large business mainframes in the U. S. and Canada.

- Their approach to this lucrative market will be gradual and careful. The middle-late 1970's will be used to establish inter-company relationships with U. S. and Canadian firms as a staging strategy in order to successfully penetrate the N. A. market during the 1980s.
- Initially, Japanese computer manufacturers will carefully select, negotiate and establish joint product-market agreements with N. A. companies for the integration of Japanese products along with local company offerings. Over-exposure and risk will be minimized by the Japanese companies. Illustrative of this strategy are the arrangements concluded by Fujitsu Limited with companies in the U. S. and Canada.
- Fujitsu has already embarked upon a phased entry strategy for the N.A. computer market.
- Phase I is the establishment of ties with N. A. computer and/or peripheral manufacturers. Fujitsu will provide components, products and/or technology currently lacking in the local companies' product offering. These products reach the ultimate end-user via the N. A. companies' sales organizations. Other product distribution arrangements will eventually evolve where a select Japanese factory sales force will sell directly to major targeted accounts. Wherever possible, Japanese trading companies will be employed, assuming sales volumes and commissions are reasonable; existing Japanese consumer distribution channels may be used initially.
- A variation of the Phase I theme is Fujitsu's relationship with Amdahl and Consolidated Computer, Inc. (CCI) in Canada. The Amdahl relationship has been adequately publicized. The CCI relationship is quite different and

suggests alternative means and arrangements for Japanese manufacturers to enter established markets.

- Fujitsu will provide technical expertise to CCI
- The Canadian government will provide extensive financial support to CCI
- CCI will license and manufacture Fujitsu computers, peripherals, etc. in Canada and the U. S. Fujitsu and CCI will cooperate on joint development projects
- At no charge, the Canadian government provides Fujitsu with 2.3 million shares of CCI stock
- Fujitsu has an option of acquiring an additional 1 million shares of CCI stock
- Fujitsu will receive 1-1/2% of all CCI gross sales as a technical assistance fee

The execution of Phase II is a continuation of the Phase I strategy. The end result calls for the virtual control of the operation by the Japanese company. A series of concurrent events precedes and accompanies the ultimate control process.

- Top management assignments will occur with Japanese nationals being placed in key operations posts. If the president of the overseas company is a local citizen, he becomes a titular head reporting to a Japanese chairman of the board who is usually on the board of directors of the parent Japanese company.

- A direct marketing organization will be established between the Japanese manufacturer and the distribution channel's manufacturer's representatives. Key house accounts are selected and become the responsibility of the direct sales force. Eventually, the manufacturers' representatives sales organizations are phased out and all sales functions are performed by company employees.
- At least one research laboratory becomes established, staffed by local nationals and Japanese technicians. The purpose of the lab is to provide a cross-fertilization of ideas involving technology and products. R&D budgets are assigned and specific development programs are undertaken.
- The end result insures that the Japanese company becomes firmly entrenched in the N. A. marketplace. Early ties with N. A. companies are relaxed and the Japanese are ready to "go it alone".

F. IBM WATCHES APPREHENSIVELY

- From time to time IBM has acknowledged the potential threat of the Japanese companies in the U. S. marketplace. Unlike a number of their U. S. counterparts who regard the European computer manufacturers as the prime source of competition, IBM has singled out Japan as their strongest potential competitor.
- The Amdahl-Fujitsu relationship will see IBM's 370/145 through 370/168 customer base receiving very special attention from current and future

product developments. If successful, this particular type of joint venture may be the pattern for future relationships between U. S. and other Japanese companies.

In the medium-large business mainframe market, other Japanese manufacturers are expected to enter the U. S. market via Amdahl-type or similar relationships. A likely entry is Hitachi. Conceivably, Hitachi could market the HITAC and M series in N. A. and target the IBM 370/135 and smaller system markets. Amdahl and Fujitsu would continue to target the 370/145 and larger systems markets. Fujitsu and Hitachi would supply peripherals through Nippon Peripherals, Ltd., a jointly sponsored peripheral manufacturer.

Hitachi has several options with which to pursue product opportunities in the U. S. market. For example, Hitachi may associate with a domestic leasing organization and enter the plug compatible mainframe market. Such a complementary arrangement could be established between Intel and Hitachi. Intel has the marketing resources to sell plug compatible M series mainframes to the N. A. users. Another equally viable alternative for Hitachi could be an association with a plug compatible peripheral manufacturer such as Memorex or Calcomp. In any event, it is likely that Hitachi Limited will conclude a joint venture agreement this year with major U. S. companies to target the lower end of IBM's customer base and/or enter the plug compatible peripheral market.

G. CHINA, EASTERN EUROPE, AFRICA AND SOUTH AMERICA STRATEGIES

- In each of these geographical areas, the Japanese computer companies will assume a more direct market approach. Here, they can compete aggressively with their own products using their own nomenclature alongside other world computer manufacturers. IBM will have an edge, however, in South Africa and South America because of established manufacturing facilities.
- Head-to-head selling for marketshare will be fatal to some. Eventual market success will result from a combination of factors encompassing equipment "deals" and high level political negotiations. The final arrangements will be laced with technology interchange, including license-to-manufacture particularly in China and Eastern block countries. In these areas, the Japanese companies backed by MITI, are considerably more flexible than most of the U.S. companies hamstrung by U. S. Government restrictions.

H. EUROPEAN MARKET STRATEGIES

- In order to achieve success in the European markets, Japan's strategy will be developed on a country-by-country basis. Recognizing the strengths and weaknesses of other established computer companies and assessing such areas as nationalistic prejudices, tariffs and overall political situations, the Japanese will utilize a combination of strategies similar to those employed in North America, China and the Eastern block countries.

- Wherever possible, Japanese companies are strongly motivated to sell all computer products with recognized Japanese labels to achieve product identity; i.e., FACOM, HITAC, "M" Series, ACOS and COSMO. This objective is more readily achievable in countries such as Spain where Japanese products, investment, and economic participation are well publicized and acknowledged by the local government and industry.

I. A "JAPAN LIMITED" ENTERPRISE

- Through various government sponsored affiliations, Japanese computer companies have united, pooled and directed resources to successfully establish Japan as a viable world computer alternative.

- This is spearheaded by the Ministry of International Trade and Industry (MITI). MITI has developed the organizational cell network and discipline necessary to orchestrate the overall direction of each Japanese computer manufacturer to achieve planned economic and market growth objectives.

- Inherent in this unique arrangement between government and private industry is the absolute control exercised by MITI in such diverse areas as: funding R&D programs; regulating favorable trade policies; assigning market areas; negotiating with foreign governments; and providing financial assistance to ensure the Japanese computer industry is afforded opportunities to compete and penetrate targeted world markets.

- ④ To better direct, monitor and administer the overall strategic planning role of the Japanese computer industry, MITI has forced consolidation of selected key development functions of the six computer manufacturers and reduced overall administration to three entities.
- ④ As indicated in Exhibit VII-2, this combine presents an ideal basis for centralized planning. By consolidating the resources of all the computer companies, MITI parcels out an annual multi-billion dollar R&D allocation for specified projects. The three entities compete for project funding and when MITI funding is allocated, each entity provides matching funds.
- ④ Competitive research is conducted between the three groups. When research or project design is proved, additional funds are provided for product development, competing research is terminated and new research programs initiated.
- ④ MITI has established an in-house R&D organization called the Electrotechnical Laboratory (ETL). ETL is primarily responsible for technology developments aimed at replacing existing IBM systems. Further, ETL is chartered to develop the technology to compete with IBM's future systems. Checks and balances are apparent throughout this complex organizationl arrangement. While such tactics may appear unfamiliar to the Western businessman, they are, however, consistent with Japanese philosphy, that internal cooperation develops strong external competition.

JAPANESE COMPUTER MANUFACTURERS' 'MATCH-UP'

WITH IBM SYSTEM/370

FUJITSU/ HITACHI	NEC/ TOSHIBA	MIITSUBISHI/ OKI	IBM TARGETS	AMDAHL REFERENCE
M130 N/A	ACOS 200	COSMO 300	370-115	
M140 N/A	ACOS 300	COSMO 400 N/A	370-125	
M 150	ACOS 400	COSMO 500	370-135/138	
M160	ACOS 500	COSMO 700	370-145/148	
M170	ACOS 600	COSMO 900	370-155/158	
M170MP	ACOS 650MP N/A	COSMO 900MP	370-158MP	470V/5
M180	ACOS 800-1	--	370-165/II	
M180/190	ACOS 800-2	--	370-168/APS	470V/6
M180MP/190	ACOS 900-1	--	370-168MP	
M190	ACOS 900-2	--	3030	470V/7

N/A = NOT ANNOUNCED

J. RISKS ARE HIGH - SO ARE THE STAKES

- Japan is playing for high stakes. The world's hardware computer market is expected to exceed \$60-\$70 billion by 1985. Japanese computer industry projects to capture 11%-13% or \$7-8 billion by 1985.
- Much of Japan's optimism regarding computer market growth results from their own internal demands. As described in Exhibit VII-3, Japanese internal growth is projected to reach over 100,000 installed computer systems by 1985. The total installed value is projected to exceed \$25 billion.
- Other world computer manufacturers have found the Japanese market lucrative. As a result, Japan expects to reduce computer import dependence to 20% in 1985 from 41% in 1974.
- In concert with reducing computer imports, MITI's Information Industry Committee, of the Industrial Structure Council, has developed a most conservative export forecast for the Japanese computer industry. Exhibit VII-4 indicates that Japan expects to ship \$1.3 billion of computer equipments during 1985.
- If any country has an opportunity to become a major contender in the world's computer market, it's Japan. To date, Japan has realized every consumer market goal sought from Western competitors. Although the risks are increased by a magnitude of 10, the benefits derived are essential to Japan's economic growth and eventually survival as a leader in the industrialized world.

