M-SIA-IN
Letter
Original

January 9, 1987

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Dear
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:

Please find enclosed the following for your Information Services Industry-Specific and Cross-Industry Markets binder from INPUT's Market Analysis and Planning Service (MAPS).

1. Revised Table of Contents - insert in Volume I following the title page
2. Systems Software - tab and text
3. Insurance - tab and text

If you have any questions or comments concerning the MAPS program, please let us know.

Sincerely,

Gill R. Macmillan
Director, Research

GRM:ml

Enclosure

U.S. INFORMATION SERVICES
VERTICAL MARKETS, 1986-1991
DISCRETE MANUFACTURING SECTOR

MAY 1986

U.S. INFORMATION SERVICES VERTICAL MARKETS, 1986-1991
DISCRETE MANUFACTURING SECTOR

CONTENTS

U.S. INFORMATION SERVICES VERTICAL MARKETS, 1986-1991
DISCRETE MANUFACTURING SECTOR

EXHIBITS

I ISSUES, TRENDS, AND EVENTS

- This section will discuss the issues, trends, and events that impact or affect the discrete manufacturing sector. One of the major concerns of the manufacturing sector is improving productivity, which in the broadest sense reflects the growing feeling of urgency to keep American manufacturing competitive in worldwide and domestic markets.

A. PRODUCTIVITY

- Discrete manufacturers are responding to the challenge of worldwide competitive pressure by embracing automation as the secret to increasing productivity. Exhibit I-1 summarizes the many related issues and provides examples of the implications for information services vendors.

- Progressive manufacturers are also considering flexible manufacturing systems (FMS). Like "just in time," the objective is to reduce the carrying costs of inventory. Effective utilization of inventory and capacity are the main productivity goals for the industry. These FMS systems are designed to address the need between the high volume lines and the low volume operations such as numerically controlled machine tools.

  - FMS is a high potential growth area in that by the end of the century, one-half of the plants in the U.S. are expected to have these systems.

EXHIBIT I-1

ISSUES AND IMPLICATIONS

AREA	ISSUE	IMPLICATIONS FOR I.S. VENDORS
Markets	• Declining share of world-wide markets • Decline in U.S. merchandise trade balance • Heavy competition from "lower-cost" foreign firms	• Increased interest in improving production efficiencies
	• Need for company-wide automation strategies	• More rapid obsolescence of older automated systems • More frequent company-wide systems contracts with vendors
	• Need for increased inter-departmental planning and coordination	• Need for more education and training services
Production	• Interest in "just-in-time" manufacturing - Reduced inventory - Flexible set-up - Improved material handling - Instant communication	• Less complex MRPII planning units • Relational DBMS and group technology • Improved automatic storage and retreival systems • Physical linkage of shop floor and engineering systems via telecommunications • Factory floor LANs + office LANs • Standardization of network protocols (e.g., MAP) • Need for electronic information interchanges between suppliers, manufacturers, and dealers

- FMS is another area that requires the development of standards. The National Bureau of Standards has established the Automated Manufacturing Research Facility to develop the standard interfaces that will be needed. While these standards will not "generalize" the factory, they will help increase the ability to link the systems of diverse vendors.

- Other productivity thrusts include:

  - The application of artificial intelligence to develop expert systems.

  - The continued emphasis on computer-integrated manufacturing (CIM). The urgency of manufacturing management to embrace CIM is best demonstrated by the rush to support the manufacturing applications protocol (MAP). (For a more in-depth understanding of the CIM environment the reader should review INPUT's 1985 report Computer-Integrated Manufacturing Markets.)

B. ABSORPTION

- Absorption is currently a major issue, although it is not always recognized as such. Absorption, in this case, means that the rate of and amount of product available has reached a point where it is well ahead of the user's ability to "absorb" or implement new products.

  - Absorption applies directly in the software area and it partially accounts for the decline in the growth rate for software vendors.

  - Absorption is not as much of a problem in the discrete manufacturing sector as in other sectors due to IS management's continuing insistence on customized solutions.

- This phenomenon also is contributing to the lengthening of the decision cycle, since more products to evaluate result in absorbing more staff resources. To compound the problem, the rate of new product introductions has IS managers even more confused.

  - Yet another factor contributing to these delays is the increasing complexity resulting from planning for integrated environments. This complexity will continue to cause delays in the decision process.

  - This is very difficult for turnkey systems vendors, as their systems become more complex and the cost of sales goes up when the sales cycle stretches out.

- While absorption may not be fully appreciated by the user community, it is an issue that vendors should analyze carefully in terms of each of their market segments.

C. MAP

- The manufacturing applications protocol (MAP), along with the involvement of General Motors, is now well documented. The plan includes a five-step process to be completed over a four-year period. There are several important issues related to the MAP objectives:

  - Most of the major players have rushed to support the MAP "standard," a standard that will take several years to develop. The issue is: Will these vendors wait, will they act independently, or are they participating only from a PR point of view?

  - While the basic development timetable has been established, it covers four years and is very complex. Vendors should not wait for MAP;

planning for product modifications or enhancements should begin now to ensure current products can be sold.

- Assuming the standards are finally incorporated, INPUT predicts the timetable will far exceed the four years. In the meantime, there are ample opportunities in this sector.

D. IBM's POSITION

- As in other large markets, IBM will be a factor. In discrete manufacturing, IBM's strategy is expected to be similar to its general strategy, which is to maintain centralized systems. There are a few specific moves relative to manufacturing systems.

  - IBM has slowly but surely put a short-term strategy in place. Included for the short term are products for computer-aided design, industrial robots, shop floor microcomputers, and specialized workstations. These products will be sold to the islands of automation, but will not connect them.

  - IBM's longer term strategy is to tie these components together with an architecture based around data base management systems on the mainframe--more of the same centralized structure that INPUT has predicted for IBM throughout the 1980s.

  - Although IBM has announced MAPICS II implementation for the System 36 and the System 38, it does not appear this was for a departmental strategy, but rather for the low-end market.

  - A clear indication of IBM's commitment to this market is the special business units (the same tactic used to launch the PC) established last year to address CAD and robotics.

- IBM can be expected to follow the overall strategy predicted by INPUT in the late seventies. This strategy consists of introducing, in the early 1990s, decentralized architectures to address office automation and departmental computing. In the meantime, IBM will participate and confuse the market where and when necessary in order to fend off any perceived competitive threats.

- Despite IBM's commitment, they may not be the lead vendor in implementing complex manufacturing systems in the late 1980s and 1990s. These systems will involve multiple subcontractors and somewhere a lead "contractor" or system integrator will emerge.

E. SECURITY

- Security in the manufacturing sector is an emerging issue and is expected to elevate in importance as more companies interface and integrate systems. These interconnected systems become more vulnerable to unauthorized access, increasing the danger of damage to or tampering with corporate data.

- Some of the sensitive data manufacturers will want to protect include:

  - Bills of material.

  - Accounts receivable data.

  - Scheduling systems and data.

  - Capacity and resources planning systems and data.

  - Vendor, customer, and prospect files.

- Research and engineering data.

- Personnel records.

- The need for systems to "talk with each other" via LANs and other technology tends to open Pandora's box, especially when gateways are installed giving access outside physical plant boundaries.

- The issue is real, especially when the stakes of the game are considered in highly competitive sectors like the automotive industry.

II MARKET ANALYSIS AND FORECAST

- INPUT has segmented the discrete manufacturing industry sector as follows:
  - Manufacturing information systems (MIS).
    - Inventory control.
    - Scheduling.
    - Material requirements planning (MRP).
    - Manufacturing resources planning (MRPII).
  - CAD/CAM/CAE.
    - Computer-aided drafting (CAD).
    - Computer-aided design (CAD).
    - Computer-aided manufacturing (CAM).
    - CAD/CAM.
    - Computer-aided maintenance management (CAMM).

- Other industry-specific.
  - Computer-integrated manufacturing (CIM).
  - Process control.
  - Shop floor control.
- Cross-industry.
  - Products and services for planning and analysis.
  - Generalized accounting systems.
  - Human resources systems.
  - Engineering and scientific.
  - Education.
  - On-line data base services.
  - Other cross-industry products and services.

- Based on this segmentation, INPUT developed the following forecast data.

A. SECTOR FORECAST—INDUSTRY-SPECIFIC AND CROSS-INDUSTRY

- The overall performance of the discrete manufacturing sector was rather good, posting an increase of 18% from 1984. The outlook for 1986 is for continuing growth at a slightly higher rate. The annual growth from 1985 to

1986 is expected to be 19%. However, analysis of the subsectors shows a very mixed picture.

- The strong growth segments are printing and publishing, electronics and electrical equipment, furniture, and fixtures.

- The transportation and scientific control instrumentation segments showed moderate growth in the period. Transportation is expected to be a strong growth area in the 1987 to 1991 period as automotive companies step up their automation efforts.

- Corresponding with their economic performance, segments like leather products are declining markets and are not expected to be good targets.

- There are a number of favorable indicators for the discrete manufacturing sector.

  - Manufacturing shipments are up for the second year in a row.

  - There continue to be increased expenditures for new and replacement capital equipment.

  - The improvements in order processing, inventory movement and control, and other information systems have increased confidence in manufacturing management and their ability to get results with information systems.

  - The hunger for productivity improvement and what appears to be an increasing confidence in the American manufacturing system's ability to be competitive are favorable factors for information services vendors.

- As shown in Exhibit II-1, user expenditures for information services in the discrete manufacturing sector will grow at an average annual growth rate of 20% for the next five years.

  - The industry-specific expenditures are growing the fastest at 22%, from $3.3 billion to $8.9 billion during the period 1986 to 1991.

  - In the cross-industry segment the 1986 base of $4.2 billion will increase at an average annual growth rate of 18% to $9.5 billion in 1991.

  - The total expenditures within the discrete manufacturing sector, including those for professional services, will nearly triple, reaching $18.4 billion in 1991.

  - This overall performance is up slightly from last year's forecast primarily due to increasing expectations from information systems by management. The climate for increasing expenditures for computer-based solutions has improved in the past year.

