DISCRETE MANUFACTURING INDUSTRY

INPUT

# ABOUT INPUT

Formed in 1974, INPUT has rapidly grown to become a leading business consulting company in the information processing industry. It specializes in market research, planning services, and special analyses for users and vendors of computer, and communications, and office products and services.

The company carries out continuous and in-depth research with vendors and users in the industry. Our staff analyze and interpret the complex and voluminous data derived from this research, based on their experience and the needs of clients. This information is presented concisely and understandably through reports and presentations. Useful recommendations and access to back-up data are strong points of our client relati

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JAPAI.

Overseas Data Service Company, Ltd.
Shugetsu Building, No. 12-7 Kita Aoyama
3-Chome Minato-Ku
Tokyo, 107
Japan
(03) 400-7090

COMPUTER SERVICES MARKETS

IN THE

DISCRETE MANUFACTURING INDUSTRY

INDUSTRY REPORT #10

OCTOBER 1977

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IN THE

DISCRETE MANUFACTURING INDUSTRY

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COMPUTER SERVICES MARKETS

IN THE

DISCRETE MANUFACTURING INDUSTRY

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# I. INTRODUCTION

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# I. INTRODUCTION

- This report is produced by INPUT as part of the Market Analysis Service, and covers the discrete manufacturing industry sector.

- This industry sector was selected for study because of high client interest, and because most major services vendors derive at least 10% of their revenues from it.

- Before the research began, INPUT clients were asked to suggest specific issues and areas of interest to be incorporated into this study. As a result, the research concentrated on an examination of the manufacturing function rather than functions such as accounting, administration, distribution, and R&D.

- Research carried out for this report included a series of interviews, as specified in the Appendix in Exhibit A-6.

- Interviews were carried out in August and September, 1977.

- Separate questionnaires were used for mail and telephone interviews for vendors, users, and non-users of processing services. Sample copies of these questionnaires are included in the Appendix.

- Inquiries and comments on the information presented in this report are invited from clients.

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# II. EXECUTIVE SUMMARY

## II.  EXECUTIVE SUMMARY


## A.    OPPORTUNITIES FOR COMPUTER SERVICES COMPANIES


- At estimated 1977 user expenditures of $900 million, the discrete manufac-
  turing industry sector is the second largest current market for computer
  services, after banking and finance.  Relative to some other markets, it is still
  underpenetrated because:

  - Manufacturing management of many establishments having less than
    $100 million annual revenues have not been aware of the potential
    benefits of EDP, and have not pressed for EDP-based solutions.

  - There is a low level of standardization in manufacturing, making
    implementation of standard processing services and standard software
    difficult in the manufacturing function.

  - Many discrete manufacturing companies have already automated seg-
    ments of the manufacturing operation, thus reducing the remaining
    savings potential.  Less automated functions such as the office (which is
    still 70-90% labor), have higher apparent economic justification and
    receive management attention.

- These constraints to services growth are being overcome as managements become more aware of EDP's potential to provide manufacturing controls.

    - The increasing cost of materials and labor averages 55% and 23% respectively of total manufacturing costs. Industry specialty services such as materials requirements planning (MRP), bill of materials control, and inventory control address these problems and will grow at an average annual rate of 32% per year.

    - The high growth results from more attention to asset management, better customer delivery, responsiveness, increasing standardization of parts, accelerating use of numerically controlled machine tools, computer aided design, and the emergence of new EDP users who are non-technical and outside of the in-house EDP establishment.

- Opportunities exist in building total manufacturing offerings. An outline of types of applications and modes of processing which make up total offerings is presented in Exhibit V-1.

    - The total market will grow at 16% per year, 1976-1981, as shown in Exhibit A-1, to a 1981 level of over $1.6 billion.

    - An outstanding opportunity exists in data base services which will grow at an average rate of 25% per year.

## B. DISCRETE MANUFACTURING INDUSTRY SECTOR STRUCTURE

- Total shipments by the discrete manufacturing industry sector amounted to $697 billion in 1976, an increase of 19% over the previous year.

- Discrete manufacturing contributes 10-15% of U.S. national income, and accounts for nearly 10% of U.S. Gross National Product.

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- Although there are 171 thousand discrete manufacturing establishments in the U.S., 191 very large firms (over $300 million per year in revenues) account for 58% of the industry's total.

- Forty-five percent of all manufacturing establishments are located in the Mid-Atlantic and East North Central regions of the U.S.

## C. COMPUTER SERVICES MARKETS

- Total expenditures for EDP by the discrete manufacturing industry amounted to $7.6 billion in 1976, and will grow to $15.4 billion by 1981. Overall, the industry spends about 1.0% of its revenues on EDP, 10% of which is for computer services.

- Industry Specialty Applications are the most rapidly growing segment of Processing Services market and will increase their share from 32% in 1976 to 38% in 1981.

    - The main reason for the rapid growth of specialty applications will be the increased use of user or vendor proprietary software products for inventory control, bill of materials, materials requirement planning (MRP), scheduling, and other applications aimed directly at the reduction of manufacturing costs.

    - The leading vendor of its own software delivered via Remote Computing Services is Xerox Computer Systems (XCS).

- Overall, processing services expenditures (Remote Computing, Batch and FM) will increase from $479 million to $990 million between 1976 and 1981, representing an average annual growth rate (AAGR) of 16%. See Exhibit II-1 for details.