EXHIBIT VII-3

JAPANESE COMPUTER INDUSTRY MARKET GROWTH

1974-1985

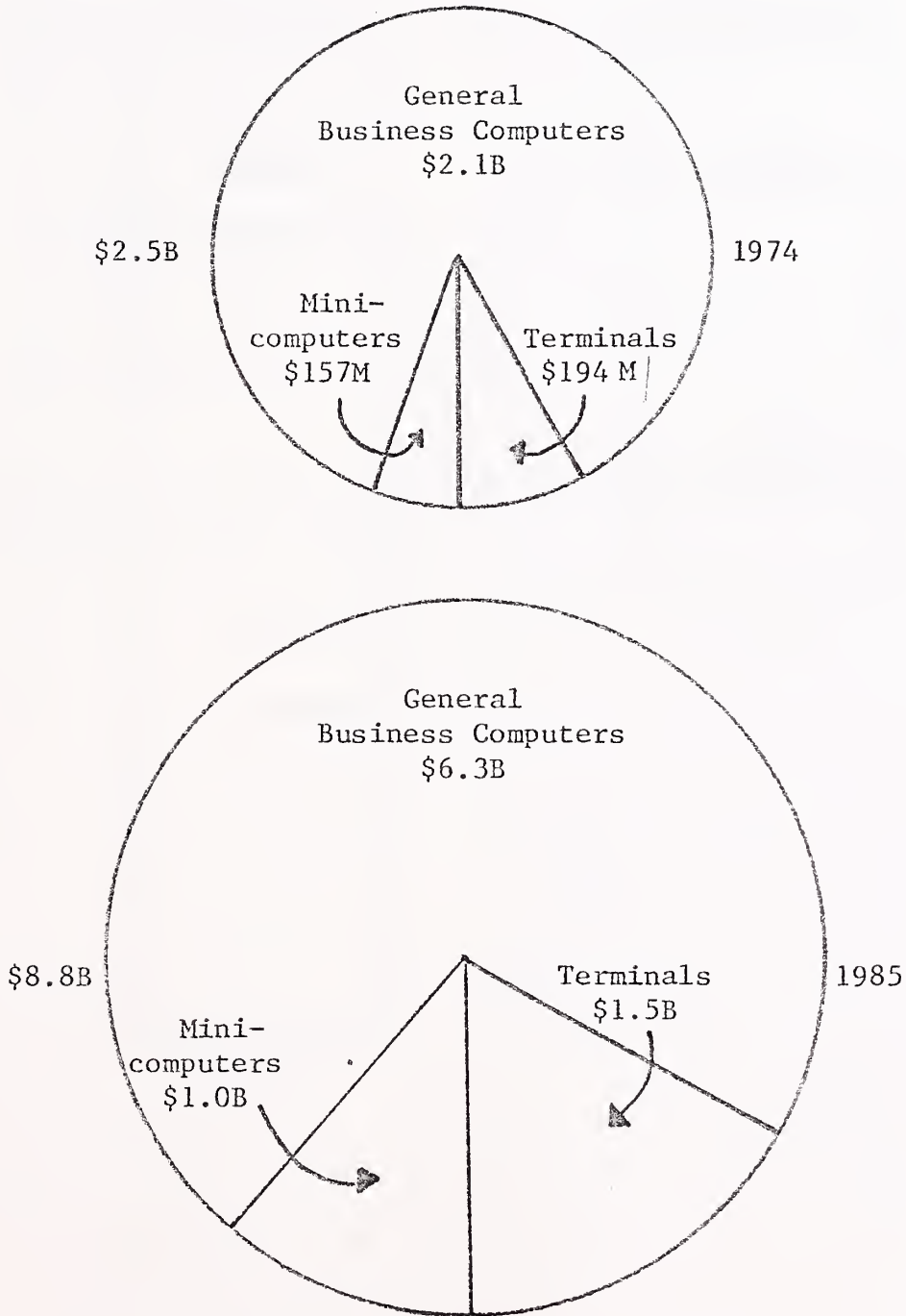
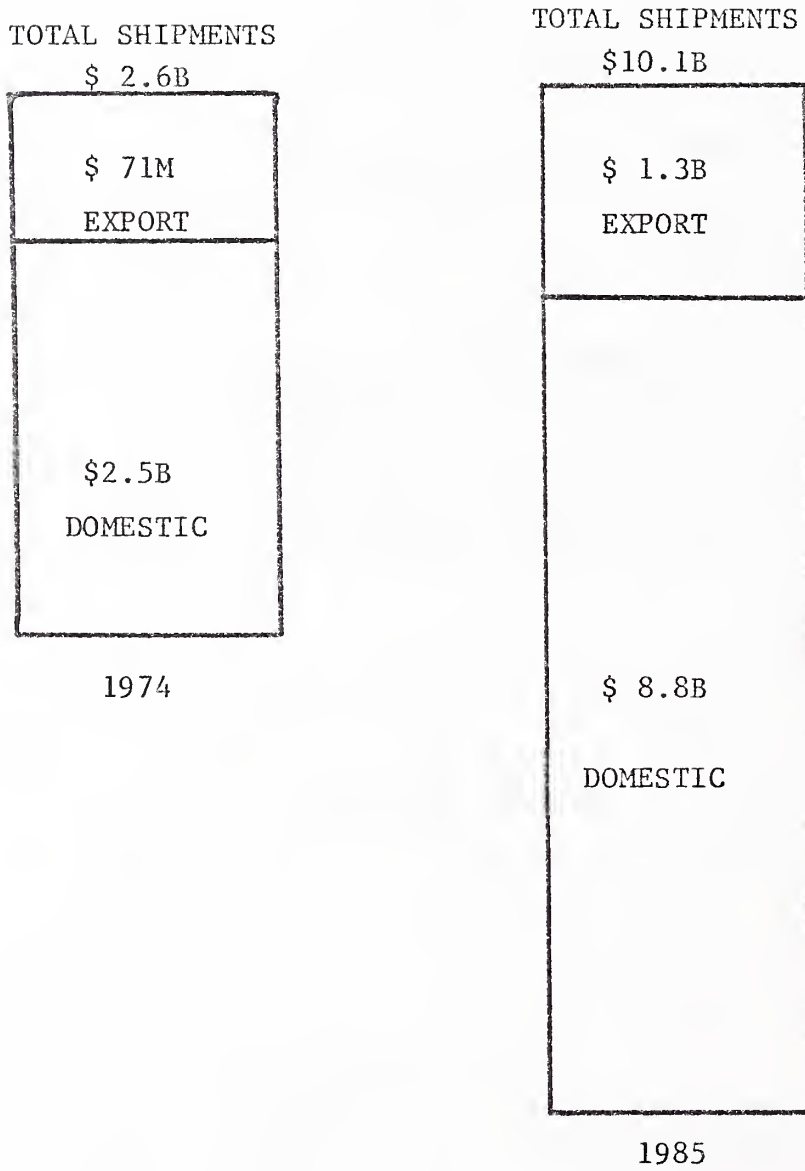


EXHIBIT VII-4

JAPANESE COMPUTER EXPORT SHIPMENTS,
1974-1985



• The world's computer manufacturers are not facing a fragmented number of Japanese companies entering new market areas. On the contrary, they are being confronted by the total Japanese computer industry backed by the Japanese government. To win this battle, U. S. companies will have to:

- Become more familiar with Japanese computer products
- Shift emphasis into areas which are unique
- Find ways to get the U. S. Government to allow them to effectively compete in Eastern Europe and China
- Establish a firmer control over the Latin-American market through joint ventures with local companies

• In addition, the U.S. must avoid the inhibiting 'provincial' controls which plague the European computer companies.

VIII. FUTURE DEVELOPMENTS AND STRATEGIES

VIII FUTURE DEVELOPMENTS AND STRATEGIES

A. IBM'S MATCHING OF PRICE-PERFORMANCE CHANGES WITH REVENUE GROWTH

- In the INPUT report "Amdahl as a Viable Alternative to IBM" the potential demand for large systems was estimated to represent a potential cumulative revenue of \$9 billion to IBM through 1980. Adjusting for revenues received during 1976, this figure would now be \$6.75 billion.
- The announcement of the 3033 with 3 times the price-performance of the 370/168-3 effectively reduces this potential revenue to \$2.25 billion, assuming forecasted demand for large systems remains the same.
- IBM may pick up as much as \$0.5 billion from the 'clearance sale' of 370/158 and 168 processors. Also, improved price-performance will encourage some consolidation of medium scale mainframes and some increased migration into the ranks of large systems users.
- However, IBM will still have about \$4.0 billion in projected future revenues to replace between now and 1980, thanks to the plug compatible mainframe manufacturers.