- The movement toward increased automation has gathered sufficient support that this segment will continue to attract a great deal of attention from vendors. Exhibit II-2 shows the three major systems categories.

- Manufacturing information systems will increase by over two and one-half times by 1991 to become a $2.5 billion market. MRP, MRPII, and inventory control will continue to be the largest components. However, systems for scheduling equipment are expected to grow the fastest.

- Contributing to this growth are the availability of more micro-based products, more MRPII products, an increasing awareness of the need for CIM systems, and the gradual acceptance by senior management that they must automate to remain competitive in their markets.

EXHIBIT II-1

DISCRETE MANUFACTURING SECTOR
USER EXPENDITURES' GROWTH RATE, 1986-1991

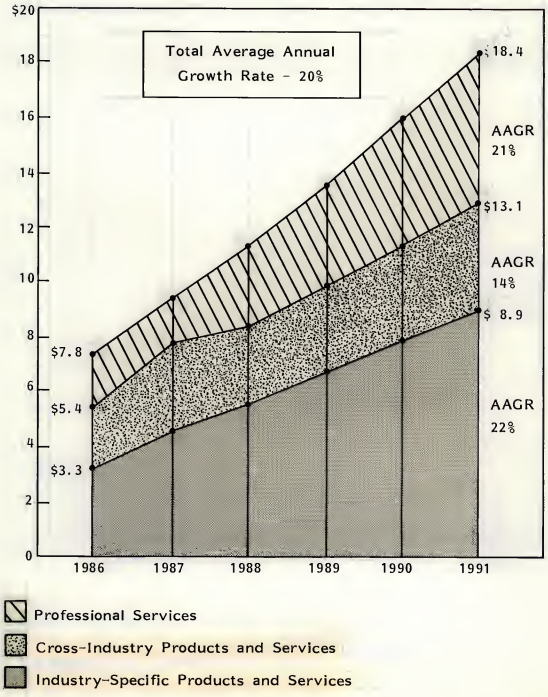
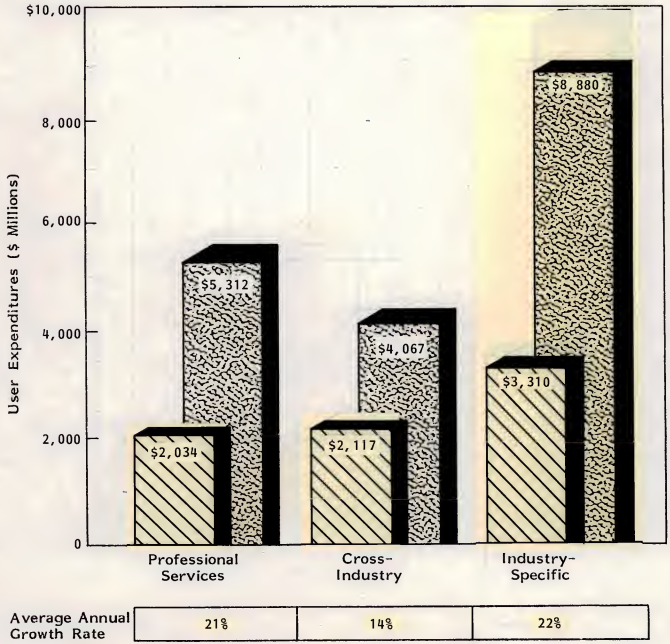


EXHIBIT II-2

DISCRETE MANUFACTURING SECTOR
TOTAL USER EXPENDITURES, 1986-1991



- Included in the "other" category are many important applications. However, only one offers a real opportunity to information services vendors, and that is CIM.

- The following section consists of an analysis of three market components--industry-specific, cross-industry, and total industry.

I. INDUSTRY-SPECIFIC EXPENDITURES

- The market size and growth rates are shown in Exhibit II-3. In terms of industry-specific products and services, turnkey systems is the dominant delivery mode in 1985 at $1.5 billion. The turnkey segment is expected to remain the dominant mode, sustaining a 21% annual growth and reaching $4.7 billion by 1991. Among the applications for turnkey solutions are CAMM, energy management systems, and real time shop floor control.

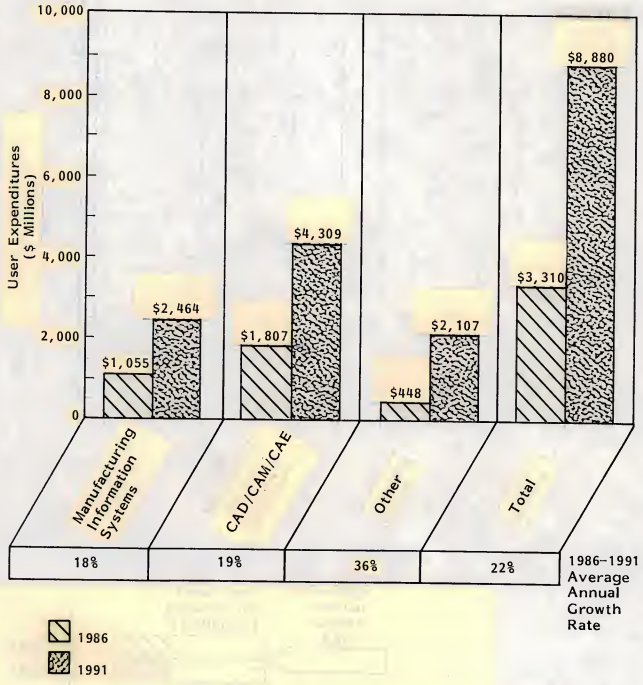
- Exhibit II-3 shows that CAD/CAM/CAE will continue to be the largest category. From a 1986 base of $1.8 billion, this segment will grow an average of 19% annually and will become a $4.3 billion market by 1991. As in the past, CAD and CAD/CAM will be the largest contributors. A relative newcomer, computer-aided maintenance management (CAMM), is expected to be the fastest growing application, expanding to five to six times its current size.

- In manufacturing information systems, software products will enjoy the highest average annual growth rate, over 21%, during the period and will reach $1.1 billion in industry-specific products and services by 1991. Expected software growth will come from a wide range of products--from micro-based MRPII systems to plant management. The sense of urgency to automate and stiffen competition will continue to fuel the growth.

- In the manufacturing information systems market, the processing/network services (PNS) market will continue to be the smallest segment but will grow

EXHIBIT II-3

DISCRETE MANUFACTURING SECTOR FORECAST COMPARISON
INDUSTRY-SPECIFIC INFORMATION SERVICES, 1986-1991



Note: Some segments included in the sector total are not broken out.

at an attractive rate, 17%, and will surpass $445 million by 1991. Among the forces driving the PNS segment are smaller manufacturers, specialty products like inventory forecasting, and emerging services like electronic data interchange (EDI).

2. CROSS-INDUSTRY EXPENDITURES

- The majority of cross-industry expenditures will come from professional services, as shown in Exhibit II-4. As stated earlier, a great deal of this is highly dependent upon industry-specific expertise.

  - Vendors should not be overly enthused by this $5.3 billion opportunity without evaluating the market requirements beyond "pure" professional services. At a minimum, knowledge of the manufacturing industry will be required to compete successfully.

  - Although the growth projections for the other cross-industry areas are 3% lower than professional services, the total available market will grow to an attractive $4.1 billion.

- The largest component of the nonprofessional services segment will be software products.

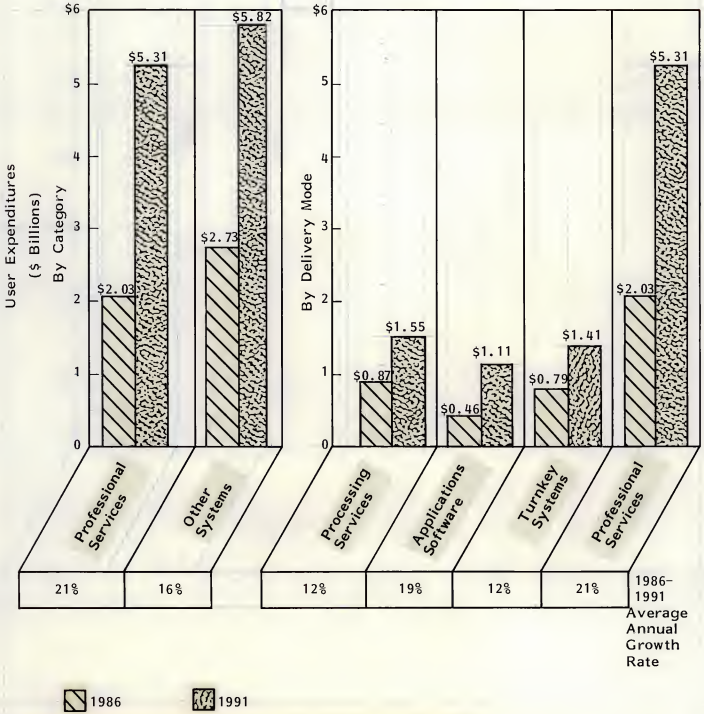
  - Applications software will tend to be more of the same--tools for planning and analysis, graphics editors, general design packages, and generalized accounting packages capable of interfacing or integrating with the other areas.

- The growth in the turnkey area will flatten out due to declining hardware prices and several other factors, such as:

  - The newer systems for discrete manufacturing becoming more and more industry-specific.

EXHIBIT II-4

DISCRETE MANUFACTURING SECTOR FORECAST
CROSS-INDUSTRY INFORMATION SERVICES, 1986-1991



Note: All dollars are rounded to the nearest $10 million.

- Most turnkey vendors have, or will have, real cost of sales problems as they try to establish distribution techniques for products that cost between $15,000 and $50,000. This is a sort of "no man's land," too expensive for retail and too expensive for traditional direct sales unless sales efforts are directed to large accounts and are multiple unit contracts.

3. TOTAL INDUSTRY SECTOR EXPENDITURES

- The Other systems category is the fastest growing and will remain so. This category, as shown in Exhibit II-5, will exceed $2.1 billion by 1991.