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EXHIBIT II-1

## PROCESSING SERVICES EXPENDITURES IN DISCRETE MANUFACTURING

## INDUSTRY 1976 AND 1981 (BY TYPE OF SERVICE)



1976

GENERAL
BUSINESS
$172M
36%

UTILITY
$96M
20%

ENGINEERING &
SCIENTIFIC
$59M
12%

INDUSTRY
SPECIALTY
$153M
32%

$480M

1981

GENERAL
BUSINESS
$360M
36%

UTILITY
$160M
16%

ENGINEERING &
SCIENTIFIC
$95M
10%

SPECIALTY
$375M
38%

$990M

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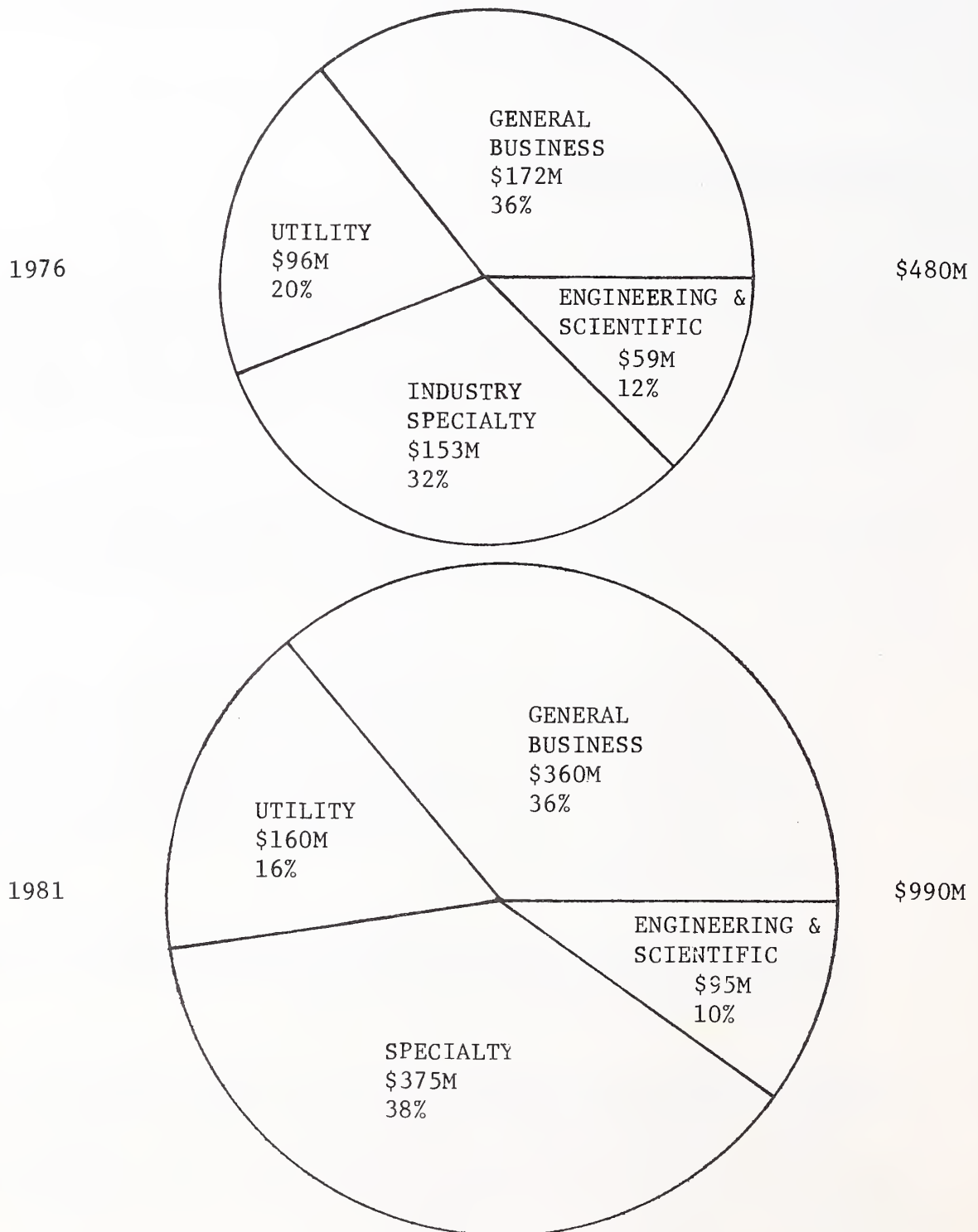
- Because of the forecasted high rate of growth of sales of Software Products (24% per year), and Remote Computing Services (22% per year), total expenditures for computer services will grow at 17% per year, from $779 million in 1976, to $1.7 billion in 1981.

- Remote Computing Services will increase their share of revenues from 27% to 34%, while Software Products will grow from 15% to 21%, as shown in Exhibit II-2.

- The major buyers of these software products will be mainly medium-sized firms in industry sub-sectors SIC 34-39. They are buying modular manufacturing systems which are integrated with financial systems, and which have great flexibility of installation. Leading vendors in this area are: Arista (currently being acquired by Xerox Computer Services), Arthur Andersen & Co., and Martin Marietta Data Systems.

## D.    APPLICATIONS NEEDS

- The major restraining force on EDP expenditures appears to be lack of understanding by manufacturing management of what is available in the way of standard computer services products, and how EDP can be used to help solve many manufacturing control and cost problems. EDP vendors, as well as industry associations such as APICS (American Production and Inventory Control Society),are undertaking to educate manufacturing management.

- Contributing to an expected 30-40% growth per year of sales of these specialty products and services are the availability of standard packages which can be easily modified by willing vendors, the possibility of either running those packages in-house or on Remote Computing Services, and the appearance of low cost turnkey manufacturing small business computers.

EXHIBIT II-2

COMPUTER SERVICES EXPENDITURES IN DISCRETE MANUFACTURING

INDUSTRY 1976 AND 1981 (BY MODE OF SERVICE)