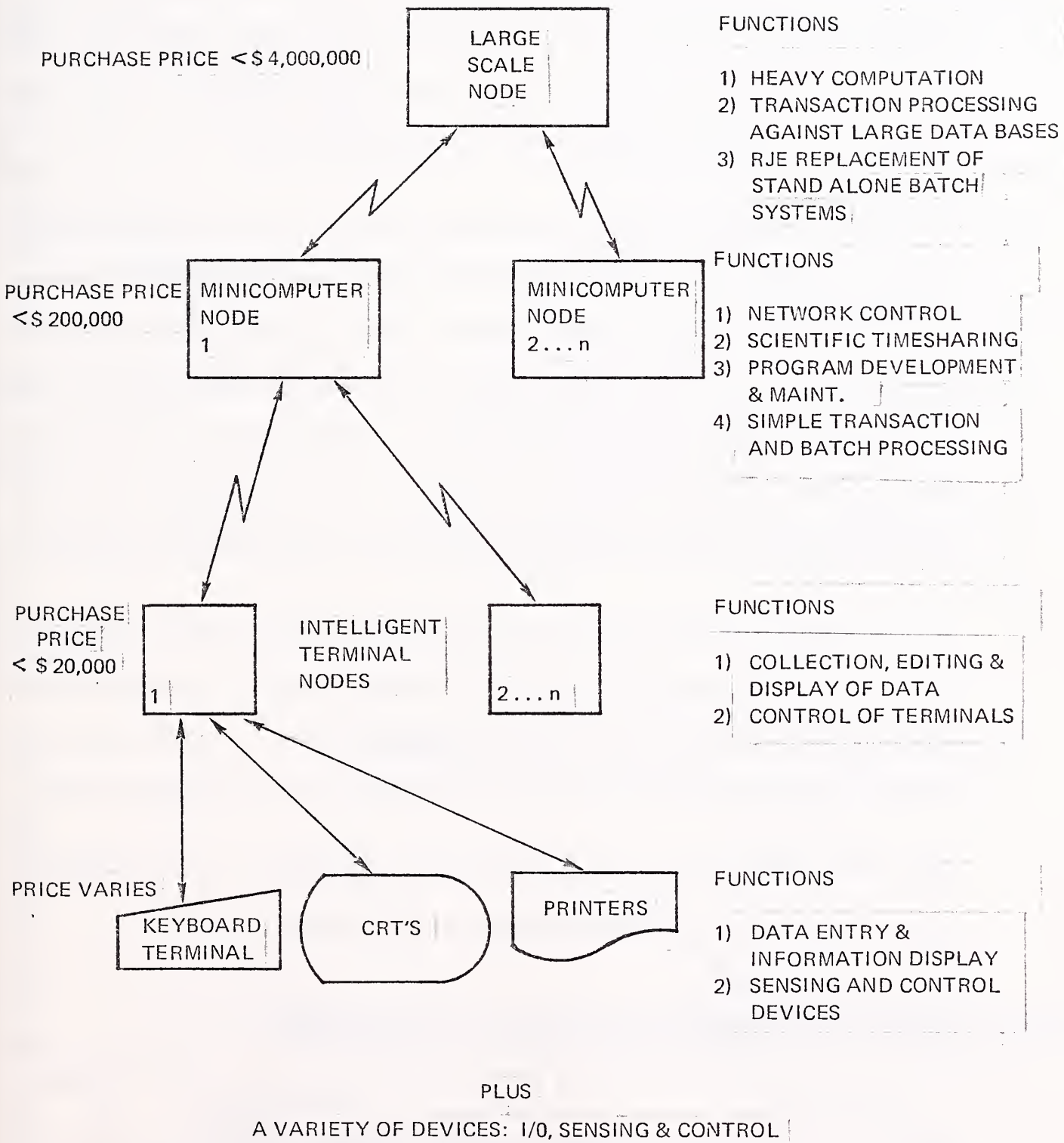
- INPUT contends that IBM did not, and does not, want to become involved in a 'horsepower' race. However, it can do better than most in that kind of race if it so chooses.
- The announcement of the 3033 processor was forced by the economics of advancing computer/communications technology, as represented by the Amdahl and National Semiconductor/Intel entries into the market. To a certain degree, the 3033 announcement is an admission by IBM that it can no longer control the release of technology to fit its business plans.
- The 3033 announcement represents a severe price-performance adjustment; IBM is certainly aware of the potential impact on its revenues and has a business plan to maintain its revenue growth. Understanding of what this plan might be is important in order to project future developments; it is addressed in the following sections.

B. ROLE OF THE NETWORK IN IBM'S PLANS

- Exhibit VIII-1 depicts a hierarchical network and the appropriate processing functions at each level. The hierarchy is dictated by the economics at each level.
- This network concept is the basis for INPUT's statement that small and medium scale systems will be difficult to justify because large systems and minicomputers will apply such severe pressure.

EXHIBIT VIII-1

HIERARCHICAL NETWORK FUNCTIONS

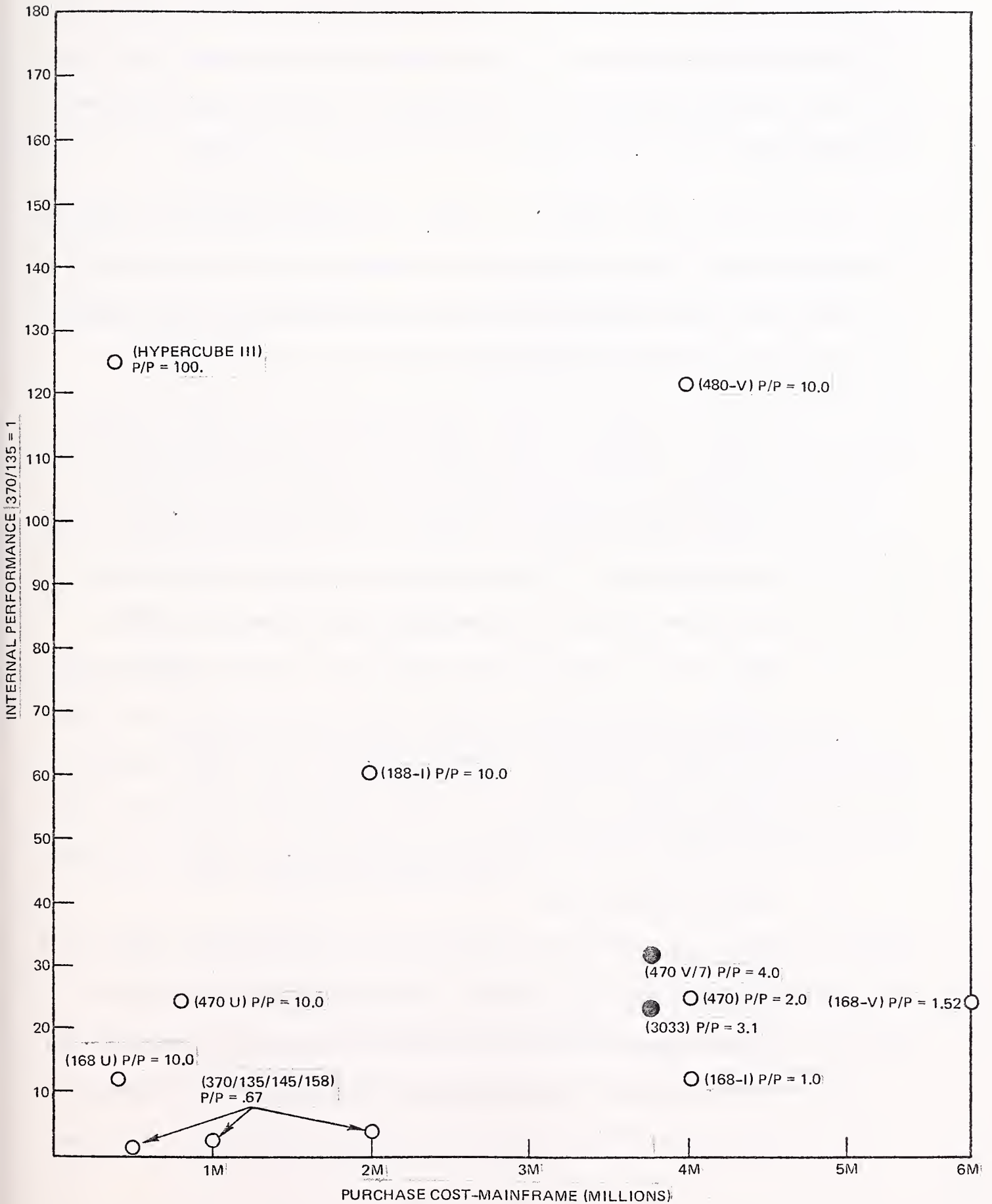


- In this type of network large systems tend to replace smaller systems more than the internal price-performance ratios may indicate. This is primarily due to the fact that editing and pre-processing functions are performed by the remote processors leaving heavy computation, data base operations, and consolidation functions to be done by the large, central processors. This is the reason for the use of the replacement ratios in Exhibit III-8.
- From IBM's viewpoint, it may have created a 'monster' with the 3033; a high price-performance, large system which 'devours' its smaller relations. In order to maintain its traditional growth, IBM must obtain a substantial portion of its revenues in the future from other products and services associated with the computer/communications networks shown in Exhibit VIII-1. This includes minicomputers, software products, terminals, word processors, and data storage systems, as well as communications services and applications services.
- In the past, IBM has been relatively weak in many of these markets, although it is moving rapidly to establish strong points within them all. It is constrained from providing computer processing and communications services in the U.S., but the restraint on providing computer processing services will expire in 1978.
- IBM's long range strategy is therefore network oriented; a fully coordinated plan in this area may not become evident until the 1980s.

C. LARGE SYSTEM PRICE-PERFORMANCE PROJECTIONS

- Exhibit VIII-2 was first published in a study produced by INPUT in early 1976 entitled "Economics of Computer/Communications Networks and Their Future Impact". The study predicted that large scale processor price-performance

POSSIBLE INTERNAL PRICE-PERFORMANCE OF
SYSTEMS IN THE MID-1980s RELATIVE TO THE IBM 370/168-1



would improve by a factor of 10 times the 370/168-1 within 10 years. The price-performance of the IBM 370 and Amdahl 470 was plotted at that time. The 370/168-5 is equivalent to the 370/168 AP announced during the course of that study.

- The chart has been updated to reflect the 3033 processor and 470 V/7 announcements. The projection of a 10 times price-performance over the 370/168 by 1981 to 1985 is still valid but probably conservative. The ways this could be accomplished were postulated as follows:

- Amdahl, or someone else, would announce a processor 5 times as powerful as the 470 V/6 at the same price; this is shown on the chart as the 480-V (preceding CDC's adoption of this numbering system). Since the announcement of the 470 V/7, this new processor would only have to be 3.5 times the 470 V/7 and the price could increase by over 10%.
- INPUT did not anticipate that IBM would cut prices so dramatically, although it was foreseen that IBM would be under increasing price-performance pressure. INPUT projected IBM would announce a processor after 5 years or so which had 5 times the power of the 370/168 and would cost half as much (plotted as the 188-1). The 3033 is a step in that direction.
- The points plotted for the 470U and the 370/168U reflect the availability of used computers in the early 1980s. The 470 V/6 at a residual value of 20% and the 370/168 with a residual value of 10% will meet the target price-performance. Considering the recent announcements those systems will probably be selling at that level at that time.

- Hypercube III, a theoretical micro-processor array, would destroy today's large computer economics. It would only have to achieve 10% of its theoretical level to be 10 times the price-performance of the 370/168-1. However, it is improbable that it will be practical within this timeframe.

- In fact, the most significant breakthrough in achieving the 10 times 370/168 price-performance by the early 1980s has already occurred. The 470 V/7 has 4 times the price-performance of the 370/168; processing which theoretically cost \$1.00 in 1973 will be available for \$0.25 in 1978, and going to the 10 times price-performance will only further lower it to \$0.10. IBM, plug compatible manufacturers, and used computers will all meet this standard before 1986.