  - The major contributors to this growth will be the systems needed to support CIM. The high expectations for CIM will free the budget for CIM-related expenditures, industrial robotics, and other shop floor control solutions since all these areas are perceived as contributing to increased productivity.

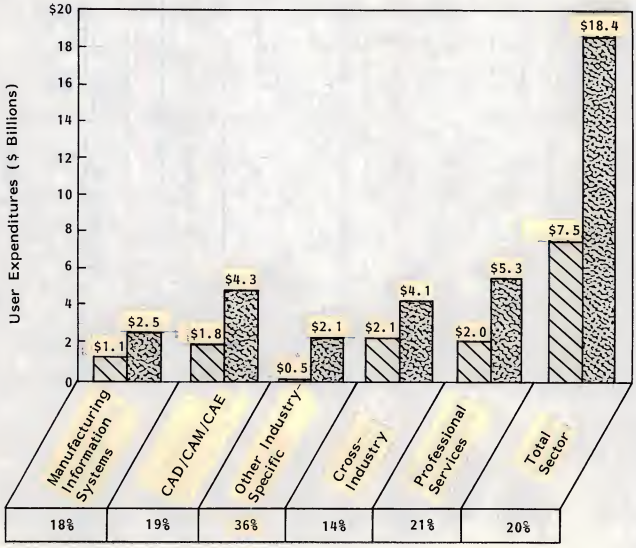
  - Impetus will also come from expenditures for networks to interface the "islands of automation." While this interfacing is short of integration, many manufacturers will implement interfaces, feeling it is better than no action at all.

  - Another contributor to the growth in this category, and in the sector overall, is the segment consisting of new/small but fast growing firms that are not tied to old systems and are conscious of the value of automated systems.

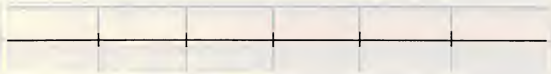
- The professional services segment's growth and size indicates that large vendors dedicated to manufacturing markets, such as EDS, will have the advantage. This will be further underpinned by the fact that users want solutions which are typically beyond their capacity to implement.

EXHIBIT II-5

DISCRETE MANUFACTURING SECTOR FORECAST
BY SYSTEM CATEGORY, 1986-1991



Note: Some segments included in the sector total are not broken out.



B. DELIVERY MODE

- The total sector expenditures by delivery mode are reflected in Exhibit II-6.
  - Software products will grow at the fastest rate, although it appears to be a fragmented market with lots of competitors and widely varied product offerings.
  - The growth in processing/network services will come primarily from EDI, VANs, and other network services.
  - Professional services and turnkey systems will continue to develop, although not at the rate many people were expecting.
- The best opportunities in the manufacturing sector may be for system integration or system integration-like activities. This is expected to emerge as the manufacturing systems become increasingly complex.
- Exhibit II-6 also shows the total picture and breakdown by the various categories and delivery modes.

C. MARKET SHARE OF LEADING VENDORS

- The market shares of the leading vendors in the CAD/CAM/CAE and manufacturing information systems markets are shown in Exhibit II-7.
- The vendor segments analyzed represent three of the four delivery modes--processing/network services, software products, and turnkey systems.

EXHIBIT II-6

DISCRETE MANUFACTURING SECTOR USER EXPENDITURE FORECAST BY DELIVERY MODE, 1986-1991

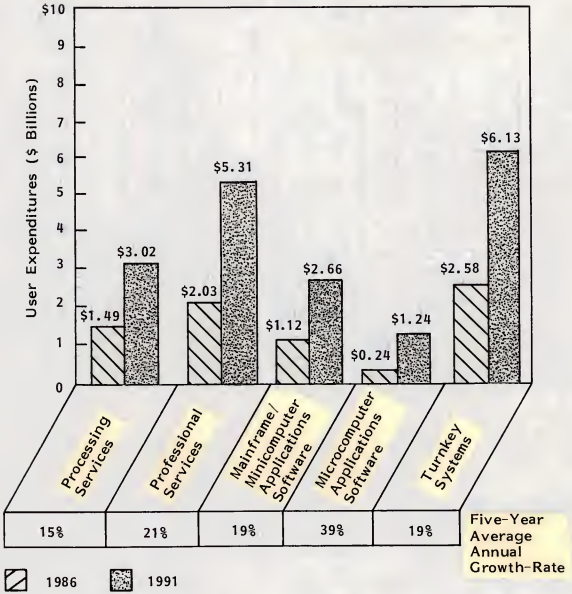


EXHIBIT II-7

VENDOR SHARES OF INFORMATION SERVICES VENDORS,
DISCRETE MANUFACTURING SECTOR, 1985

Vendor Name	1985 REVENUES ($ Millions)			
	Processing and Network Services	Applications Software	Turnkey Systems	Total
IBM	$12	$310		$322
General Electric Information Services	65	42	$111	218
Gerber Scientific			154	154
Computervision*			130	130
Boeing Computer Services	81			81
McDonnell Douglas Information Systems*	10		68	78
ASK Computer Systems	10	11	48	69
Control Data Corp.*			62	62
Hewlett-Packard		16		16
DEC		15		15
Subtotal	178	394	573	1,145

* 70% of U.S. Revenue for CAD/CAM/CAE

EXHIBIT II-7 (Cont.)

VENDOR SHARES OF INFORMATION SERVICES VENDORS,
DISCRETE MANUFACTURING SECTOR, 1985

Vendor Name	1985 REVENUES ($ Millions)			
	Processing and Network Services	Applications Software	Turnkey Systems	Total
Xerox Computer Service	$20	$25	$6	$51
Martin Marietta Data Systems	27	15		42
Intergraph*			36	36
Dun and Bradstreet	15	20		35
NCA		22		22
Comserv		21		21
Cullinet		20		20
American Software		18		18
MSA		17		17
Sperry		14		14
Madic		13		13
Subtotal	62	185	42	289
Total	240	579	615	1,434

* 10% of U.S. Revenues

- The delivery mode that has attracted the most vendors is software products. This is due partially to user demand and partially to vendor assessments of the market. Systems software vendors like Cullinet and Cincom are seeking to leverage their presence in these markets by launching applications software based on their tools, while others like MSA and Xerox are relying on their experience in applications software.

- Another important factor is the significance of the hardware vendors, especially DEC, HP, and IBM. This has a potential impact for other information services vendors to establish strategic partnering agreements with hardware manufacturers.

- While IBM does have a significant position in this sector, INPUT believes IBM's current strategy of centralizing information processing on large host computers provides a window of opportunity for competitors.

  - Manufacturing is currently one of the more decentralized industry sectors, and it appears they are willing to continue to embrace decentralized solutions.

  - INPUT further believes that IBM will not move aggressively into decentralized systems, based on the premise that the manufacturing sector will not find adequate solutions from competitors in the near term.

- The strong showing of the turnkey vendors in the market is evidence of the "islands of automation." These vendors are predominantly suppliers of CAD/CAM systems and are expected to maintain their presence and, through alliances such as GE Calma, be able to expand in the emerging CIM market.

III COMPETITIVE DEVELOPMENTS

A. MARKET STRUCTURE

- The discrete manufacturing sector can be analyzed several ways. This analysis will cover segmentation by the information systems categories of manufacturing information systems and computer-aided engineering.

1. MANUFACTURING INFORMATION SYSTEM

- The manufacturing information system has been the focal point of manufacturing systems for information services vendors. As previously stated, the primary components of the manufacturing information system are:

  - Inventory control.
  - Scheduling.
  - Materials requirement planning (MRP).
  - Manufacturing resources planning (MRPII).

- The underlying thrust for these "back office" systems is for planning and control. As such, manufacturers are having difficulty trying to figure out how the back office can truly support the other functional departments. This is a potential inhibitor to growth.

- Nevertheless, this segment continues to grow. In 1985 expenditures increased 19% to $1.1 billion. This growth is expected to contract slightly from 1986 to 1991, growing at 18% and reaching $2.5 billion by the end of the forecast period.

- This segment should benefit from new systems that are being developed to permit merging into the computer-integrated manufacturing architecture and, in some cases, into networked systems.

- Vendor participation in these back office systems is highly fragmented and diverse. The dominant vendor is IBM; others are:

  - In processing/network services the major players are McDonnell Douglas Information Systems Group, Boeing Computer Services, and GEISCO.

  - Cullinet, MSA, NCA, and Comserv are major software products companies in the MRPII market.

  - Computer Task Group, GMS/EDS, Arthur Andersen & Company, Analysts International, Keane Associates, and many others are pursuing the professional services opportunities.

  - In the turnkey systems area ASK Computer Systems is the dominant vendor.

- The large hardware manufacturers, IBM, DEC, Honeywell, Sperry, and a few others, will be the prime competition. INPUT recommends information services vendors consider alliances with these firms, especially for the very large opportunities.

- Another opportunity that is emerging with respect to these complex systems is systems integration. Long a practice by the federal government in procuring large complex systems, systems integration as a discipline is expected to become a major procurement strategy of the discrete manufacturers.

2. CAD/CAM/CAE

- The size of the CAD/CAM/CAE market has attracted many vendors. However, it is not as fragmented as the back office segment. The participants can be grouped in the following four categories:

  - Hardware (processors, digitizers, plotters, interface boards, controllers, and other peripherals) from vendors like IBM, DEC, HP, Tektronix, CDC, Perkin-Elmer, Apollo, and Sun Microsystems.

  - Software (graphics operating systems, image processing, animation, and application-specific products) from Applicon, Cadam, Grafcon, and others.

  - Turnkey systems (complete hardware and software applications systems for design, layout, and other applications) from Auto-trol, Intergraph, ComputerVision, GE Calma, IBM, and others.

  - Processing/network services (application-specific service products) from McDonnell Douglas, CompuServ, CDC, Dun & Bradstreet, and others.

- The highly structured nature of CAD/CAM/CAE applications creates the necessity for structured applications highly focused on the end-user requirement, thus making room for vendors who truly understand the market at a detailed application level.