1976

PROFESSIONAL
SERVICES
$170M
22%

RCS
$210M
27%

$770M

SOFTWARE
PRODUCTS
$120M
16%

FM
$35M
4%

BATCH
$235
31%

1981

PROFESSIONAL
SERVICES
$280M
17%

RCS
$530M
32%

$1,630M

SOFTWARE
PRODUCTS
$360M
22%

FM
$90M
6%

BATCH
$370M
23%

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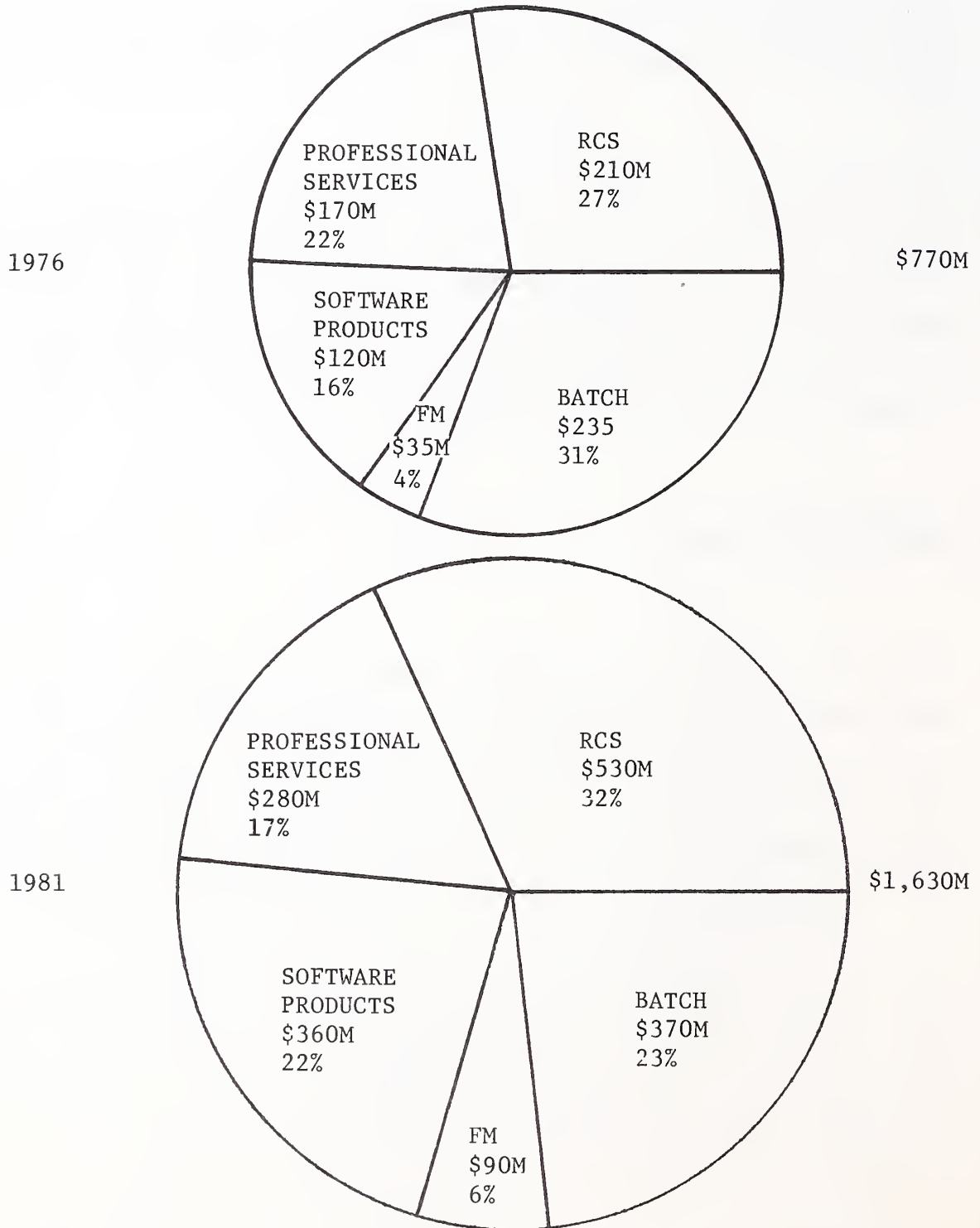
- Very large users of EDP tend to want to develop their own systems, yet some are willing to purchase standard products because of the long lead time and high cost of development of internal systems. In addition, the standard products have proven to work well.

- Small users are currently unable to cost justify the use of these integrated manufacturing/financial systems, and are turning increasingly to the use of small business computers until their business grows large enough to afford the more comprehensive products.

- Thus, the use of remote computing services is mainly targeted toward medium- and large-size firms, and may be seen as a transitionary activity between outgrowing the small computer system and later purchasing the software to run in-house when the company grows large enough.

## E.    TECHNICAL REQUIREMENTS

- For establishments with extensive shop floors, computer services companies must provide terminals on the shop floor for data entry, status inquiry, and expediting. These intra-site communication systems must be rigged to withstand heavy use under often extreme environmental conditions.

- On-line support for order entry and distribution is mandatory. Local CRT support for order entry using formatted screens is preferable.

- Modular, modifiable software with sound basic design is required. Software must be able to be modified quickly and easily.

- Manufacturing and distribution software and services should be supported by financial and accounting software or services which the client may or may not choose to use. If not used, interfaces must be provided with the software or services actually used.

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- Processing services vendors must provide multiple services in order to be able to penetrate the market for processing services completely.

    - General business applications including accounting, financial, and personnel systems.

    - Scientific and engineering capability for the support of development and engineering functions.

    - Specialized applications processing, particularly computer aided design, numerical control machine tool processing, manufacturing payroll, and job distribution.

    - Utility services which allow the user or the vendor to develop custom applications.


## F.  MARKETING REQUIREMENTS


- Selection of the target industry, company size, and even geographic location is most important in this industry sector. Services and software required vary more by these characteristics than in almost any other industry sector.

- The way into discrete manufacturing companies is through top management, staff, or financial executives, not through the production function. This requires sales staff who can sell to financial and top management executives, but who will be able to hold their own with production management - a rare combination.

- Approaches to companies in this sector emphasize time saving over the long lead time for in-house development, particularly as it relates to inventory control.

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- For some software products and services, the in-house EDP manager could be an ally: This requires an approach to EDP, especially in the large, but not very large, companies.

- For manufacturing services to be credible, they must be seen in operation. Thus, it is advisable to make special software available for in-house use even when processing services are the prime target.

- Processing vendors for the manufacturing function must be prepared for:

  - Long lead time on sales.

  - Significant problems in conversion and implementation.

  The latter requires on-site support during the implementation phase.

- Heavy education is required to support manufacturing application services.

- Competition in providing products and services to discrete manufacturing companies lies mainly in the distribution and accounting functions. It is easier for a vendor to move from these functions into production rather than vice versa.

- To sell manufacturing engineering applications requires engineers to market and support products and services. Although a fast growing and profitable opportunity, a successful move from other services to this function is doubtful unless the vendor uses technically oriented salesmen.