- The next series of innovations providing a major improvement in price-performance will be accomplished in three ways; software, firmware, and hardware:

- Software and firmware improvements will be introduced gradually

- Hardware innovations will stem from new production techniques made possible by the use of ultra-dense circuitry based on electron beam lithography or other technologies.

- IBM has been working on new production techniques at its Thomas J. Watson Research Center in Yorktown Heights. Electron beam lithography, for example, has produced lines up to 20 times narrower than those generated optically. A computer can also be used to directly control electron beams.

- Scanning electron beam lithography is the most direct method of generating high resolution patterns. After the development of the scanning electron microscope at Cambridge University in 1966, the potential of using the technique for semiconductor processes began to be explored at universities and by a large number of companies.
- IBM, Bell Labs, Hughes, General Electric, Texas Instruments, Hitachi, Thomson CSF, Westinghouse, Bell Northern and UC Berkeley all became involved in research and the development of experimental devices.
- One of the most recent systems capable of direct device fabrication in a manufacturing environment is the ELI at IBM's East Fishkill Laboratory. This laboratory is part of IBM's semiconductor manufacturing facility. The vector scan one (VS 1) is the predecessor system used for fabrication of high-resolution experimental devices.
- The scanning electron-beam approach is presently the most promising and the only proven fabricating technique for ultra-high density components. Although the technique will probably not be ready for use in the production environment for the next 5 years it will provide the technology to enable IBM and others to leapfrog existing systems and achieve the price-performance breakthrough forecasted by INPUT.

D. MASS STORAGE DEVELOPMENTS

- Another important component of large systems is random access memories. There is a critical level at which on-line electronic storage becomes cheaper

than paper. Once this level is reached systems concepts will change rapidly and major new applications areas will appear.

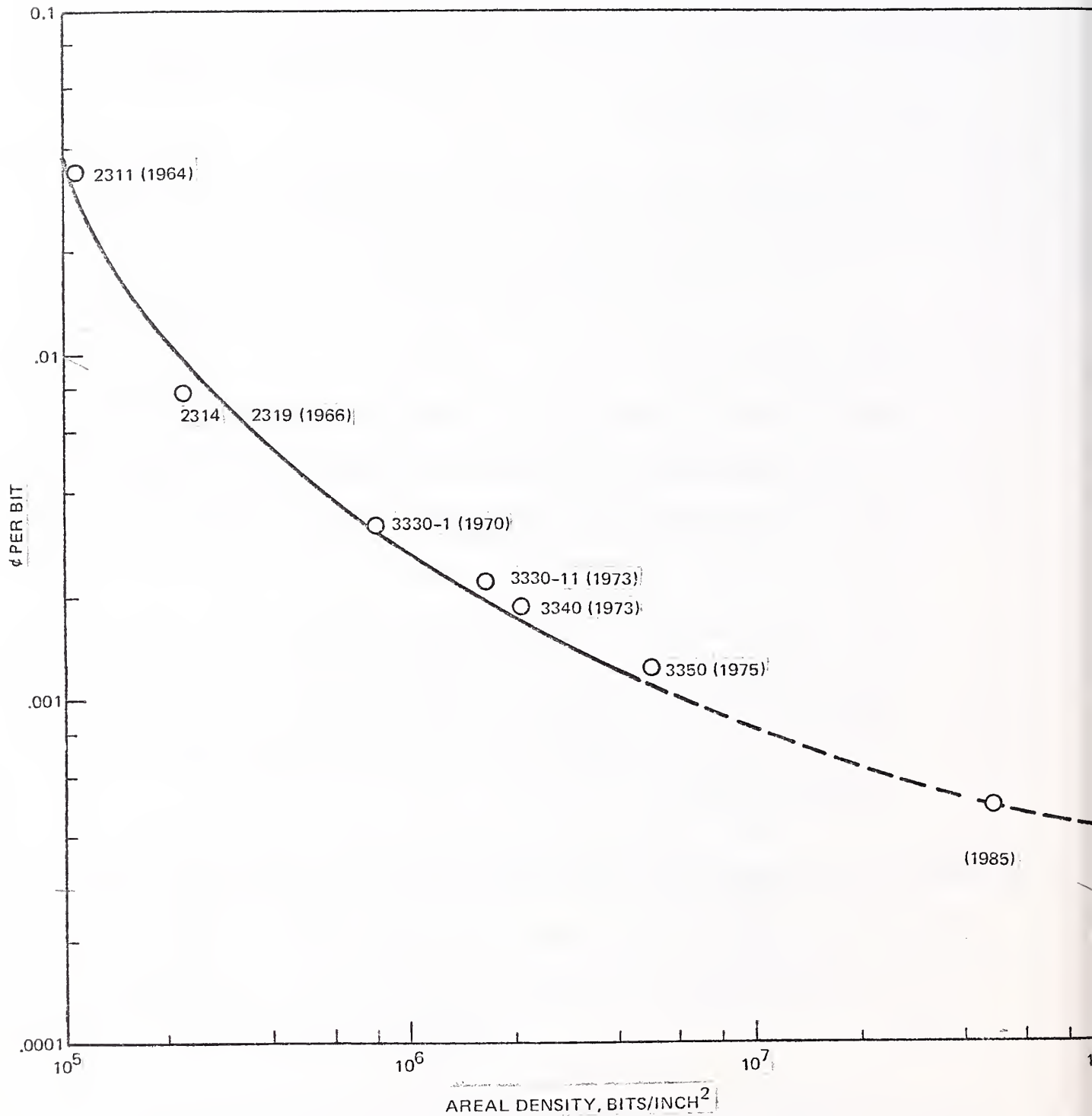
● Exhibit VIII-3 projects conventional disk storage costs and density based on historical trends. The projections are very conservative. However, simple analysis shows the following:

- On-line disk storage is projected to cost .0005 cents per bit by 1985.
- One billion bytes will therefore cost \$40,000.
- Based on average page contents, this represents 256,000 pages of computer printout.
- The cost of producing a page of computer printout has been estimated to be in the range of 4 to 13 cents. An average of 9 cents would mean that it would cost (on a one-time basis), \$23,040 to print that amount of data.
- The above cost does not include bursting, handling, filing, storage, and retrieval. As a matter of interest, 256,000 pages of printout would take 170 hours to print at 1,000 lines per minute and would be approximately 50 miles in length.

● INPUT forecasts that, with rising paper and labor costs, it will be cheaper to store and retrieve information electronically before 1985. This cross over will cause a profound change in the way business is conducted and information is handled.

● There are two new technologies which will make these breakthroughs possible.

HISTORICAL AND PROJECTED COST AND DENSITY
OF IBM DISK STORAGE DEVICES



- 'Thin films' which have the capability of increasing present disk densities at least 10 times and theoretically 100 times.
- 'Bubble memories' to be used in fast intermediate memories.
- Infomag plans to deliver production quantities of their thin film heads to an OEM vendor by the end of 1977.
- Texas Instruments has already announced a small bubble memory storage device. Univac, and perhaps others, plans to introduce a bubble memory intermediate storage device by the end of 1977.
- The direction is towards a microprogrammable, hierarchical memory adapting its configuration dynamically to the requirements of the programs being processed.

E. IBM STRATEGY AND TACTICS

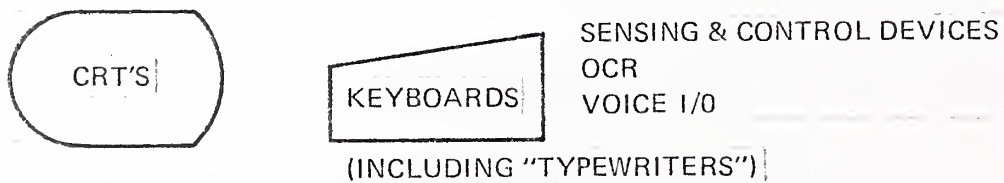
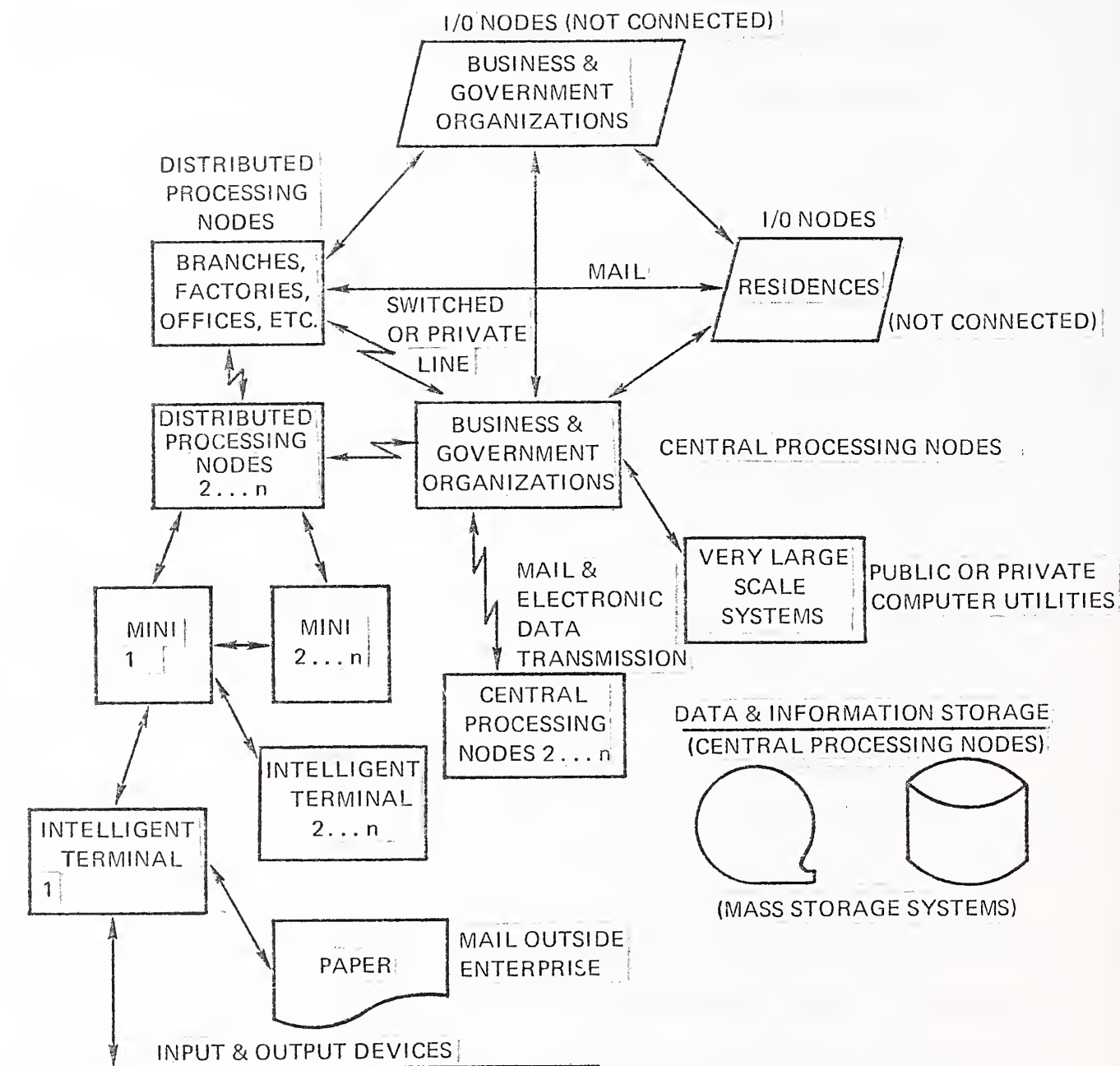
- This section analyzes IBM's projected strategy and tactics in computer/communications network development. Potential regulatory and legal restraints are considered beyond the scope of this analysis.