- The supermicro and, to a lesser extent, micro-based products are creating confusion in this segment due to the very low price systems these products allow. The most dramatic evidence of this can be seen by the very poor performance of vendors like ComputerVision and Gerber.

- The CAD and CAM areas are still growth markets, but the emphasis for the future will be integrating CAD and CAM with other systems including:

  - Programmable controllers.
  - Shop floor control.
  - Quality control.
  - Planning.
  - Numerical control.

- The CAMM application system involves computer-based analysis and scheduling of maintenance. This is a most valuable tool and is primarily used for scheduling preventive maintenance. The next step is predictive maintenance that allows the system to analyze the machines and predict when failures are about to occur.

- The CAMM system consists of three major components:

  - Machine and production monitoring.
  - Maintenance dispatch.
  - Preventive maintenance.

- The leading users of CAD/CAM/CAE will continue to be in the electronics and transportation segments. The overall market for CAD/CAM/CAE systems will continue to grow. The projected growth from 1985 to 1986 is 22%. From a base of nearly $1.8 billion in 1986, expenditures are forecasted to grow to $4.3 billion in 1991, an average annual growth of 19%.

B. TEN LEADING COMPETITORS

1. IBM

a. Products/Services

- MAPICS, COPICS, many third-party applications.

b. Markets Served

- Large discrete manufacturing companies using IBM large systems (4300 and larger) with DOS/VS operating systems. Also, IBM's personal computers will be used extensively to extend market reach and depth.

c. Company Strategy

- IBM's strength centers around the widespread use of its hardware combined with the strength of its name recognition and support capabilities. In addition, IBM has the additional advantage of being able to integrate hardware and software at the point of sale. IBM can price low in order to promote hardware sales while still being able to support continued product improvements with lower R&D costs as a percentage of total sales.

d. Recent Activities

- IBM has not made public any significant activity in the areas of computer-integrated manufacturing (CIM) or in the integration of its traditional manufacturing software with CAD/CAM data conversion. However, IBM is moving behind the scenes in efforts like licensing AML, a manufacturing language, to machine tool vendors such as Cincinatti Milacron.

e. Future Directions

- IBM will move quickly to increase penetration of this sector in order to expand its presence now and leverage that presence in development of the CIM market. IBM will use its control of the corporate data base to gain control of factory systems through a "data integrity" strategy.

2. DEC

a. Products/Services

- VMCS, FDCM, PMCS.

b. Markets Served

- Large discrete manufacturing companies using VAX-11 and PDP-11 with RSX-11 and VMS operating systems.

c. Company Strategy

- Like IBM, DEC's strength is based on widespread use of their hardware, especially in industrial environments. DEC has been very strong in manufacturing communications and government applications. DEC has a worldwide software support and training services operation and provides services in 47 countries.

d. Recent Activities

- DEC has been emphasizing relationships with third-party application developers as well as developing new OEMs with machine tool and automated materials handling vendors.

e. Future Directions

- DEC will seek to develop allies in the non-computer technology segments and to leverage its existing strengths on the factory floor and with OEMs. DEC will also seek alliances with potential large-scale systems integrators

3. MSA

a. Products/Services

- Manufacturing system (MRPII).

b. Markets Served

- Very large (greater than $100 million) discrete and process manufacturers using IBM mainframes.

c. Company Strategy

- MSA benefits from excellent name recognition and size with a large user base and enough resources available to build a successful sales and support force. MSA entered the marketplace by acquiring ARISTA Manufacturing Systems from Xerox in 1982 and further strengthened its position in the marketplace by working with DBMS specialist ADR in developing MRPII's data base capabilities. Thus, MSA has been able to keep product development costs down while providing a truly integrated manufacturing/financial/design package based on an advanced DBMS product.

d. Recent Activities

- MSA has placed much emphasis on its fourth generation language known as Information Expert, which provides links from purchasing to accounts payable, from order processing to accounts receivable, and from manufacturing accounting to general ledger. MSA hopes to demonstrate the effectiveness of this product extension toward the ultimate goal of CIM.

e. Future Directions

- MSA has clearly taken advantage of the interest in its products spurred by the introduction of its Information Expert. By stressing the concept of integration along with increased ease of use, MSA will be able to attract a broader range of manufacturing customers.

4. CULLINET

a. Products/Services

- Cullinet Manufacturing System.

b. Markets Served

- Medium to large discrete and process manufacturing firms using IBM and plug-compatible mainframes.

c. Company Strategy

- Cullinet entered the manufacturing software market in 1980 by purchasing a manufacturing system from Rath and Strong. Prior to 1981, Cullinet (then known as Cullinane Data Base Systems) made a name for itself in data base development. Cullinet stresses the advantages of its MRPII software offering,

utilizing the highly regarded IDMS/R relational data base. While competitors tend to point out Cullinet's relative inexperience in manufacturing, Cullinet counters that a truly integrated manufacturing solution revolves around the data base and that its competitors' MRPII products utilize revamped 1970s technology in data base design. As a result, Cullinet tends to attract IS managers who like Cullinet's reputation, particularly in the area of data base design.

d. Recent Activities

- A recent shakeup at Cullinet reflects a desire to strengthen its image in manufacturing. Cullinet brought in former Data General executive David Chapman as Vice Chairman and Chief Executive Officer, prompting President Robert N. Goldman (one of Cullinet's original ten employees) to resign. Chapman's last position with Data General was Senior Vice President for manufacturing, and this move should signal increased attention to technological development into the manufacturing processes.

e. Future Directions

- After 21 consecutive quarters of growth in the 50% range, Cullinet slumped in the second quarter of their fiscal year 1986, down $2 million from the previous year. While initial reactions were still optimistic, in recognition of a slowdown in the overall software market, Cullinet is apparently recognizing the stagnancy of the cross-industry market and instead will concentrate on enhancing its manufacturing software. Specifically, Cullinet will increase activity in the areas of repetitive manufacturing processes and in integration of CAD/CAM and CIM applications.

5. ASK COMPUTER SYSTEMS, INC.

a. Products/Services

- MANMAN Information System, available as a turnkey system, as a software package, or as RCS processing services.

b. Markets Served

- Discrete and process manufacturing firms. Smaller companies (less than $10 million) are targeted with the RCS offering. Larger companies ($10-$100 million) that currently have DEC VAX or HP 3000 systems are targeted with the software offering. ASK has announced plans to offer a package for the IBM 4300 small mainframes and the DEC Micro VAX II supermicrocomputer.

c. Company Strategy

- After targeting the HP 3000 market exclusively, MANMAN sales for VAX systems are quickly catching up to MANMAN/3000 (for HP 3000 systems) and ASK expects that MANMAN/3000 sales should be equaled by the VAX sales in 1987. ASK's attempt to access the microcomputer market (via the Micro VAX II) is not its first. In 1983 ASK acquired Software Dimensions, turning it into ASK Micro, Inc. ASK hoped to expand the financial software offering into a micro version of MANMAN; however, distribution problems and persistent losses moved ASK to discontinue the project in 1984. With the Micro VAX II offering, ASK will compete for smaller ($1-$10 million) manufacturers with such vendors as MDS Qantel.

d. Recent Activities

- ASK has announced its intention to link MRP with automated test equipment and to develop a transaction-oriented data base management system.

e. Future Directions

1985 proved to be difficult year for ASK. While ASK has established plans to broaden its offering to more hardware engineers, reality may force it to focus its efforts. Being a major player in this sector may be beyond ASK's resources.

6. XEROX COMPUTER SERVICES

a. Products/Services

- Xerox Manufacturing System.

b. Markets Served

- Discrete manufacturing companies with IBM 4300, 370, 303X, or 308X mainframe systems. Also, Xerox targets smaller, decentralized, and transitional manufacturing companies with its RCS manufacturing system. Xerox also markets a turnkey manufacturing product called the Xerox Business Management System (XBMS) for customers as small as $10 million in annual sales and a turnkey system for companies with revenues of $40 million and up called the Entry Turnkey System.

c. Company Strategy

- In 1982 approximately 90% of XCS total computer service revenues were derived from processing services, with just under 10% from software products and only a fraction of a percentage coming from turnkey systems. Since then, the costs of acquiring computing power have come down to a level that has enabled many companies to bring processing in-house. Software and turnkey sales, particularly in the manufacturing market, now account for over 30% of XCS' annual revenues and could grow to 50% by 1987. While Xerox is certainly emphasizing manufacturing software sales, they are by no means

abandoning their RCS business. XCS stresses the advantages of RCS processing for those large manufacturers with widely dispersed operations locations due to XCS' networking expertise and the increased phone rates and difficulty in dealing with multiple phone companies since the breakup of AT&T. Other prime candidates for RCS manufacturing processing are startup companies who have not yet decided on their own data processing strategies. Thus, XCS steps in on an interim basis, providing both the industry-specific expertise and the data processing experience.

d. Recent Activities

- The major share of recent developments by XCS are in the software area, specifically in introducing or improving specific modules for its integrated manufacturing software products. Within the last year, XCS has introduced a number of new modules, including a repetitive manufacturing module for its Xerox Business Management System. Xerox also expanded its CAD systems line by introducing its Xerox Professional Mechanical Systems, an Ethernet-linked LAN of workstations that share common data bases.

e. Future Directions

- XCS has made public two specific goals for the future: first, to concentrate on accessing an enormous potential market of small- to medium-sized manufacturing companies and automating their factories' work floor; second, to place greater emphasis on moving toward computer-integrated manufacturing with much greater integration with CAD and MRP applications.

- Further, XCS has targeted Cullinet as its chief competitor in the market and should continue to make improvements and enhancements in its own package to compete with Cullinet's Manufacturing System, particularly in the data base management area. XCS feels that its offering is already superior on a functionality basis.