## G.    RECOMMENDATIONS

- For discrete manufacturers of all sizes, target:

  - Distribution (on-line order entry and shipping)

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- Production engineering (quality control)

- Development engineering (computer aided design)

as prime functions/applications opportunities.

- For small companies in selected industries, target:

    - Fast growing, multi-site establishments with some requirements for large scale processing.

    - Subsidiaries or divisions of decentralized larger companies.

- Use Data Base Management Systems (DBMS) to develop manufacturing applications. On installation in a company, reverse the inefficiencies by recoding key routines.

- Offer manufacturing software for sale and processing.

- Software product developers should target:

    - Large companies for secondary applications.

    - Small companies for accounting applications.

- Recommended industries are:

    - Fabricated Metal Products

    - Electrical and Electronic Machinery

    - Non-Electrical Machinery

    - Transportation Equipment Parts

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- Government regulation should be closely followed.

    - Standards will be developed through the National Bureau of Standards and other means. Standards will ease the use of packaged software.

    - Consumer protection laws and regulations will create major record keeping requirements for manufacturers.

- For full processing services to manufacturers, including the production functions, vendors should target $20 million to $200 million companies with further emphasis on the $50 million to $150 million companies. Such a company could be part of a larger decentralized organization.

- Vendors should only address this market if they are willing to make a large, long-term commitment. Returns in investment and profits will take several years to develop.

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# III. INDUSTRY STRUCTURE

# III. INDUSTRY STRUCTURE

## A. FUNCTIONAL DESCRIPTION

- Manufacturing has two major sub-divisions: discrete manufacturing and process manufacturing.

    - Discrete manufacturing, the subject of this report, involves the fabrication and assembly of individually identifiable parts and sub-assemblies. Product output is measured in terms of numbers of individual parts or assemblies such as gears, shoes, chairs, and automobiles.

    - Process manufacturing involves a continuous series of operations on one or more raw materials which ultimatley yield one or more products which are measured in volumes, rather than units, such as barrels of oil, gallons of gasoline, yards of cloth, and tons of paper.

- Exhibit III-I identifies those Standard Industry Codes (SICs) which are included in discrete manufacturing, and the degree of emphasis given each in this study.

    - Electrical and Electronic and Non-electrical Machinery received the greatest attention because of their relatively high level of use of computer services.

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EXHIBIT III-1

SICs INCLUDED IN THE DISCRETE MANUFACTURING INDUSTRY SECTOR

| MAJOR GROUP | DESCRIPTION | TOTAL NUMBER OF ESTABLISHMENTS/FIRMS (THOUSANDS) | REPORT EMPHASIS |
|---|---|---|---|
| 23 | APPAREL | 23.0 | MEDIUM |
| 25 | FURNITURE | 9.8 | LOW |
| 27 | PRINTING AND PUBLISHING | 38.0 | LOW |
| 31 | LEATHER AND LEATHER PRODUCTS | 3.1 | LOW |
| 34 | FABRICATED METAL PRODUCTS | 27.0 | LOW |
| 35 | NON-ELECTRICAL MACHINERY | 38.4 | HIGH |
| 36 | ELECTRICAL AND ELECTRONIC | 12.2 | HIGH |
| 37 | TRANSPORTATION EQUIPMENT | 8.8 | MEDIUM |
| 38 | INSTRUMENTS | 4.8 | MEDIUM |
| OTHER | | 6.4 | NONE |
| | TOTAL | 171.5 | |

- Transportation Equipment was chosen because of the very large size and importance of the industry and its advanced use of EDP in automotive and aerospace manufacturing.

- Apparel and Instruments were chosen as unique sub-sectors, with special applications requirements.

● Discrete manufacturers are often wholesale distributors as well. This report considers all EDP expenditures, by firms whose primary SIC is discrete manufacturing, to be manufacturing expenditures. Interviews were distributed among pure manufacturers and firms with multiple SICs (such as the Ford Motor Company).

● This industry sector has a large number of small establishments:

- Two-thirds of all manufacturing establishments have fewer than 20 employees.

- Only 21% of establishments have more than 500 employees.

- Only in Electrical/Electronic and Transportation Equipment are there more than 5% of establishments with more than 500 employees.

● Exhibit III-2 shows the overall distribution of discrete manufacturing by size of firm.

● With regard to geographic distribution, the eastern north-central region has the largest number of manufacturing establishments (discrete and process) and accounts for over 28% of total manufacturing revenues, as shown in Exhibit III-3.

● The top 5 U.S. counties in total manufacturing shipments for 1976 in rank order are:

EXHIBIT III-2

DISTRIBUTION OF DISCRETE MANUFACTURING FIRMS

BY SIZE

| SIZE | RANGE | NUMBER OF ESTABLISHMENTS/FIRMS | |
|------|-------|-------------------------------|---|
| VERY LARGE | > $300M | 191 | (1) |
| LARGE | 100-300M | 253 | (1) |
| MEDIUM | 20-100M | 7,066 | (2) |
| SMALL | < 20M | 163,932 | (2) |
| TOTAL | | 171,442 | |

(1)   Number of Firms

(2)   Number of Establishments


Note:   An establishment is defined as a single location business
        unit.  A firm may have multiple establishments.

EXHIBIT III-3

## GEOGRAPHIC DISTRIBUTION OF U.S. MANUFACTURERS

### (DISCRETE AND PROCESS)

| REGION | ESTABLISHMENTS | | 1976 SHIPMENTS | |
|---|---|---|---|---|
| | NUMBER (000) | % OF TOTAL | $ BILLION | % OF TOTAL |
| NEW ENGLAND | 24.9 | 7.8% | $    61.6B | 5.3% |
| MID-ATLANTIC | 78.7 | 24.6 | 205.7 | 17.7 |
| E. NORTH CENTRAL | 65.0 . | 20.3 | 330.0 | 28.4 |
| W. NORTH CENTRAL | 21.1 | 6.6 | 95.3 | 8.2 |
| SOUTH ATLANTIC | 39.0 | 12.2 | 146.4 | 12.6 |
| E. SOUTH CENTRAL | 16.3 | 5.1 | 72.0 | 6.2 |
| W. SOUTH CENTRAL | 22.4 | 7.0 | 93.0 | 8.0 |
| MOUNTAIN | 9.0 | 2.8 | 27.9 | 2.4 |
| PACIFIC | 43.6 | 13.6 | 130.1 | 11.2 |
| TOTAL | $320.0 | 100  % | $1,162 .0B | 100 % |

1.  Cook County, IL
2.  Los Angeles County, CA
3.  Wayne County, MI
4.  Cuyahoga County, IL ohio
5.  Harris, TX


## B.  REVENUES AND GROWTH FORECASTS


- Total shipments by the discrete manufacturing industry in 1976 amounted to $697.2 billion, an increase of 19% over the previous year. Revenues (including sources other than shipments) were $778 billion.