I. IBM'S LONG TERM STRATEGY (BEYOND 1981)

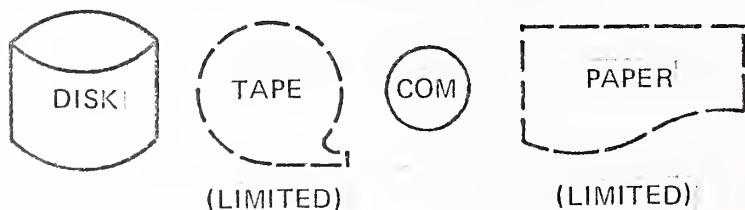
- By the early 1980s, IBM will be prepared to support a distributed processing network similar to the one depicted in Exhibit VIII-4. However, it will still offer users the choice of distributed or highly centralized processing.

DISTRIBUTED PROCESSING NETWORK

(MID-1980s)



DATA & INFORMATION STORAGE (DISTRIBUTED PROCESSING NODES)



- The functions of this network are essentially the beginning of a nationwide, and eventually worldwide, computer utility. However, in the early 1980s few major processing nodes will be interconnected.
- Within this framework, IBM will be positioned to offer the most complete range of products and services possible, including:
 - Large, data base oriented systems to support both private and public computer utilities. In addition, IBM will establish its own large scale computer/communications centers to provide services.
 - Distributed processing nodes which will be supported with a full line of minicomputers, intelligent terminals, and other input/output devices.
 - Specialized applications will incorporate firmware and hardware and will be sold on an 'as used' basis. Customization of hardware will start.
 - Value added network services will be offered as a separate item or as part of a broader computer/communications service.
 - Complete information handling systems and services for data entry, storage, processing, retrieval, duplication, and communications will be offered, including electronic mail for intracompany traffic.
 - Information (data and text) will be entered through digitizing rather than encoding techniques.
 - Switching services will be provided for interorganizational transfer of funds or business communications. Security bonds will probably be provided on such a service.
 - Bonded electronic storage of vital records will also be provided as a service.
 - Eventually (by the late 1980s) IBM will provide home data services.

- For various reasons, IBM may not be allowed, or may choose not to offer, some of the above services in the U.S. However, it must expand beyond current hardware and software boundaries in order to continue its growth.
- Implementing a plan to provide all these products and services is a task which will strain IBM's resources. From now until the early 1980s, when the characteristics of this plan become clear, INPUT anticipates a number of interim actions designed to contain the competitive situation until the new line of products and services, incorporating processors with new technology, are announced.
- At that time, instead of the characteristics of the central CPU being the prime feature, as it has with the System/360 and System/370, the characteristics of associated products and services will be more important.

2. IBM'S INTERIM STRATEGY AND TACTICS (1977-1981)

a. New, Large Processor Announcements

- An immediate concern to IBM must be the price-performance pressure on the 370/158 and 168 because of the 3033 processor and Amdahl announcements. The 370/158 and 168 have essentially been removed from the front-line of IBM products, except perhaps for attached processor configurations.
- INPUT predicts that, after enough time (less than a year) has elapsed to permit a thorough analysis of the reaction to the announcements, IBM will announce one or two processors below the 3033 for delivery in 1978 or early 1979.

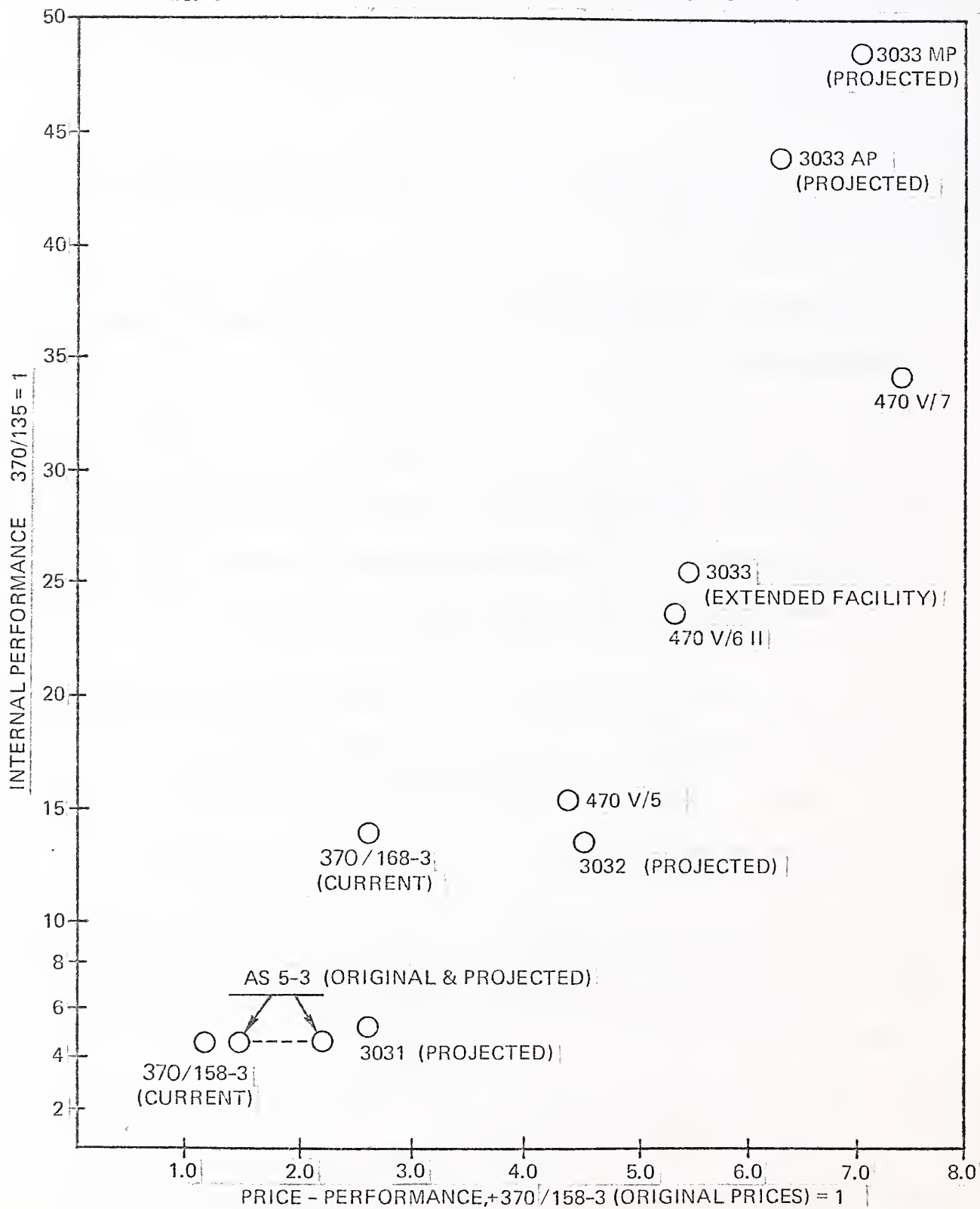
- As shown in Exhibit VIII-5, the 3032, the next largest processor to the 3033, will have power equivalent to the 370/168-3 at a price of approximately \$2 million and price-performance of 4.5 making it highly competitive with the Amdahl 470 V/5.
- The 3031 will be equivalent to the 370/158-3, sell for \$1 million, and have price/performance of 2.7.
- This will 'smooth' the product line down to the 370/148 and put great pressure on the Intel AS 5-3.
- The prompt reaction by Amdahl to the announcement of the 3033, with the 470 V/7, maintained its lead in uniprocessor power and price-performance. INPUT does not anticipate that IBM can obtain the power, or want to match the price-performance, of the 470 V/7 using its current technology.
- IBM's counter-reaction to the 470 V/7 was foreshadowed by the MVS Systems Extension announcement: "To meet the breadth of our customers' requirements, tightly coupled processors continue to be a prime vehicle for implementing advanced systems".
- The reaction of IBM at the high end will, therefore, probably be a 3033 AP or MP with 1.7-1.9 times the internal performance of the 3033 EF and 6.5-7.0 times the price-performance of the 370/158-3.

b. Mass Storage and Other Activities

- With the 'new hardware economics' central processors and main memory will reduce their share of the total systems cost until they eventually represent

EXHIBIT VIII-5

PRICE-PERFORMANCE OF PROJECTED LARGE SCALE PROCESSORS



less than 10% of the total (for large systems this is now about 40%). Therefore, processor announcements will not have as much potential significance as those for storage devices and communications systems.