7. EDS

a. Products/Services

- Professional services and facilities management.

b. Markets Served

- EDS' association as part of General Motors is coordinating efforts to actively pursue improvement of the manufacturing process. EDS has been spearheading the efforts of American manufacturers to force hardware vendors to implement MAP on their systems. Now it has gone one step further by designing and testing MAP at GM's plants.

c. Company Strategy

- While EDS is working to put MAP on the factory floor, it is also building the large, complex data bases needed to tie in suppliers and dealers. Building and maintaining complex, accurate data bases is one of EDS' major strengths and will provide the means to integrate all segments of the manufacturing process. The dealers are being given direct electronic data communications with GM's computers, which will greatly speed up order taking and production scheduling. EDS will have great potential for commercializing this manufacturing systems integration expertise once the company can show off a few automated GM factories.

d. Recent Activities

- Besides manufacturing systems, EDS is building GM its own private communications network to expand communications capacity and reduce the cost of voice, video, graphics, and data exchange. This will provide new capabilities to enhance segments of the manufacturing information system.

e. Future Directions

- EDS will seek to expand the GM experience into the systems integration role and to be a leader in CIM markets.

8. COMSERV

a. Products/Services

- AMAPS/Q, AMAPS/G, AMAPS/3000.

b. Markets Served

- Discrete manufacturing companies with sales of at least $60 million using IBM and plug-compatible mainframes (AMAPS/Q); manufacturing companies who pursue government contracts (AMAPS/G); smaller manufacturing companies and companies with decentralized data processing facilities running HP 3000 minicomputers.

c. Company Strategy

- Comserv has relied on its reputation as the most experienced (its first product, MAPS, was introduced in 1976), most flexible (in terms of hardware that AMAPS can run on), and most specialized in the manufacturing industry. Comserv has developed a loyal customer base, due in part to continual product development since the early 1970s, but more importantly due to heavy emphasis on customer support services, including consulting, customization, and training. However, a slowdown in new orders (a slowdown that impacted most manufacturing software companies) along with questionable spending by the company (i.e., a $15 million headquarters in 1982) started a decline in revenues and profit that has forced the company to make a number of cost cutting moves, including the divestiture of its service bureau and international subsidiary businesses, significant staffing cuts, and a restructuring of both

executive and administrative organizations. Since 1983 the Securities and Exchange Commission has been investigating the company's financial reporting of 1981 and 1982 as a result of undisclosed agreements and irregularities in contract signing dates. Thus, Comserv has had to overcome an industry slowdown, questionable management direction during the early to mid-1980s, and the adverse publicity of an SEC investigation.

d. Recent Activities

- Comserv has taken a number of steps to reverse its slide. Along with the previously discussed reorganizational moves, Comserv has strengthened its relationshiop with Control Data Corporation, selling the distribution rights for Comserv's products outside of the U.S. In addition, CDC acquired an additional 815,281 shares of stock in the company in exchange for the cancellation of a $1.5 million promissory note. As a result, CDC owns preferred stock convertible into 20% of Comserv's common stock, with an option for additional stock purchases.

e. Future Directions

- In order to restore its place among the leaders in manufacturing software, Comserv will need to continue the structural changes started in 1985. While customer satisfaction and loyalty to its products remained high, the company will need to demonstrate to potential and new customers that the company is back on track, both financially and strategically, by emphasizing the company's strong points--an extremely well developed yet flexible software package, experience in manufacturing, and customer support.

9. NCA

a. Products/Services

- MAXCIM Manufacturing and Financial Software System, NCA/Design Verification System (NCA/DVS).

b. Markets Served

- Start-up discrete manufacturing companies utilizing DEC VAX superminicomputers and DEC PDP traditional minicomputers. NCA also offers both systems as an interactive timesharing basis.

c. Company Strategy

- NCA benefits from a close working relationship with DEC, continuing a cooperative marketing arrangement with DEC that facilitates NCA's ability to offer its software as a turnkey package. While NCA was able to survive the recent downturn in the semiconductor industry (which impacted NCA/DVS) sales, it has gradually emphasized its MRPII package (MAXCIM) which now accounts for 80% of all company revenues, up from just under 60% in 1983. Like many other MRPII vendors, NCA recognizes the importance of increasing CIM capabilities in its manufacturing software.

d. Recent Activities

- In early 1985, NCA completed the acquisition of two software development and consulting firms--The Systems Practice (Los Gatos, CA) and Avera Corporation (Scotts Valley, CA)--whose manufacturing products and expertise prove very complimentary to NCA's existing product family.

e. Future Directions

- NCA has been able to rely on limited competition for manufacturing software markets for DEC VAX equipment. In the past, NCA's only real competition has been ASK Computer. While the VAX penetration into manufacturing markets should provide steady growth potential, NCA will now have to be concerned with Martin Marietta Data Systems' entrance in the VAX market.

10. BOEING COMPUTER SERVICES (BCS)

a. Products/Services

- Production Management System (PMS), Maintenance and Materials Management (MMS).

b. Markets Served

- Discrete and process manufacturing software for HP 3000 systems.

c. Company Strategy

- Boeing is a well-recognized name, providing various forms of remote computing services, facilities management, and software products. Major industry markets are services to the federal government, engineering, and energy sectors. Future markets for BCS services will emphasize telecommunications, manufacturing, and distribution.

d. Recent Activities

- Boeing Network Architecture (BNA) is Boeing's architecture for systems within which the Technical and Office Protocol (TOP) has been linked with products from the Manufacturing Automation Protocol (MAP). MAP was demonstrated in model form in November 1985 at the Autofact Conference.

General Motors is implementing parts of MAP, with full implementation expected in 1988. MAP is the GM-developed and promoted manufacturing standard.

e. Future Directions

- Boeing will continue to develop capabilities in the manufacturing sector and will have the resources and technical knowhow to be a major competitor. Boeing will expand its products and presence.

IV INFORMATION SYSTEMS DEPARTMENT OUTLOOK

- This section presents the viewpoint of the internal information systems (IS) organization. This profile of IS is intended to provide additional insight into the user/buyer environment.

A. MAJOR ISSUES

- Discrete manufacturers and their IS organizations perceive themselves as facing two major threats to their survival. First, there is the threat of increased competition from low-cost offshore competitors and, second, the markets for their products are maturing. Their response to these forces is to try to reduce costs in any way possible.

- Technology is viewed as the panacea to the threats. Most major manufacturers are feverishly trying to implement automation, and they perceive the survival of the U.S. manufacturing industry as dependent on winning the technology race. This is an important issue, one that deserves more action and less talk. The current mode in the industry appears to be more talk than action. This may be due to a lack of products and services that address the real needs of firms in this sector.

B. ISSUES AND OBJECTIVES

- The purpose of most of the applications of technology is to improve productivity, not customer service or any other objectives. IS has the goal of integrating computer-based information resident in the product design, factory floor, and back office areas. Each of these have key information systems demands.

  - Product Design. Shorter product life cycles dictate the need to use computer-aided systems to shorten the product development time and make existing engineers more productive.

  - Factory Floor. The key issues are improved flexibility, service, and quality. The objective is again automation. However, IS perceives risk due to complex labor and equipment issues and the lack of application expertise among users.

  - Back Office. IS has difficulty supporting the organization. Many of their systems are out of date and/or standalone, making it nearly impossible to integrate with the other functions.

- Computer-integrated manufacturing (CIM) is being promoted as the solution to integrating these functional areas, but the current base of installed hardware and software presents major obstacles in attaining the objective.

  - As in other industries, information systems have been developed, or evolved, by function with little thought to integration. The need for integration was recognized 20 years ago in MIS theory but was discarded when it was recognized the technology was not sufficiently advanced to be considered feasible.

- Technology is now adequate, and IS management must determine how to integrate current systems within the CIM architecture. The challenges lie in deciding where to start and in developing a realistic plan to implement these new architectures.

- MRP applications are another key issue. IS management knows these systems need upgrading to include:

  - On-line operation.

  - Realtime capabilities.

  - Integration with a standard data base management system and other functional systems within the organization.

  - Connectivity with micro-based systems.

- Most manufacturers still perceive the operational value of IS, but not its strategic importance. IS managers continue to face the challenge of becoming an integral part of the corporate planning process. Information systems should be viewed as a key element of the business, not merely the vehicle for implementing technology.

- Exhibits IV-1 and IV-2 summarize the key issues and objectives for IS in the discrete manufacturing sector.

C. MANAGEMENT PERCEPTION AND ORGANIZATIONAL ISSUES

- Most manufacturers still view IS as a vehicle for cost containment. IS managers state that most senior managers have not grasped the true potential impact that information systems can have on the organization. Few senior managers perceive information systems as a corporate asset.

EXHIBIT IV-1

DISCRETE MANUFACTURING INFORMATION SYSTEMS ISSUES

- Operational Productivity
- Out-of-Date Systems
- Conversion to CIM
- Business versus Technical Orientation
- Ability to Assimilate New Technology
- Cost versus Competitive Systems Pressure

EXHIBIT IV-2

DISCRETE MANUFACTURING INFORMATION SYSTEMS OBJECTIVES

- Plan and Implement CIM Systems
- Upgrade MRP and Back Office Systems
- Increase Management Awareness of IS Value
- Create Compatible Networks
- Develop Measureable Corporate Objectives

- Most IS organizations report they have no formal measurement of their contribution to the company's success. Others report using budget comparisons or cost benefit analysis of individual projects as measurements.

  - IS still views results as project completion, and most projects are still focused on improving operations or programmer productivity.

  - In some cases the projects are more innovative and center on customer order entry or the integration of functional systems.

  - Exhibit IV-3 shows the measurement techniques used by IS and their views of the success of these techniques.

- In the past two years, IS has increased its corporate visibility. Among the factors accounting for this change, the most important are end-user computing and the gradual "sinking in" of the awareness that attaining competitive staying power through automation is, in fact, a necessity, not a luxury.

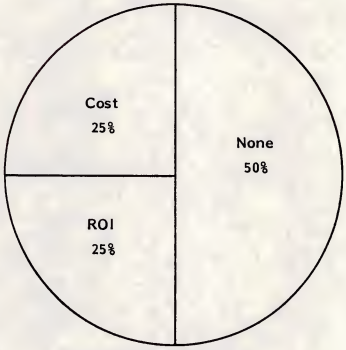
- Over the next two years, IS managers see their role increasing and their organizations becoming more involved in the business operations. This shift from a DP department to a true information systems provider includes more involvement in corporate planning, provision of end-user training and consulting, and more involvement in operational organizations.