- The 10 sub-sectors shown in Exhibit III-4 account for nearly 1/3 of all discrete manufacturing shipments, led by motor vehicles and motor vehicle parts, with 13% of the industry total.

- Forecasts for 1977 indicate an expected average rate of growth, of these 10 sectors, of 15.2% with automobiles leading with a forecasted increase of 21%.

- For all manufacturing, the cost of materials is quite high, accounting for about 55% of the value of shipments. Direct labor accounts for half of the remainder. Thus, the major values of EDP lie in material control and reduction of labor costs.

    -   Inventories average 15% of shipments.

    -   Shipments per employee average $44,000 per year.

- The total manufacturing industry is the source of 25% of national income and 18% of U.S. GNP with discrete manufacturing accounting for approximately half of that amount.

EXHIBIT III-4

10 LARGEST DISCRETE MANUFACTURING SUB-SECTORS

| RANK | SIC | INDUSTRY | 1976 SHIPMENTS | |
|------|-----|----------|----------------|--|
| | | | $ BILLION | % OF TOTAL |
| 1 | 3711 | Motor Vehicles & Car Bodies | $ 60.6B | 8.7% |
| 2 | 3714 | Motor Vehicle Parts | 28.5 | 4.1 |
| 3 | 3573 | Electronic Computing Equipment | 11.8 | 1.7 |
| 4 | 3721 | Aircraft | 11.2 | 1.6 |
| 5 | 2711 | Newspapers | 9.9 | 1.4 |
| 6 | 3679 | Electronic Components, N.E.C. (+) | 9.8 | 1.4 |
| 7 | 3662 | Radio and TV Manufacturing | 9.2 | 1.3 |
| 8 | 3585 | Refrigeration and Heating | 9.0 | 1.3 |
| 9 | 3531 | Construction Machinery | 8.2 | 1.2 |
| 10 | 3861 | Photographic Equipment & Supplies | 8.2 | 1.2 |
| | ALL OTHERS | | 530.8 | 76.1 |
| | | TOTAL | $ 697.2B | 100 % |

(+) NOT ELSEWHERE CLASSIFIED

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- Significant investments in "resource management" of air, water, and power are anticipated in the years to come. In 1976, 60% of the overall increase of all plant and equipment expenditures was attributed to the need to monitor and control pollution. That percentage will probably be repeated in 1977 with manufacturers planning an average 8% real dollar increase in capital spending, led by the auto industry's planned 61% increase.

- Numerical control equipment expenditures in 1977 should average an 18% increase over 1976 for a total of $77 million. NC equipment is shifting from tape control to computer control.

  - General Electric's Industrial Controls Products Department, the largest builder of tape controlled NC machines (with 40 to 50 percent of the U.S. market), shipped over 2,000 machines in 1976. Only 10-20% of those were CNC (Computer Numerical Control). Next year that will increase to about 50%.

  - Actron Division of McDonnell Douglas Corporation (Monrovia, CA), an OEM supplier for less than 2 years, expects to ship 300 CNC units this year. Actron's control unit uses three microprocessors with a common memory and sells between $15,000 and $20,000.

- In spite of the movement to CNC, penetration of computers in machine control today is less than 10%.

# IV. USE OF EDP

# IV. USE OF EDP

## A. FACTORS AFFECTING USE OF EDP

- As a first step in the selection of EDP users to interview for this study, a sample of 53 firms, selected at random, were screened in an effort to:

    - Locate a representative sample of processing services users to interview.

    - Examine the distribution of EDP usage and the degree of EDP penetration within the discrete manufacturing industry.

- Large and very large manufacturers all have in-house computers and smaller firms are approaching saturation. Responses shown in Exhibit IV-I indicate that it is the very large firm which uses computer processing services the most; the very large firms currently contributed the most revenue to services vendors, as will be discussed in greater detail in Chapter VI.

    - According to Computer Intelligence Corporation's files of computer sites, discrete manufacturing accounts for 4973 computer installations - nearly 21% of the U.S. total.

- Manufacturing is a highly unionized industry. Users indicate that this has no effect on their use of EDP. In fact, where terminal operators have been recruited and trained from manufacturing union ranks, unions and employees have been supportive of the use of EDP.

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EXHIBIT IV-1

USE OF EDP BY RESPONDENTS

| EDP USAGE BY RESPONDENT SAMPLE | FIRM SIZE | | | | TOTAL | |
|---|---|---|---|---|---|---|
| | S | M | L | VL | NUMBER | % |
| | (NUMBER OF FIRMS) | | | | | |
| IN-HOUSE COMPUTER PROCESSING ONLY | 11 | 11 | 10 | 3 | 35 | 66% |
| IN-HOUSE COMPUTER PLUS SOME OUTSIDE PROCESSING SERVICES | 0 | 2 | 2 | 6 | 10 | 19 |
| OUTSIDE PROCESSING SERVICES ONLY | 2 | 1 | 0 | 0 | 3 | 6 |
| NO EDP | 3 | 2 | 0 | 0 | 5 | 9 |
| A.  TOTAL NUMBER | 16 | 16 | 12 | 9 | 53 | 100% |
| B.  PERCENTAGE PENETRATION: | | | | | | |
|   - SOME EDP | 81% | 88% | 100% | 100% | | 91% |
|   - FIRMS WITH IN-HOUSE EDP | 69% | 81% | 100% | 100% | | 85% |
|   - FIRMS USING PROCESSING SERVICES | 13% | 19% | 17% | 67% | | 47% |

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- The number of levels in the bill of material appears to be the best measure of product-process structure complexity which relates to the use of computers in the production-inventory management functions.* Organizational size is not directly related to the probability that production-inventory control functions are computerized.