- The long range potential market for random access storage is almost unlimited.
- New mass storage devices and systems announced before the new processor line of the 1980s will only be supported on the 3030 'mini-line' of processors. They will contain their own processors, relieving the central systems of function and improving price-performance at all levels.
- Unlike the 3030 processors, these storage systems will be oriented to the 1980's environment and part of IBM's overall strategy. IBM will continue to announce products at the high end of the spectrum emphasizing non-removable media.
- More significant than any hardware announcements will be activities in the software area. The burden of operating systems overhead obviously represents an area for systems performance improvement independent of processor speed.
- IBM will continue to unbundle operating system functions using hardware, firmware, and program products in a manner similar to System/370 Extended Function.
 - Current stable, program products such as compilers and sorts will be incorporated into firmware and hardware.
 - Stable portions of otherwise volatile products, such as IMS and CICS, will also be incorporated into firmware.

- General purpose applications systems will be made available at all levels in the processing hierarchy and will have firmware features.
- Functions will tend to migrate out from the central processor to local storage processors (as described previously), and to communications processors through the implementation of Systems Network Architecture (SNA), which is shown in Exhibit VIII-6.
- The divisions among hardware, firmware, and software will become blurred as new releases of system software and new program products are announced. This will have the following results:
 - Direct comparisons of performance will be difficult.
 - Additional revenue will be produced for IBM as it 'value prices' its products and services to maintain its revenue growth.
 - Hardware and software vendors will find it increasingly difficult and expensive to maintain compatibility with IBM systems in the SNA environment.
- IBM is heavily emphasizing the MVS operating system. A shift to VM, or integration with VM, is expected as the network plan is developed and the announcement of a new product line approaches. VM will have major advantages in a network environment, and new technology and architecture should facilitate its effective implementation.

c. Schedule of Product Announcements

- As demonstrated by Exhibit VIII-7, INPUT expects a stream of large system announcements between now and 1980. This does not include software,

EXHIBIT VIII-6
SYSTEMS NETWORK ARCHITECTURE

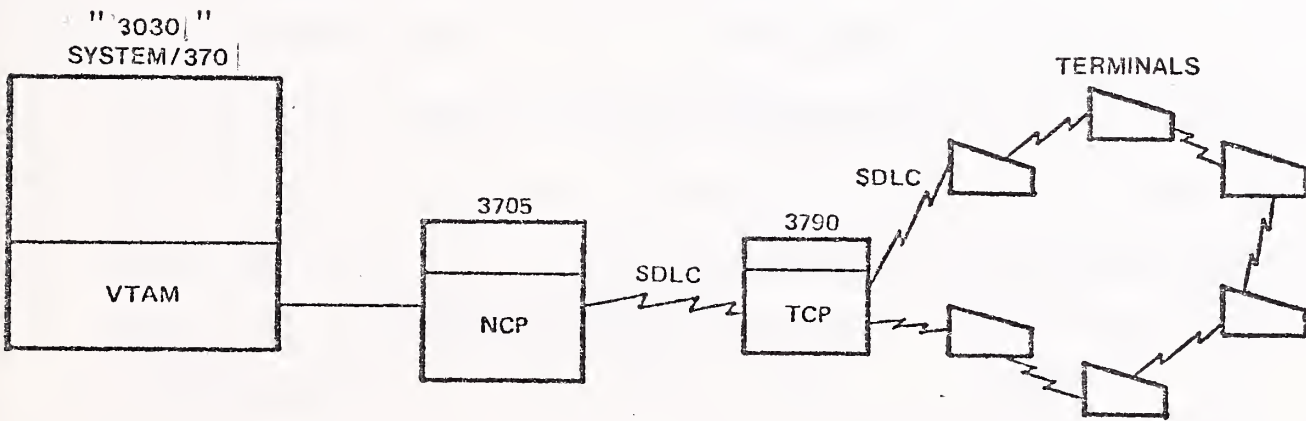


EXHIBIT VIII-7

PROBABILITY DISTRIBUTION BY YEAR OF LARGE SYSTEM
ANNOUNCEMENTS FROM IBM BY YEAR

PRODUCT	YEAR OF ANNOUCEMENT			
	1977	1978	1979	1980 OR LATER
NEW PRODUCT LINE		10%	20%	70%
3032 PROCESSOR	60%	40		
3031 PROCESSOR	40	60		
3033 AP OR MP	60	40		
NEW MASS STORAGE SYSTEMS		10	30	60

firmware, and specialized processor announcements that are expected to come at a relatively rapid pace. As IBM has stated: "Future developments will be driven by software".

- With a continuous, coordinated stream of product announcements, IBM can keep its competitors off-balance. This will also dissuade users from making commitments to other suppliers except as second sources.

F. AMDAHL'S REACTION TO IBM'S TACTICS

- Amdahl's prompt response to IBM's announcement of the 3033 processor will help them in the marketplace. However, the impact of the increased price-performance of the 470 V/7 on potential revenues falls heavily on Amdahl as it does on IBM. But Amdahl has a much smaller user base than IBM and little or no lease revenues.
- Amdahl also expanded its potential market area with the announcement of the 470 V/5. This was a controlled attempt to broaden its potential customer base without the requirements for substantially increasing marketing or systems support staff. The 470 V/5 appears well-positioned with regard to the IBM line at present.
- However, the 470 line itself is under severe compression. Within a price range from \$2,650,000 to \$3,480,000, Amdahl will have three major systems (470 V/5, V/6-II, and V/7) with the internal performance of the V/7 being 2.2 times the V/5. There does not appear to be enough price spread to support three systems and some realignment will probably be required in concert with delivery schedules. The 470 V/6-II can be viewed as a system to upgrade current V/6 and future V/5 users.

- In order for Amdahl to sell its mainframes it must continue to have a clearcut price-performance advantage over the comparable IBM systems. However, Amdahl's main advantages now are delivery and as an upgrade path for current customers. Amdahl must recognize this and be prepared to anticipate further IBM announcements.
- When the projected 3032 is announced, Amdahl could respond by adjusting the price of its 470 V/6-II to that of the V/5 and lowering the V/5 price to approximately \$2 million. This would result in a more reasonable price spread for the 470 line and establish clear price-performance advantages over the IBM line.
- The resulting price-performance comparisons could then be:
 - 3032 = 1.0
 - 3033 = 1.13
 - 3033EF = 1.26
 - 470 V/6-II = 1.49
 - 470 V/7 = 1.66
- Although this would place Amdahl in a favorable price-performance position, INPUT cannot predict its impact on profit margins.
- While the large systems market will represent a decreasing share of IBM's revenues over the long run, it is the only market Amdahl has and this could be an advantage. One of the proper functions of large systems is the replacement of multiple medium and small systems. IBM will not market aggressively in this area since it would result in negative 'Net Sales Revenue Increase' (NSRI). Amdahl, therefore, has an opportunity to exploit this marketplace.

- The most serious current issue to be addressed by Amdahl is the IBM System/370 Extended Facility announcement to which it has not yet adequately responded. Amdahl can certainly respond in some manner. However, any deviation from compatibility will result in an adverse customer reaction out of all proportion to its true significance.
- The important question to be addressed by Amdahl is: 'What will the long range solution be if IBM continues to employ the strategy represented by System/370 Extended Function?' INPUT predicts that this strategy will be followed by IBM.
- IBM could set a software direction Amdahl will find it difficult to follow. INPUT considers Amdahl may find it economically impossible to react to all the hardware/firmware/ software tactics in the large systems area described in this study.
- There is only one long-range answer; eventual deviation from total IBM compatibility. Under the proper circumstances this may be positive for Amdahl. The question here is 'Can Amdahl build a sufficiently large revenue base to support an independent development effort?' IBM's timing is critical to the answer.
- Between now and 1980, Amdahl will need to expand its product line. INPUT considers Amdahl will not expand its plug compatible processors to lower levels of the IBM product line. There are, therefore, two main expansion possibilities:

- Mass storage systems
 - Communications processors
- These are the two major market areas congruent with large systems in the future. Further, these are existing products in the Fujitsu-Hitachi lines. This strategy provides U.S. markets for the Fujitsu-Hitachi combine and continues the strong technology-manufacturing relationship (and possibly financial, if needed) between Amdahl and its Japanese associates.

G. ITEL HAS THE BEST OF BOTH WORLDS

- Under the new hardware economics, it is questionable whether the 370/158 should be regarded as a large system and Intel's systems are aimed at the 370/145 to 158 markets. Only the AS5-3 will be addressed in this report, since it has the performance of a 360/158-3 which is included in the scope of the study.
- The price reductions on the 370/158 moved it into practically a one-for-one price-performance relationship to the AS5-3. Intel has not issued a formal statement on its reaction to the IBM move. Intel probably anticipates additional IBM announcements which would be significant for them. Also, since the AS5 is 'sold-out' until the end of the year, Intel feels no immediate pressure to announce price changes.
- Nevertheless, Intel did not anticipate the severity of IBM's price cuts and the announcement caught it at a critical time when installing the first AS system.

- However, in the long run, Intel must have a clear price-performance advantage in order to have a viable product. This is less important in Intel's case than with Amdahl because of Intel's ability to 'package' the system as described below.
- The nature of Intel's business and its marketing approach gives it considerable advantages and flexibility in addressing specific user needs. Intel prefers to present an overall systems solution to the user at attractive savings. It is a financial services company and emphasizes financial advantages. Substitution of other manufacturers' products for IBM ones in a basically 'IBM' system package is its key to reducing overall system cost and keeping its profit margins.
- If a customer is reluctant to take an AS5, Intel will sell a 370/158 as the central component in a '370/158 system'. Hence, Intel has not felt compelled to publish specific prices of its processors which are 'bundled' in an overall package. This approach has definite advantages in a confused competitive environment.
- Intel will continue to market IBM products since it has a large inventory of IBM equipment. The effective management of this inventory is more important to Intel's overall profitability than any of its own products. IBM's aggressive price-performance attitude may give Intel second thoughts about the desirability of additional plug compatible processor offerings.
- The impact of IBM's hardware/firmware/software strategy must also cause Intel concern. Their business is marketing IBM systems, and users at the 370/148 to 158 levels are more sensitive to total compatibility than are Amdahl's customers. The prospect of continuing technical resource commitment to

remain compatible may cause Intel to question whether plug compatible mainframes represent a business it really wants to be in.

- The relationship with National Semiconductor may represent a 'target of opportunity' rather than part of a long-term strategy.
- As profits on plug compatible processors decline and the pressure in the middle of the IBM product line continues, Intel may choose to concentrate on the financial and packaging aspects of its business and to emphasize memory products. As systems become fully integrated into networks, they will have increased effective life and Intel will benefit from this trend.