- IS management views information systems being used as a competitive weapon primarily for reducing costs, improving productivity, and providing better tools for sales and marketing personnel.

- Exhibit IV-4 shows that discrete manufacturers primarily have a distributed processing environment. Most of the computing in the plants and summary information is transmitted either manually or electronically to corporate headquarters. This distribution will not change noticeably in 1986, although some additional emphasis for end-user computing is projected.

EXHIBIT IV-3

DISCRETE MANUFACTURING
I.S. MEASUREMENT TO MANAGEMENT



Percent of Responses

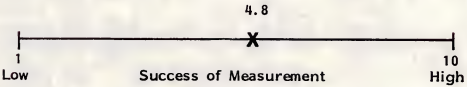
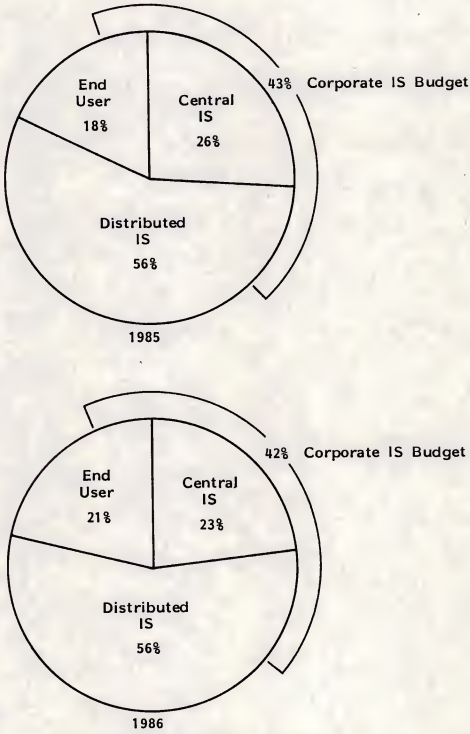


EXHIBIT IV-4

DISCRETE MANUFACTURING
DISTRIBUTION OF CORPORATE COMPUTING EXPENSES



Percent of Corporate and Company-wide IS Budgets

D. IMPACT OF TECHNOLOGY

- End-user computing is having a major impact on many organizations. Information centers to support users have increased the resource requirements of IS, but have also strengthened IS and increased the understanding of the potential of information systems. Also of value is the fact that more people in the organization are becoming computer literate.

- This awareness has also created other demands for micro-mainframe links and local area networks (LANs) to satisfy end-user needs or perceived needs. While this has expanded the scope of IS, it has also created opportunities for vendors to offer training, consulting, and other products and services.

- IS management views these developments favorably, citing that departmental computing works well in the distributed environment of most manufacturers and helps to solve some of the inherent problems of communications in this environment.

- Distributed systems development (DSD) is seen as having a moderate impact at present in spite of the high incidence of distributed processing. Most development is now done centrally, but this is expected to change, creating a major shift in the current development strategy.

- Other technology impacts are under study or only in the early stages of development.

  - Relational data bases are only being used in conjunction with fourth generation languages and are not expected to be widely used for at least five years.

  - Voice/data integration is seen to have high potential for significant cost savings, but is not considered to be a viable technology until the 1990s.

- While LANs are being used experimentally, the lack of standards has reduced the priority of wide-scale implementation.

- The impact of these technology issues is summarized in Exhibit IV-5.

E. END-USER COMPUTING

- While end-user computing has broadened the scope of IS responsibilities, it has also increased the demand on IS resources to support this new community of users.

  - IS management has taken the position of leading the microcomputer utilization.

  - Formal training programs on microcomputer use are being developed to meet the demand created by the increasing use of micros.

  - In this sector, IS is active in other support areas such as recommending hardware and evaluating and rating software.

- Exhibit IV-6 summarizes the role of IS in the discrete manufacturing sector.

  - IS is active in microcomputer acquisition and, in most cases, is responsible for controlling the proliferation of micros.

  - IS does little software development. Rather, they are advising users on the advantages and/or disadvantages of software products and how to use them.

  - IS provides training, mostly informal and primarily through the information center.

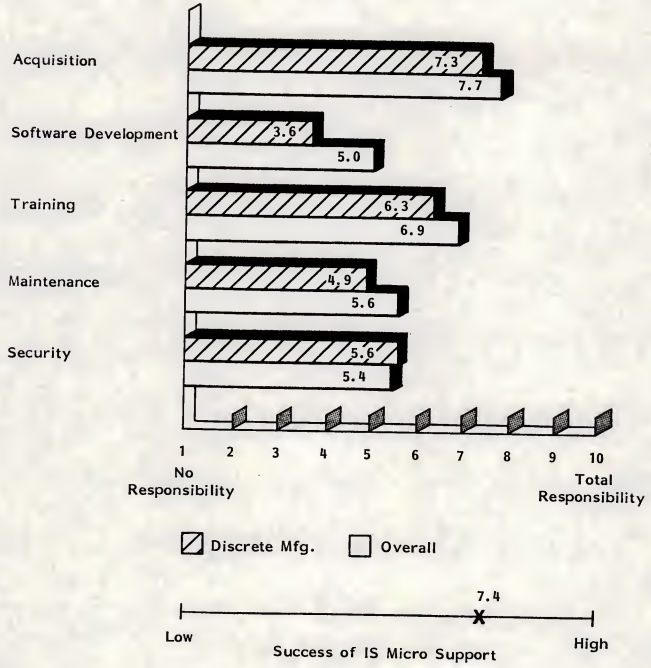
EXHIBIT IV-5

DISCRETE MANUFACTURING
IMPACT OF TECHNOLOGY

	IMPACT	COMMENTS
End-User Computing	Medium/High	Improves IS relationship with user. Increased IS workload.
Departmental Processing	High	Improves service and response time. Unique department data should be supported locally.
Distributed Systems Development	Medium	Major direction, usually only in planning stage.
Relational Data Bases	Low	Very little activity except in in conjunction with fourth generation languages.
Voice/Data Integration	Medium	Potential for voice paying for data; many companies waiting at least five years.
LANs	Low/Medium	Primarily experimental; standards are needed before corporate-wide implementation can occur.

EXHIBIT IV-6

DISCRETE MANUFACTURING
I.S. ROLE IN MICROCOMPUTER SUPPORT



- While maintenance is contracted, most IS organizations are at least coordinating this support.

- In terms of security, IS has generally established procedures and corporate policy. Their other role has been to create awareness of the need for security. Few companies audit for security compliance.

- Overall, the performance of this sector's IS organizations is fairly consistent with the overall industry results. The group rates their performance as being successful. They have not, however, surveyed the users to verify that belief.

I. NEW APPLICATIONS

- Most of the new applications development has been either upgrading old systems or implementing new versions of these old systems that can be integrated under a CIM architecture.

- Back office systems are also high priority, primarily for the CIM reason, although some of the pressure here is from the end-user computing experience.

- These and other high-priority applications are shown on Exhibit IV-7, which also shows nearly three-quarters of application development continues to be accomplished centrally by the IS department.

  - Software products have made some inroads as replacements for complex systems, but are typically heavily modified to reflect the unique needs of the company.

  - As expected, the heavy reliance on internal systems reflects a perception that standard packages cannot meet the "unique" requirements of these firms.

EXHIBIT IV-7

DISCRETE MANUFACTURING
NEW APPLICATIONS IN 1985

Most Important Applications

Finance (e.g. G/L, A/R, Cash Management)

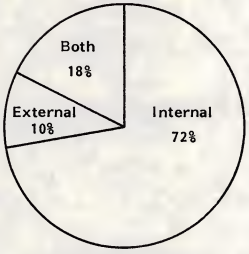
Shop Floor and Production Control

Human Resources and Payroll

Office Systems

MRP

Source of Development (All New Applications)



Percent of Responses

Cost Range
$2.5K - $16M

2. BUDGET ANALYSIS

- Discrete manufacturers' IS budgets are growing at a significantly lower rate than industry as a whole. While IS reports this is due to cost containment practices, it also demonstrates that senior management sees IS as an unavoidable cost rather than a potential competitive weapon.

- Exhibit IV-8 shows the 1985 budget distribution and the projected budget growth as a category for 1986.

  - The greatest growth is for micros, minis, and data communications, reflecting the distributed strategy of this sector.

  - Outside processing services are projected to decline, but they seldom do. Also, little growth is seen for turnkey systems or professional services. While this is to be expected, since this sector emphasizes internal development, it is unfortunate that IS does not see the value these services could offer to the monumental task at hand.

  - Exhibit IV-9 shows the 1985 budget growth for discrete manufacturing was 5.6%, only slightly more than half the overall industry rate of 10%. The plan for 1986 reveals more of the same budget constraints, rather surprising for an industry sector whose stated goal for the future is based on technology.

- Even more astounding is the fact that, as shown in Exhibit IV-10, over 40% of IS organizations say their budgets will grow at a slower rate than in 1985. While this can be accounted for by the financial difficulties of many manufacturers, it is a very shortsighted plan.