- With regard to distributed computing/processing, the larger the user, the more active the interest. The major use described is for RJE terminals to update financial and manufacturing data and to be used as inquiry terminals with those updated data bases.

## B. EXPENDITURES ON EDP

- Respondents to INPUT's survey account for $24.9 billion in discrete manufacturing revenues, 4% of the industry total, and are well distributed over size and SIC groups. Thus, the survey data may be extrapolated as in Exhibit IV-2, showing overall industry expenditures for EDP to be 1.0% of industry shipments. This average expenditure is reduced by lower penetration in small and medium-size firms. Those large companies with in-house computers often spend considerably more than 1% of their revenues on EDP.

- Expenditures for services show a graduated reduction as a percent of EDP expenditures as the size of the firm increases from a maximum of 58% to a minimum of 6%.

- Overall, 10% of the industry's EDP expenditures go for computer services, derived largely (45%) from very large companies, although the largest growth rate will come from medium-size firms which are the main marketing targets of manufacturing specialty services vendors. Further detail is shown in the Appendix, Exhibit A-5.

* Utilization and Effectiveness of EDP: An Industrial Survey, by Donald W. Fogarty, Ph.D., Production and Inventory Management, Second Quarter, 1977.

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EXHIBIT IV-2

DISTRIBUTION OF EDP AND COMPUTER

SERVICES EXPENDITURES BY ORGANIZATION SIZE

(DISCRETE MANUFACTURING INDUSTRY)

1976

| | SIZE | | | | TOTAL |
|---|---|---|---|---|---|
| | SMALL | MEDIUM | LARGE | VERY LARGE | |
| REVENUES ($ BILLIONS) | 156.0 | 172.0 | 43.0 | 385.0[1] | $756.0B |
| EDP EXPENDITURES ($B) | 0.4 | 1.2 | 0.4 | 5.6 | 7.6 |
| COMPUTER SERVICES EXPENDITURES ($M) | 170.0 | 190.0 | 60.0 | 350.0[1] | 770.0M |
| % INDUSTRY REVENUES FOR EDP | 0.26 | 0.7 | 1.0 | 1.5 | 1.0% |
| % OF EDP EXPNDITURES FOR COMPUTER SERVICES | 58.0 | 16.0 | 13.0 | 6.0 | 10.0% |
| % INDUSTRY REVENUES FOR COMPUTER SERVICES | 0.11% | 0.11% | 0.13% | 0.09% | 0.1% |

(1) Excludes $21.5 billion in revenues and an estimated $367 million in captive services expenditures by Boeing, General Electric, Martin Marietta, and McDonnell Douglas

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- Several major computer services firms are spin-offs of major manufacturers: Boeing Computer Services (BCS), General Electric Information Services (GEIS), Martin Marietta Data Systems (MMDS), and MCAUTO. Three of their parent companies are large aircraft/aerospace manufacturers and the fourth, GE, is a major machinery and equipment manufacturer. Their combined revenues of $21.5 billion, and their captive computer services expenditures of $367 million, have been deleted from Exhibit IV-3 so that only available EDP expenditures are represented.

- Aerospace manufacturers tend to spend a larger than average share of revenues on EDP, as much as 3.5% in some cases.

## C.  COMPUTER SERVICES EXPENDITURES TO GROW FASTER THAN IN-HOUSE

- Computer services expenditures will grow somewhat faster than in-house expenditures over the next 5 years, despite many large firms planning to bring certain applications in-house. This will be accomplished by:

  - Using standard software products and professional services.

  - Attracting many new processing services users in the medium-size and large-size company range for manufacturing applications.

- Vendors expect that expenditures for computer services will increase by more than 20% per year overall, with perhaps 30-35% per year increases in their individual manufacturing specialties.

- As shown in Exhibit IV-3, INPUT expects EDP growth rates to be lower.

  - Corporate revenue and profit growth will restrict in-house expenditures.

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EXHIBIT IV-3

DISCRETE MANUFACTURING EDP EXPENDITURES FORECAST, 1976-1981

| SOURCE OF EDP | EXPENDITURES ($ MILLIONS) | | % AAGR |
|---|---|---|---|
| | 1976 | 1981 | |
| IN-HOUSE | $6,820 | $13,700 | 15% |
| COMPUTER SERVICES | $ 770 | $ 1,600 | 16% |
| TOTAL EDP | $7,590 | $15,300 | 15% |

- Slower growing accounting, batch-oriented applications in small companies will restrict computer services growth.

• These growth rates could be heavily impacted, even in a relatively stable economy, by expenditure shifts away from automobiles and aerospace. Should the auto industry experience a slowdown in 1979, or should significant redistributions of the defense budget occur, overall EDP expenditures by these industries will be reduced.

# V. APPLICATIONS ANALYSIS

## V. APPLICATIONS ANALYSIS

## A. FUNCTIONAL USE OF EDP

- Aside from the traditional general business financial applications, the primary use of EDP in discrete manufacturing is to reduce the cost of production by reducing inventory investment, scheduling people and machines, and controlling the shop floor.

- For the most part, all SICs included in discrete manufacturing have the same problems, amenable to solution with the same types of EDP products shown in Exhibit V-I. However, the emphasis is quite different in different sub-sectors.

    - The auto industry's main problem is capacity planning.

    - Aerospace is concerned with ECNs (Engineering Change Notices).

    - A computer manufacturer is concerned with bill of materials and inventory control.

- Some industry sub-sectors have unique requirements which may be solved with a specialized stand-alone installation. For example, some apparel manufacturers use specialized turnkey systems for layout and cutting of garment patterns.