IX. IMPACTS OF THE
NEW HARDWARE
ECONOMICS

IX IMPACTS OF THE NEW HARDWARE ECONOMICS

A. 'CHEAP' COMPUTER PROCESSING POWER IS HERE

- After all the promises, 'cheap' computer power is becoming a reality, at least from a processor capacity viewpoint. Conversion of this power to reduced costs of, or to increased capabilities for, user applications processing requires comparable improvements in software, storage, and communications functions.
- Advancing technology and competition IBM cannot afford to ignore, at both ends of its product line, have created this environment. IBM's reaction to these pressures and its own initiatives to increase its markets and market shares will impact every entity associated with the computer and communications industries.
- As the computer and communications technologies and industries merge, computer/communications networks will eventually become the dominant industrial force in the economy with wide impacts and implications.
- The remainder of this chapter, however, is concerned with the short range impacts of the new hardware economics.

B. IMPACTS ON PROCESSING SERVICES COMPANIES

- The internal power of the new, large systems limits their market in the sense that relatively few organizations actually can use that much processing power, as can be seen from the replacement ratios for the 470 V/7.
- This represents a substantial market opportunity for the processing services firms. As large system price-performance ratios (in throughput, storage and processing power) improve over medium and small systems, so do potential market areas and profit margins.
- As shown earlier, the distributed processing networks of the 1980s includes public and private 'computer utilities'.
 - Public computer utilities are those operated for sale as a service, by IBM, AT&T, services companies (such as ADP, CSC, Tymshare and UCC), and others
 - Private computer utilities are those set up by very large organizations, such as government and super-corporations, for their own use.
- In this framework, other organizations will find it increasingly difficult to justify the establishment of private utilities or more rudimentary networks.
- All else being equal, the service with the best price-performance should be most competitive. For example, if two companies were starting from scratch, an Amdahl 470 V/7 based service would have a 30% capacity advantage over a company installing an IBM 3033 processor.

- In the case of remote computing services in particular, these straight capacity considerations may be relatively unaffected by software and storage considerations. The impact of the price-performance characteristics is less important from the point of view of the possible impact on the price of services to the end user than it is from the point of view of the capacity of the vendors "factory." (In the above example, for instance, the actual price to the end user of the Amdahl 470 V/7 based service would be almost identical to that of the IBM 3033 based service if price of the central processor were the only difference; this price difference being swamped by the vendors' other direct costs.)
- It is important, therefore, for computer services companies to consider price-performance and straight performance improvements to take advantage of the new hardware economics.
- However, the new hardware economics reinforces a point INPUT has emphasized. The utility processing market will become increasingly price competitive; it is the specialized computer-based services, the software dependent services (particularly those for specialized applications), and the people - dependent 'packaging' of computer/communications facilities which will provide the continuing growth of revenues with reasonable profit margins.
- The increased capacity of large systems at reduced prices is also a threat to the computer services industry. Data processing management tends to spend the amount of money it has in the budget and if the same amount of money will buy twice the capacity at a given point in time then that will be done.

- Consequently, INPUT expects that the new hardware economics will result in a considerable number of large installations having excess capacity. Confronted with this, many installation managers will tend to sell it.
- 'Amateurs', selling excess capacity at cost recovery rates or lower, have been a real problem to the professional computer services industry, as witness the current controversy between Citibank and ADAPSO. INPUT projects this form of competition will increase with the new hardware economics.
- More seriously, however, some of the DP departments, with corporate direction, will decide to enter the computer/communications market directly in specialized areas. After all, the difference between a public and private utility, as defined previously, may appear to be a relatively straight forward case of adding marketing and support. And the computer/communications services areas are attractive from the point of view of corporate diversification.
- Companies in the remote batch market have often remained compatible with IBM. Timesharing or interactive services companies have not, even when they had IBM hardware. Services vendors must now evaluate anew the compatibility question; this is particularly true when considering the price-performance advantages of plug compatible processors.
- Large systems are becoming increasingly dependent upon the communications services and terminals which constitute parts of the overall system. All processing services companies must become increasingly sensitive to their customers' requirements in these areas and be prepared to provide end-to-end

service. In order to support terminals and/or minicomputers connected to customers' networks, the services companies must be prepared to follow any IBM hardware/firmware/software developments under SNA. This will become increasingly difficult in the future.

- IBM's possible entry into the computer/communications services business has become an issue. INPUT considers the computer services market in the U.S. very attractive to IBM. Furthermore, it cannot permit the computer/communications utilities to be formed and be relegated to the role of the 'Western Electric' of this emerging industry.
- As IBM makes its presence felt, mergers and acquisitions within the computer services industry will accelerate and there will be a substantial reduction in the number of significant processing services companies.

C. IMPACTS ON SOFTWARE PRODUCTS AND SERVICES COMPANIES

- Deficiencies and gaps in IBM systems software have led to the development and growth of a segment of the software industry which specialized in improving the function and/or performance of both the operating systems and specific program products.
- As IBM adopts a hardware/firmware/software approach to these problems, it will be difficult for companies who provide systems software enhancements alone to compete. For example, even the best systems programmer will find it difficult to write a Basic or APL interpreter which can outperform one which is in firmware.

- Future operating systems inefficiencies will tend to be either improved (or obscured) as functions are put into firmware or migrate to hardware at different levels of the processing hierarchy. (This includes storage systems which have their own processors, as well as dedicated processors to perform specialized processing or, eventually, data base functions).
- Included under this category are both hardware and software performance measurement systems. These systems have been (quite properly) applied primarily to the measurement and improvement of operating systems overhead and compiler inefficiencies. It will be difficult to develop and/or maintain independent performance measurement systems as functions are distributed to different levels of the processing hierarchy or implemented in firmware.
- Applications systems development may also be threatened in the new environment. IBM has repeatedly stated that human costs far outweigh hardware costs. This will become very clear to DP management as processing costs go down.
- General purpose data base systems have been one answer to the "programming problem". With processors becoming less expensive, terminals or minicomputers can be dedicated to specific applications, or at least receive their programs (perhaps in microcode) from other nodes in the hierarchy. Elimination of programming at the end user level represents an enormous marketplace. IBM knows this, and will not ignore this potential market.

- The increased recognition of programming costs will present opportunities for those computer services companies which can reduce these costs. Companies able to keep up with advancing technology will find a substantial increase in their potential markets.
- Applications programming as we now know it will become the target of its own technology. End users will be provided with hardware and languages which will permit them to "program" and get results tailored to their needs. Processing and storage inefficiencies will decrease rapidly as important factors.

D. MANUFACTURERS OF IBM PLUG COMPATIBLE MAINFRAMES

- The impact of IBM's 3033 announcement has already been presented and the potential impact of IBM's future strategy discussed. The same impacts apply to all potential plug compatible mainframe vendors.
- Although improved price-performance lowers both IBM and plug compatible mainframe vendor revenues (and profits), IBM will continue to strongly react to plug compatible competition in this way.
- IBM must obtain additional revenues to replace revenue gain 'lost' from new processors. A portion of this revenue will be obtained from systems software which was previously covered by processor prices.
- Plug compatible mainframe vendors are dependent upon that software. As the price of the software increases to users, the effective price-performance margin of the plug compatible systems will shrink; in some cases the margin will fall below the threshold at which users will consider them as viable alternatives.

E. IMPACTS ON MINICOMPUTER MANUFACTURERS

- The IBM 3033 and Amdahl 470 V/7 have improved price-performance of large scale mainframes to the point where they are competitive with minicomputers on a sheer price-performance basis. However, INPUT does not consider this will disrupt the basic economics of minicomputers in a hierarchical network as described in Chapter VIII. The 'trade-offs' are between communications costs and processing costs in many cases, and also between local file storage costs and file communications costs.
- Some minicomputer manufacturers welcomed IBM's endorsement of distributed processing. There was a feeling that it somehow made the concept 'socially acceptable' to computer users. There is some truth in this.
- In the past, minicomputer manufacturers have been selling "distributed processing" (but usually standalone processors) to end users, while IBM was selling large, centralized mainframes to DP management. Once IBM endorsed distributed processing in concept, it was difficult to argue that it would not work.
- This 'quasi-welcoming' of IBM by minicomputer manufacturers was based on the assumption that IBM's products would not be competitively priced.
- The announcements of Series I and System 34 have dispelled that illusion.
- Prices of these systems, the aggressive nature of the 3033 announcement, and price reductions on other 370 systems substantiate that IBM intends to compete on a price-performance basis across its product line.

- Revenues 'lost' on its traditional general purpose computers must be recovered by IBM. Minicomputers and terminals represent the fastest growing markets available. Thus, IBM will heavily penetrate them, regardless of past performance.
- Surprisingly, minicomputer manufacturers may initially have a marketing advantage in large organizations since IBM has traditionally sold to DP management and minicomputer manufacturers have sold to end users. Also, some end users have had poor experience with IBM systems, especially timesharing systems.
- The IBM sales staff has been trained to sell large systems even to the detriment of other products. This will result in an initial tendency to make improper distribution of function across the network. However, IBM will swiftly reorient key parts of its marketing organization to avoid this tendency.
- Minicomputer and terminal manufacturers will also be affected by the compatibility problems associated with IBM's implementation of SNA. As this develops, it will require considerable effort to interface with IBM hardware/firmware/software within the network.
- This effort will be far greater for a manufacturer trying to supply a minicomputer sharing processing and data bases with an IBM host processor than for a manufacturer of a 2780-compatible RJE terminal.

F. IMPACTS ON LARGE COMPETITIVE MAINFRAME MANUFACTURERS

- Except for the super-scientific processors, all large scale computer systems have grown up under the IBM pricing umbrella. When IBM increases performance and lowers prices, everyone in the industry is affected. However, the large system competitors have an additional cushion against processor price-performance moves by IBM: generally speaking, they have superior systems software.
- The burden of IBM operating system overhead has made superiority in this area relatively easy to achieve, because other manufacturers with more limited resources have adopted a more cautious approach on operating system development.
- Burroughs, CDC, Honeywell, and Univac are all using operating systems which have been incrementally improved for well over a decade. The result has been reliable and efficient software; however, it may not be effective for the next round of systems.
- Despite this software cushion, other manufacturers must reach to IBM's new competitive posture. IBM has decided the cost of processing data units is going down; hence it will go down for the whole industry not only its own customers. IBM will achieve growth from processing greatly expanded volumes of data and information; other manufacturers must position themselves to share in these new markets to survive.