- The factors contributing to increasing IS budgets, in order of frequency of mention, are:

EXHIBIT IV-8

1985 BUDGET DISTRIBUTION AND 1985/1986 CHANGES
IN THE DISCRETE MANUFACTURING SECTOR

BUDGET CATEGORY	1985 PERCENT OF I.S. BUDGET	1985-1986 EXPECTED BUDGET GROWTH
Personnel Salaries and Fringes	41.1%	7.2%
Mainframe Processors	12.0	7.0
Minicomputers	3.7	9.4
Microcomputers	0.8	10.5
Mass Storage Devices	3.5	7.5
Other Hardware	7.1	5.0
Total Hardware	27.1%	8.6%
Data Communications	6.9%	9.4%
External Software	4.3	6.3
Professional Services	3.9	2.0
Turnkey Systems	1.7	0.0
Software Maintenance	0.8	6.4
Hardware Maintenance	5.1	5.6
Outside Processing Services	5.8	(2.5)
Other	3.3	1.9
Total	100.0%	8.8%

EXHIBIT IV-9

DISCRETE MANUFACTURING
I.S. BUDGET GROWING SLOWER THAN ALL I.S. BUDGETS

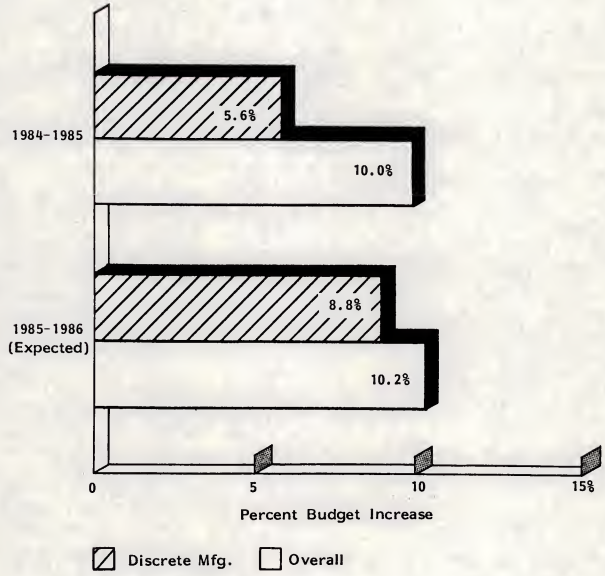
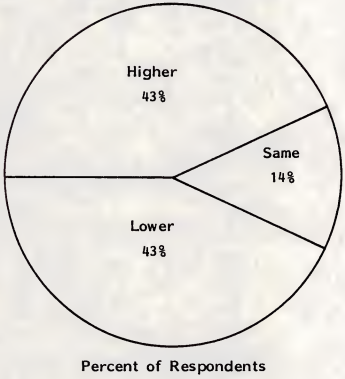
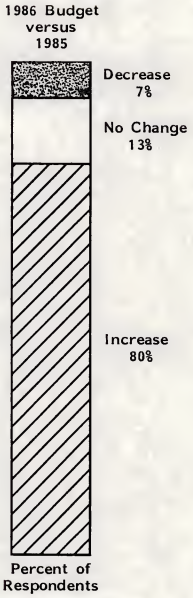


EXHIBIT IV-10

DISCRETE MANUFACTURING
MOST BUDGETS WILL INCREASE IN 1986





- Personnel expense.
- Hardware.
- Software.
- Data communications.
- Inflation.

- Factors contributing the most to decreases in IS budgets include:
  - Replacement systems.
  - Staff reductions.
  - Improved hardware efficiency.
  - Management edict to reduce costs.

- In summary, IS is still viewed as an operations department, although a transition has begun. Full acceptance of IS as a strategic partner is at least five years away in most discrete manufacturing companies. While this may be true, the pressure to compress this timeframe will become, as IS managers properly perceived it, a matter of survival.

V NEW OPPORTUNITIES FOR CLIENTS

- This section will discuss some of the opportunities for information services vendors.

- Because of its size, the manufacturing market has long been attractive for computer software and services vendors. The current size of the information services segment is approaching $7.5 billion.

- Many of the opportunities in this sector are well understood and well defined. Among these are the traditional segments including CAE, CAD/CAM, MRP, MRPII, and inventory management and control.

- The following is a discussion of significant opportunities for INPUT clients.

A. MANUFACTURING INFORMATION SYSTEMS

- There is a great deal of demand for linking these "back office" systems to other functional departments. Opportunities exist for network products, data base systems, systems integration, and professional services.

- There is also demand to replace the older back office systems with more up-to-date architectures that will allow connectivity. This is the real target for applications software developed around data base systems. This is also a potential foot in the door for participating in CIM.

- Electronic data interchange (EDI) is expected to be a significant opportunity for processing/network services vendors.

B. CAD/CAM/CAE

- As in the manufacturing information systems area, there is an opportunity in the CAD/CAM/CAE segment to link independent systems together. In some instances this is an interface strategy, in others an integration approach is required.

- An emerging demand is in the area of computer-aided maintenance management (CAMM). This is a high-potential opportunity for both software and turnkey vendors to develop systems for analyzing and scheduling maintenance in the plant. The predictive maintenance function is a logical enhancement to complete offerings in this area.

C. PROCESS CONTROL

- The demand for process control systems solutions is widespread and has created an opportunity for professional services vendors to develop interim systems for scheduling and inventory management.

- Another need in the process control area is for LAN and Gateway systems to connect the multitude of existing peripherals located in the plant.

D. SHOP FLOOR CONTROL

- The opportunities in shop floor control tend to be greater for hardware-oriented vendors.

- Because of this, information services vendors should consider joint venture relationships with hardware vendors who need applications software, installation support, and custom software development.

- While opportunities seem to be available for turnkey vendors, there are associated risks due to the potential demand for customization of these highly complex processes.

E. COMPUTER-INTEGRATED MANUFACTURING (CIM)

- The moving target labeled CIM presents many opportunities supported by enormous demand that will attract the very large competitors. Most information services vendors should develop strategies to partner with these very large vendors.

  - Systems integration (SI) is expected to be a very large market. The practice of using SI-type procurements has been employed successfully by the federal government for a number of years and would be a good model to emulate in the private sector.

  - Expertise in any of the following CIM components would make an attractive potential partner for the strategy of teaming with one or more of the very large vendors.

    . Computer-aided design.

    . Group technology.

- Manufacturing information systems.
- Automated handling systems.
- Computer-aided manufacturing.
- Industrial robots.
- Processing/network integration.

- There are also corresponding opportunities with small- to medium-sized manufacturers where the competitive pressures may be less severe.

VI CONCLUSIONS AND RECOMMENDATIONS

- The discrete manufacturing market will continue as a large and attractive opportunity for vendors of computer-based products and services. However, the market is expected to change frequently over the next few years as new applications and new solutions emerge.

- Clients wishing to participate in the discrete manufacturing market should begin now by developing detailed long-range plans. These plans should include, as a minimum:

  - Market segmentation and identification of specific segments by type of manufacturer, by functional target, by geographic area, and by the current competitive environment.

  - A thorough competitive assessment completed in order to understand who to compete with and who to team with. Potential competitive advantages and disadvantages must be identified and understood by all levels within the organization.

  - A complete staff analysis performed to determine the type of staff needed, the appropriate organization required, and the sources available for staffing to meet the plan.

  - A technology assessment by vendors to predict both new technology impacts and the potential timing of competitive or new technology. This evaluation should also include an analysis of technology needed to respond to competitive threats.

- Analysis by clients of the market for potential teaming alternatives. Candidates and their perceived strategies, strengths, and weaknesses should be identified and included in the plan by the gap that candidate would fill in executing the strategic plan.

- Don't be greedy. This is a very large market with many multi-million dollar opportunities.

- The manufacturing industry sector has had a history of propensity to build versus buy. Vendors should expect this attitude to continue to be prevalent. For software and turnkey vendors this means a strategy that includes the ability to customize the product. Such a decision must be a conscious, not opportunistic, one.

- Professional services vendors should evaluate the system integration practice in the federal government. Large, complex systems such as those expected in the manufacturing industry could benefit from this approach. A creative proactive thrust in system integration may be a winning strategy.

- INPUT's analysis concludes there will be many opportunities for vendors to "waste their time" on big deals that will never happen or whose decision cycle will be continually extended. All sales activity should be carefully monitored to determine any patterns in these procurements in order to adequately plan and deploy the sales resource.

- Sales campaigns should be structured around two central themes:

  - Cost reduction (this sector must be competitive to survive).

  - Time savings (translates to cost and the ability to respond to competition).

APPENDIX DM-A: DEFINITIONS

A. MANUFACTURING-SPECIFIC DEFINITIONS

- Bill of Material (BOM). A listing of all subassemblies, parts, and materials that go into an assembled part (showing the quantities of each).

- CAD/CAM. The integrated applications of CAD and CAM.

- Capacity Requirements Planning. The translation of open shop orders and planned shop orders into hours of work by time period and work center.

- Computer-Aided Design (CAD). Applications of computer and graphic technology to engineering, design, and drafting.

- Computer-Aided Engineering (CAE). The use of the full range of software and systems to model, simulate, and analyze a product before construction of production models. Also an encompassing term to include CAD/CAM.

- Computer-Aided Maintenance Management (CAMM). Systems for analyzing and scheduling maintenance in manufacturing plants. The predictive maintenance function would be the next logical development.

- Computer-Aided Manufacturing (CAM). Application of computer and graphic technology to manufacturing, engineering, planning, and control.

- Computer-Integrated Manufacturing (CIM). Integration of separately automated factory functions. These functions include MRPII, CAD/CAM/CAE, DSS, process control, ATE, and robotics. CIM is very complex and should be considered as requiring management change to commit to the technology and philosophy.

- Electronic Data/Document Interchange (EDI). The use of a communications network to transmit and receive electronic business transactions between multiple locations on an intra- or inter-company basis.

- Finite Element Analysis. As used in this report, includes all tasks involved in structural analysis using finite element methods--mesh generation, preprocessing, finite element analysis processing, and post-processing.

- Group Technology. The application of classification and coding technology to search a data base for information on similar parts and to apply this to CAD and CAM tasks.

- Manufacturing Resource Planning. An extension of MRP where MRP is integrated with financial planning, a simulation capability, and other functions on a closed-loop basis for the planning of all of the resources of a manufacturing company.

- Master Production Schedule. An anticipated build schedule that drives the MRP systems.

- Material Requirements Planning (MRP). A system to calculate material requirements on a dynamic basis using inputs from BOM, inventory status, open order status, and master production schedules.

- Nesting. Software to automatically or interactively arrange patterns for parts within stock material boundaries.