**INPUT**

EXHIBIT V-1

DISCRETE MANUFACTURING INDUSTRY APPLICATIONS AND MODE OF PROCESSING

| FUNCTIONAL TYPE | APPLICATION | | MODE OF PROCESSING | | |
| --- | --- | --- | --- | --- | --- |
| | PRIMARY | SECONDARY | BATCH | REMOTE BATCH | INTER-ACTIVE |
| 1. General Business and Financial | Payroll and Personnel | | * | * | |
| | General Ledger | | * | * | |
| | Billing and A/R | | * | * | |
| | | Sales Forecasting Analysis | | * | |
| | | Accounts Payable | * | * | |
| | | Personnel | * | * | |
| | | Capital Goods Inventory and Accounting | * | * | |
| 2. Scientific and Engineering | Structural Analysis | Engineering Program Development | * | * | |

INPUT

EXHIBIT V-1 (CONTD)

DISCRETE MANUFACTURING INDUSTRY APPLICATIONS AND MODE OF PROCESSING

| FUNCTIONAL TYPE | APPLICATION | | MODE OF PROCESSING | | |
| --- | --- | --- | --- | --- | --- |
| | PRIMARY | SECONDARY | BATCH | REMOTE BATCH | INTER-ACTIVE |
| 3. Specialty | Order Entry | | | * | * |
| | Planning & Scheduling | | | * | * |
| | Bill of Material | | | * | |
| | Inventory Control | | * | * | |
| | Shop Floor Control | | | * | * |
| | | Capacity Planning | | * | |
| | | Quality Control | | * | * |
| | | Product Costing | | * | |
| | | Standard Costing | * | * | |
| | Computer Aided Design | | | | * |
| | NC Tape and Program Preparation | | | * | * |
| | Econometric Forecasting | | | | * |
| | | Transportation Rate & Route | | * | * |

1. GENERAL BUSINESS APPLICATIONS

- This industry sector is characterized by complicated payroll computations (due to unions, benefits, incentive plans, retirement programs, etc.), and large numbers of accounting transactions (due to high throughput of inventory and product).

- Sales forecasting and sales analysis are important factors in scheduling production. In many companies, these activities are informal or carried on by sales and marketing organizations for their own self-evaluation and performance ranking of sales people. In more sophisticated managements, sales forecasting and analysis is the basis for the corporate master plan for budgeting, production planning, capital expenditures, and long-range planning.

- In integrated manufacturing systems, communication between the financial and manufacturing systems and organizations is maintained. Data is exchanged either on-line or via daily batch or remote batch processing.

2. SCIENTIFIC AND ENGINEERING APPLICATIONS

- Different industry sub-sectors have quite different design and manufacturing engineering requirements.

  - Electronics firms use circuit design, circuit board layout, micro-electronics layouts, microprogramming algorithms, etc.

  - Automotive and aircraft firms use mechanical layout, modeling, structural analysis, performance simulation, etc.

- Most of these applications are highly specialized. They are usually developed in-house or on-line to a Remote Computing Service which serves as a utility for program development. Some packages are used via Remote Computing Services (e.g., ANSYS for structural analysis available over numerous networks). Applications and services specialized to discrete manufacturing are included in

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**INPUT**

the next category, Industry Specialty Applications. Applications and services used in a variety of industry sectors, such as ANSYS and STARDYNE, are included in this category.

3. INDUSTRY SPECIALIZED APPLICATIONS

- Engineering data control for maintaining parts lists, bills of material, and engineering drawings is an essential EDP function for smoothing the interface between manufacturing and engineering and for insuring that only current data are used. This is especially urgent in the aerospace industry where design changes are rapid and continuous, and frequently only one prototype missile, aircraft, submarine or vehicle is being built on an R&D contract.

- The manufacturing department's allocated portion of a firm's EDP expenditures ranges from 35% to 80% according to INPUT's sample, as shown in Exhibit V-2. The median respondent indicated manufacturing activities account for 65% of total EDP expenditures.

  - The 35% share was reported by a $13 million boat manufacturer.

  - The 80% share was reported by a $15 million electronics equipment manufacturer and a $1.2 billion transportation vehicle manufacturer.

- Computer Aided Manufacturing - International, Inc. (CAM-I), a non-profit research organization (Arlington, TX), was organized in 1972 to be custodian of standarized programs arising out of APT (Automatic Programmed Tooling). APT was originally initiated by the U.S. Air Force in 1949, developed by MIT to field trial stage in 1958, and had as its purpose the development and proliferation of electronically controlled machine tools. The aerospace industry has been the major user and primary custodian of such systems. Now CAM-I membership is available to all companies in all countries, and has as its purpose the advancement of the art of computer aided manufacturing. (Membership costs $5,000 per year, per company.) Members assist each other in the development of new technology.

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EXHIBIT V-2

SHARES OF RESPONDENTS' EDP EXPENDITURES

FOR MANUFACTURING APPLICATIONS



SHARE OF TOTAL EDP EXPENDITURES (%)