- IBM may well renew efforts to penetrate competitive accounts with the new hardware economics, especially with larger companies. Fortunately for other vendors, conversion is still a problem and most of them have a relatively loyal customer base. Nevertheless, the pressures will mount and, in fact, most competitive mainframe manufacturers have already cut prices since IBM's announcement.
- In the long run, as large computer/communications networks develop and become interconnected, there will be a need for different systems to communicate with one another. Ultimately they will "speak the same language"; INPUT projects that future large scale systems will have multi-manufacturer application program operating modes, while operating in a true virtual machine environment.
- In this environment there will be minimal conversion problems. If IBM achieves this first and combines it with significant price-performance advantages, few of the other manufacturers will be able to defend their base of central processor customers.
- Computer services companies and computer utilities will find this feature especially useful.

G. IMPACTS ON COMPUTER USERS

- The computer user has come to expect that he or she will ultimately pay for improved price-performance. However, in this case, it appears the user will truly benefit from cheaper processing. The price is going to be several years of confusion which will make planning extremely difficult.

- Installing computer/communications networks, complex operating systems (such as MVS), and data base systems (such as IMS) are decisions which require consideration of many other factors besides processing costs. Key questions to be addressed include:
 - Will all today's systems (hardware and software) be made obsolete by the next generation?
 - Should processing be distributed or centralized?
 - Is the cost of chasing 'state-of-the-art' or advancing technology greater than the benefits?
- Few users have the resources available to evaluate the alternatives available in this complex competitive environment.
- It is possible to make multi-million dollar mistakes by moving too rapidly or too slowly in these areas.
- By the time computer/communications utilities are established, most users will be ready to purchase their computer/communications 'power' and let someone else worry about technology in that environment. Most organizations are going to have to worry about the impacts of technology on their basic business or function. In the meantime, they should enjoy the most economical data processing in the history of the industry.

ADDENDUM I

ADDENDUM I

COMPETITIVE RESPONSES TO THE NEW HARDWARE ECONOMICS

- Amdahl's rapid response to IBM's announcement of the 3033 and the price reductions on the 370/158 and 168 has been detailed in this report. The impact of the new hardware economics on other computer manufacturers has also been quite evident in the flurry of activity which has occurred during the last two months. The chronological sequence of events is depicted in the following exhibit.
- The chart indicates clearly the extent and sequence of IBM's new price-performance strategy.
 - New large scale system and price cuts on the established line
 - Minicomputer price cuts
 - Lower disc storage prices
 - New minicomputer and low to medium processor price reductions
 - New minicomputer models
 - Terminal & communications systems price reduction
- The reaction of other mainframe manufacturers clearly illustrates who set the price-performance standards in the industry. When IBM moves, everyone else follows even though direct price-performance comparisons are not possible.
- The CDC Omega series announcement is especially significant since it is a plug compatible announcement which occurred after the "New Hardware Economics". Preliminary analysis indicates the following:

ADDENDUM 1 EXHIBIT

ANNOUNCEMENTS ESTABLISHING THE NEW HARDWARE ECONOMICS

- x IBM ANNOUNCES 3033; 370/158 & 168 MARKED DOWN (30% to 35)
- ANDAHL ANNOUNCES 470V/5, 470V/7; 470V/6 MARKED DOWN (30%)
- x IBM SERIES/1, SYSTEMS 3, 7 & 32 MARKED DOWN (30 to 35%)
- x IBM CUTS 3033 DISK PRICES (15%)
- x IBM ANNOUNCES SYSTEM 34; 370/115, 125, 135, 145 MARKED DOWN (20%)
- BURROUGHS MARKS DOWN 7800 (13-29%)
- x IBM ANNOUNCES NEW SERIES/1 MODELS
- NCR ANNOUNCES N-8350, 8450, 8560
V-8450, 8560, I-8230 (CUTS MEMORY PRICES 30%
ON I-8250)
- HIS CUTS MEMORY PRICES (35%)
- UNIVAC CUTS 1100/10, 90/60, &
MEMORY PRICES (30%)
- x IBM CUTS TERMINAL
& COMMUNICATION
SYSTEM PRICES
(16-28%)
- o CDC ANNOUNCES
OMEGA LINE

3/27 4/3 4/10 4/17 4/24 5/1 5/8 5/15 5/22

- The CDC 480-I has internal performance 1.7 times the IBM 370/138, and a 1.9 to 1 price-performance advantage.
- The CDC 480-II has internal performance 1.6 times the IBM 370/148, and a 2.0 to 1 price-performance advantage.
- This is extremely aggressive pricing on the part of CDC, and practically indicates "calculator type" competition.
- CDC's marketing strategy has the advantage of an established IBM plug compatible peripheral customer base. Packaged systems proposals similar to Intel's can be made and financed through Commercial Credit (the financing arm of CDC). CDC also has an extensive IBM mainframe service capability.
- INPUT projects continuing price-performance improvements as the competitive battle heats up.

ADDENDUM 2

ADDENDUM 2

ANALYSIS OF PREVIOUS INPUT PROJECTIONS RELATIVE TO RECENT ANNOUNCEMENTS

- INPUT published "Amdahl as a Viable Alternative to IBM" in October 1976. That report projected various strategies and technical developments in the large scale systems marketplace. Those projections will be analyzed against the recent announcements which created the new hardware economics.
- The primary prediction was that IBM would be forced to react to the challenge of plug-compatible mainframes during late 1976 or early 1977. This certainly occurred!
- INPUT's predictions of short term (11/76-11/77) actions by IBM in the large scale systems market:
 - Lower the lease and purchase price of MOSFET memories. Comment: Announced.
 - Integrate the data channels into the mainframes and reduce prices by 20%. Comment: Channels integrated on the 3033, prices reduced 30%-35% on 370/158 and 168.
 - Increase the size of the high speed buffer to increased throughput. Comment: Buffer size doubled on the 3033.
 - Introduce a 370/158 APS with a 1.4 to 1.6 price-performance improvement. Comment: Announced before release of the 10/76 report and included as an addendum. Indicated performance improvement 1.5 to 1.8.

- Introduce replacements for the 370/158 and 168, a 370/168 APS-2. Comment: 3033 effectively replaces 370/168 and INPUT projects additional announcements in this study.
- Introduce a 2305 replacement to speed up the virtual memory operating system. Comment: Hardware/firmware/software assists for both VS and VM have been announced, but a 2305 replacement has not. (INPUT has another 5 months to find out whether we are human!)

• INPUT's predictions of longer term (1978) actions by IBM in the large scale systems market:

- Modify the architecture of the 370/158 and 168 by converting the mainframes into a functional multiprocessor containing an instruction processor, a service processor, a control processor, and one or more I/O processors, similar to the 115 and 125 design. Comment: The 370/158 and 168 have been obsoleted by the 3033 which is a move in the direction indicated.
- Change channel interfaces and introduce security hardware codes between I/O processors and the instruction processor. Comment: Still a good prediction.
- Put some of the operating system software into hardware to make compatibility more difficult. Comment: The hardware/firmware/software strategy adopted by the Extended Facility and MVS/System Extensions program product is just the beginning of this.
- Utilize the relocatable control storage and ROM's to put into hardware a variety of operating system kernals, applications and language processors to increase throughput and reduce the operating system overhead. Comment: Same as above.

- Increase number of instructions to facilitate VM. Comment: The VM/System Extensions have been announced. We still see hardware activity in the near future.
- Replace present components with higher density chips. Comment: This is still a possibility, although, as pointed out in this study, IBM did not do much with the 3033. The technical capacity exists, but the product strategy may delay introduction.
- Utilize a new memory technology such as bubble or CCD to reduce memory costs. Comments: Will still probably be done in selected areas.

INPUT also published the price-performance of projected 370 models as indicated in the following exhibit. The announcement of the 3033 obviously established a new scale of price-performance for the industry by a combination of improved performance and reduced price which was not anticipated.

The reason INPUT felt IBM would be restrained from making radical price-performance improvements was because of potential impact on its own revenues. IBM now has this revenue exposure; the "New Hardware Economics" explores the possible strategies which IBM may adopt to maintain revenue growth.

INPUT did project the 370/158AP accurately, and the 370/158-3 with reduced prices has price-performance approaching that which was projected to be necessary to maintain a competitive posture in that market area.

ADDENDUM 2 EXHIBIT

PRICE-PERFORMANCE COMPARISONS OF
PREVIOUSLY PROJECTED AND ANNOUNCED SYSTEM/370 MODELS

MODEL NUMBER	INTERNAL SPEED	PRICE-PERFORMANCE
370/135 (BASE)	1.0	1.0
<u>PROJECTED 10/76</u>		
370/158 AP	7.5	1.6
370/168 R	18.0	2.0
370/168-APS-2	34.2	2.8
<u>ANNOUNCED</u>		
370/158 AP	7.6	1.5
3033	22.4	5.0
370/168-3 (NEW PRICES)	13.2	2.3
370/158-3 (NEW PRICES)	4.6	1.4

- The 370/168 replacement projected had price-performance of 2.0; the 370/168-3 at reduced prices has price-performance of 2.3.
- INPUT stated that IBM would not introduce a "fighting machine", and it does not consider the 3033 to be a "fighting machine" for several reasons.
 - While aimed at the Amdahl 470V/6, the 3033 is a logical extension of the 370 line. Subsequent announcements have established an entirely new price-performance curve for the entire computer industry.
 - Previous "fighting machines" had only limited sales (the 360/9X had only 20 installations) and questionable profitability. Orders for the 3033 are already rumored to exceed 2,000 systems of which half are probably 'real' orders as opposed to speculation.
 - Rather than a "fighting machine", the 3033 announcement presaged IBM's intention to be price-performance competitive throughout its product line.
- It was also stated that Amdahl's management was aware of IBM's options and was ready with its own counter moves. They responded to the IBM announcement in 72 hours.