- Numerical Control (NC). CAM technology and systems for generating numerically-controlled machine tool programs.

- Shipments. The dollor equivalent of products shipped by a manufacturing establishment. Will usually be approximately equal to annual revenue.

- Shop Floor Control. Control of the progress of each customer order or stock order through the operations of its production cycle and the collection of data about actual completion results or status.

- Value Added. The portion of product shipment values originating in that industry; includes factors such as labor costs, depreciation, various business expenses, and energy costs. It is basically the difference between shipments and raw or input materials costs.

B. OTHER DEFINITIONS

- Data Base Management System (DBMS). A software system that allows a user to structure a data base by defining the data, its organization, and the association between data elements. It also includes a data manipulation language (for accessing, sorting, merging, etc.) and controls for concurrent use (security, request, queuing, etc.). Functions as a common interface to multiple applications.

- Distributed Data Base. A data base that is physically located at multiple sites, with each site having a part of the total data base. The sites are usually linked to a central site and have access to each other.

- Distributed Processing. Multiple computers simultaneously processing elements of a CAD or CAM task.

- Management Information System (MIS). A DP system specifically designed to provide business managers with company, financial, project, or program data.

- Networking. The interconnection and control of remotely located systems and devices over communications lines.

APPENDIX DM-B: FORECAST DATA BASE: DISCRETE MANUFACTURING SECTOR

- This appendix contains the following forecast information, as shown in Exhibits DM-B-1 through DM-B-4.
  - Market size by delivery mode for each year, 1985-1991.
  - Market growth rates for 1985-1986
  - Average annual growth rate (AAGR) for each delivery mode for the five-year period 1986-1991.

EXHIBIT DM-B-1

DISCRETE MANUFACTURING INDUSTRY SECTOR
USER EXPENDITURE FORECASTS, 1986-1991

SEGMENTATION BY DELIVERY MODE	($M) 1985	85/86 GROWTH	($M) 1986	($M) 1987	($M) 1988	($M) 1989	($M) 1990	($M) 1991	AAGR 86-91
PROCESSING SERVICES									
INDUSTRY SPECIFIC	525	18	621	740	887	1062	1218	1470	19
CROSS INDUSTRY	766	13	866	969	1086	1227	1374	1553	12
TOTAL PROCESSING	1291	15	1487	1709	1973	2289	2592	3023	15
APPLICATION SOFTWARE									
MAINFRAME/MINI									
INDUSTRY SPECIFIC	661	22	806	984	1210	1491	1644	1972	20
CROSS INDUSTRY	268	18	317	371	430	516	594	689	17
TOTAL MAIN/MINI	929	21	1123	1355	1640	2007	2238	2661	19
MICRO									
INDUSTRY SPECIFIC	56	63	91	157	241	331	476	714	51
CROSS INDUSTRY	110	32	145	188	245	304	423	529	30
TOTAL MICRO	166	42	236	345	486	635	899	1243	39
TOTAL APPL. SOFTWARE									
INDUSTRY SPECIFIC	717	25	897	1141	1451	1822	2120	2686	25
CROSS INDUSTRY	378	22	462	559	675	820	1017	1218	21
TOTAL APPL. SOFTWARE	1095	24	1359	1700	2126	2642	3137	3904	23
TURNKEY SYSTEMS									
INDUSTRY SPECIFIC	1481	21	1792	2155	2655	3191	3809	4724	21
CROSS INDUSTRY	699	13	789	898	1009	1131	1277	1405	12
TOTAL TURNKEY SYS.	2180	18	2581	3053	3664	4322	5086	6129	19
PROFESSIONAL SERVICES	1681	21	2034	2522	3103	3816	4579	5312	21
SECTOR TOTAL									
INDUSTRY SPECIFIC	2723	22	3310	4036	4993	6075	7147	8880	22
CROSS INDUSTRY *	3524	18	4151	4948	5873	6994	8247	9488	18
TOTAL	6247	19	7461	8984	10866	13069	15394	18368	20

* PROFESSIONAL SERVICES ARE INCLUDED IN THE CROSS INDUSTRY TOTAL.

EXHIBIT DM-B-2

DISCRETE MANUFACTURING INDUSTRY SECTOR-CAD/CAM/CAE
INDUSTRY-SPECIFIC
USER EXPENDITURE FORECASTS, 1986-1991

SEGMENTATION BY DELIVERY MODE	($M) 1985	85/86 GROWTH	($M) 1986	($M) 1987	($M) 1988	($M) 1989	($M) 1990	($M) 1991	AAGR 86-91
PROCESSING SERVICES	183	17	214	246	283	326	370	424	15
APPLICATION SOFTWARE									
MAINFRAME/MINI	293	24	364	401	488	612	760	912	20
MICRO	20	55	31	44	59	93	120	162	39
TOTAL APPL. SOFTWARE	313	26	395	445	547	705	880	1074	22
TURNKEY SYSTEMS	989	21	1198	1426	1711	2036	2402	2811	19
TOTAL	1485	22	1807	2117	2541	3067	3652	4309	19

EXHIBIT DM-B-3

DISCRETE MANUFACTURING INDUSTRY SECTOR
MANUFACTURING INFORMATION SYSTEMS
INDUSTRY-SPECIFIC
USER EXPENDITURE FORECASTS, 1986-1991

SEGMENTATION BY DELIVERY MODE	($M) 1985	85/86 GROWTH	($M) 1986	($M) 1987	($M) 1988	($M) 1989	($M) 1990	($M) 1991	AAGR 86-91
PROCESSING SERVICES	174	17	204	239	281	325	370	445	17
APPLICATION SOFTWARE									
MAINFRAME/MINI	339	19	404	468	554	665	798	957	19
MICRO	18	61	29	41	56	77	108	146	38
TOTAL APPL. SOFTWARE	357	21	433	509	610	742	906	1103	21
TURNKEY SYSTEMS	352	19	418	489	572	669	783	916	17
TOTAL	883	19	1055	1237	1463	1736	2059	2464	18

EXHIBIT DM-B-4

DISCRETE MANUFACTURING INDUSTRY SECTOR
OTHER MANUFACTURING APPLICATIONS
USER EXPENDITURE FORECAST, 1986-1991

SEGMENTATION BY DELIVERY MODE	($M) 1985	85/86 GROWTH	($M) 1986	($M) 1987	($M) 1988	($M) 1989	($M) 1990	($M) 1991	AAGR 86-91
PROCESSING SERVICES									
INDUSTRY SPECIFIC	168	21	203	255	323	411	478	601	24
CROSS INDUSTRY	766	13	866	969	1086	1227	1374	1553	12
TOTAL PROCESSING	934	14	1069	1224	1409	1638	1852	2154	15
APPLICATION SOFTWARE									
MAINFRAME/MINI									
INDUSTRY SPECIFIC	29	31	38	115	168	214	86	103	22
CROSS INDUSTRY	268	18	317	371	430	516	594	689	17
TOTAL MAIN/MINI	297	20	355	486	598	730	680	792	17
MICRO									
INDUSTRY SPECIFIC	18	72	31	72	126	161	248	406	67
CROSS INDUSTRY	110	32	145	188	245	304	423	529	30
TOTAL MICRO	128	38	176	260	371	465	671	935	40
TOTAL APPL. SOFTWARE	425	25	531	746	969	1195	1351	1727	27
TURNKEY SYSTEMS									
INDUSTRY SPECIFIC	140	26	176	240	372	486	624	997	41
CROSS INDUSTRY	699	13	789	898	1009	1131	1277	1405	12
TOTAL TURNKEY SYSTEMS	839	15	965	1138	1381	1617	1901	2402	20
PROFESSIONAL SERVICES	1681	21	2034	2522	3103	3816	4579	5312	21
SECTOR TOTAL									
INDUSTRY SPECIFIC	355	26	448	682	989	1272	1436	2107	36
CROSS INDUSTRY	3524	18	4151	4948	5873	6994	8247	9488	18
TOTAL	3879	19	4599	5630	6862	8266	9683	11595	20

APPENDIX DM-C: FORECAST RECONCILIATION

- This appendix contains the following information:
  - Exhibit DM-C-1 which indicates the changes made in this year's forecast as compared to last year's.
  - An explanation of any changes that were made to the forecasts.
- INPUT has made a significant adjustment in the size of the market for processing services. To avoid double counting, the cross-industry CAD/CAM/CAE processing services sold to the discrete manufacturing industry have been largely subcontracted out. It was deemed that those revenue had also been counted in the Engineering and Scientific cross-industry processing services. There is considerable overlap betwen the two sectors; previously, they each contained industry-specific and cross-industry CAD/CAM/CAE user expenditures. This year, INPUT has removed the cross-industry component from the Discrete Manufacturing industry-specific user expenditures and likewise removed the industry-specific component from the Engineering and Scientific sector.

EXHIBIT DM-C-1

DISCRETE MANUFACTURING INDUSTRY SECTOR
DATA BASE RECONCILIATION OF MARKET FORECAST
INDUSTRY-SPECIFIC BY DELIVERY MODE

DELIVERY MODE	1985 MARKET			1991 MARKET			85-90 AAGR FORECAST	86-91 AAGR FORECAST
	1985 FORECAST ($M)	1986 REPORT ($M)	VARIANCE AS % OF '86 RPRT	1985 FORECAST ($M)	1986 FORECAST ($M)	VARIANCE AS % OF '86 FCST	IN '85 REPORT (%)	IN '86 REPORT (%)
PROCESSING SERVICES	825	525	57%	2241	1470	52%	19%	19%
INDUSTRY SPECIFIC APPLICATION SOFTWARE								
MAINFRAME/MINI	661	661	0%	1813	1972	-8%	20%	20%
MICRO	56	56	0%	685	714	-4%	53%	51%
TOTAL APPLICATION SOFTWARE	717	717	0%	2498	2686	-7%	24%	23%
TURNKEY SYSTEMS	1481	1481	0%	4549	4724	-4%	21%	21%
INDUSTRY SPECIFIC TOTAL	3023	2723	11%	9288	8880	5%	21%	22%