INPUT
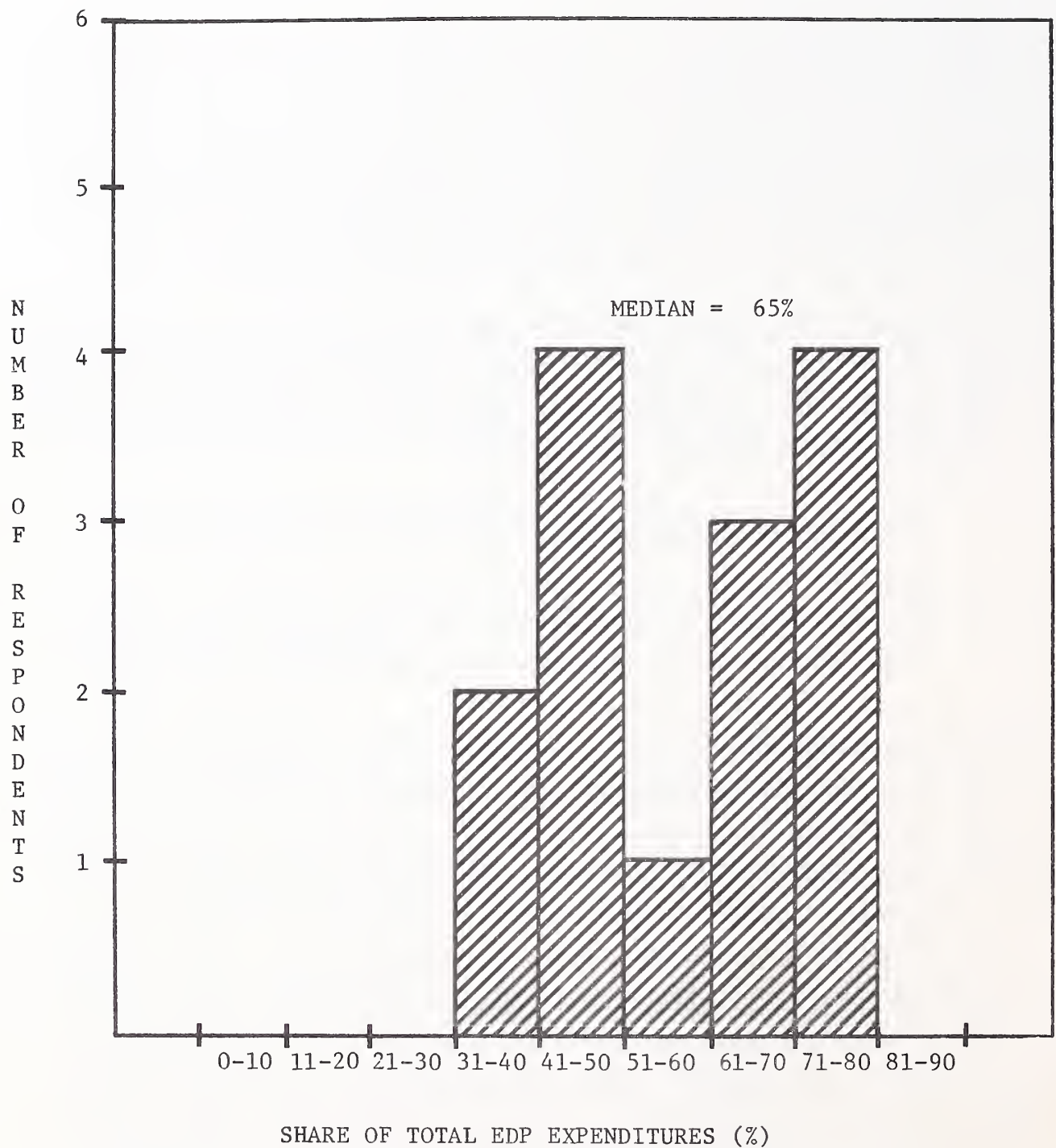
- In 1976, the Manufacturing Technology Division of the Air Force Materials Laboratory (AFML) announced a 5-part program for Integrated Computer Aided Manufacturing, which will last at least into 1978. Functions and start dates are:

    - April 1976: Identify all existing manufacturing computer standards.

    - October 1976: Development of plans, relationships between Air Force and industry, assignment of study groups and projects.

    - February 1977: Development of procedures to feed back manufacturing information to designers so that "design to cost" procedures can be developed.

    - March 1977: Establishment of a theoretical basis for advanced manufacturing in sheet metal parts fabrication.

    - MDSI (see next paragraph) has been selected by the Air Force to participate in this last portion.

- The preparation of tapes for numerical controlled machines is dominated by Manufacturing Data Systems, Inc. (Ann Arbor, MI), with a 50% share of the $35 million market (for software and services) in 1976 which is expected to grow at 25-30% per year through 1980.

- NC machine tool manufacturers, including Kearney and Trecker, Giddings and Lewis, International Harvester, and Cincinnati Milicron also provide customers with diagnostic applications programs and back up Remote Computing Services.

- As demonstrated in Exhibit V-3, there are very few computerized planning and shop floor control systems in use. This area offers a great potential for growth, and specialist software and services firms in that marketplace expect growth rates from 30-100% per year for the next 5 years.

**INPUT**

EXHIBIT V-3


SME* DELPHI FORECAST OF MANUFACTURING TECHNOLOGY

| CONDITION | MEDIAN OPINION OF 90% PROBABLE YEAR |
|---|---|
| Computerized capacity planning and shop floor control systems to be used by at least 10% of the plants in the manufacturing industry. | 1982 |
| Software systems will be available which will accurately predict manufacturing cost based on part definition only. | 1985 |
| Computer graphics and/or automated drafting will be used more for mechanical components than for electronic components. | 1986 |
| The application of numerical control will exceed 1/3 of machining output in plants employing less than 30 workers. | 1990 |

*Society of Manufacturing Engineers, "Delphi Forecast of Manufacturing Technology," May 1977

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- In the factory data collection area, IBM has 60% of the market. Data Pathing, Inc. has 20% of the market and was recently acquired by NCR. DEC is entering the market with systems built around the PDP 11.

- In software packages and services for mainline discrete manufacturing applications such as production control, there are few increases. As a consequence of the wide variation in user need, even the successful software products and systems for this industry are modular and can be enhanced to meet specific client requirements. Few clients use all of the modules available in any one system offering.

- An example of such a product is Martin-Marietta Data Systems' Modular Application System (MAS); 5 of the 6 modules of this package are shown in Exhibit V-4. The sixth module, Business Planning System, supports the Inventory and Manufacturing Control Systems and integrates these modules with the financial data processing functions.

- MAC-PAC, another of the most successful discrete manufacturing software products available from Arthur Andersen & Co., one of the "Big 8" accounting firms, contains 10 integrated applications modules:

    - Requirements Planning      - Labor Performance Reporting
    - Inventory Control          - Design Engineering
    - Shop Floor Control         - Product Costing
    - Capacity Planning          - Manufacturing Engineering
    - Inventory Accounting       - On-Line Inquiry

- Regardless of the particular modular design, the major "buzz-word" for discrete manufacturing is MRP - Manufacturing Requirements Planning. MRP can be defined as that function which projects the manufacturing plan and establishes and maintains priorities on parts. The 3 basic elements of an MRP system are:

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EXHIBIT V-4

ORGANIZATION OF MANUFACTURING APPLICATIONS:

MARTIN MARIETTA DATA SYSTEMS' MAS PACKAGE

**INPUT**
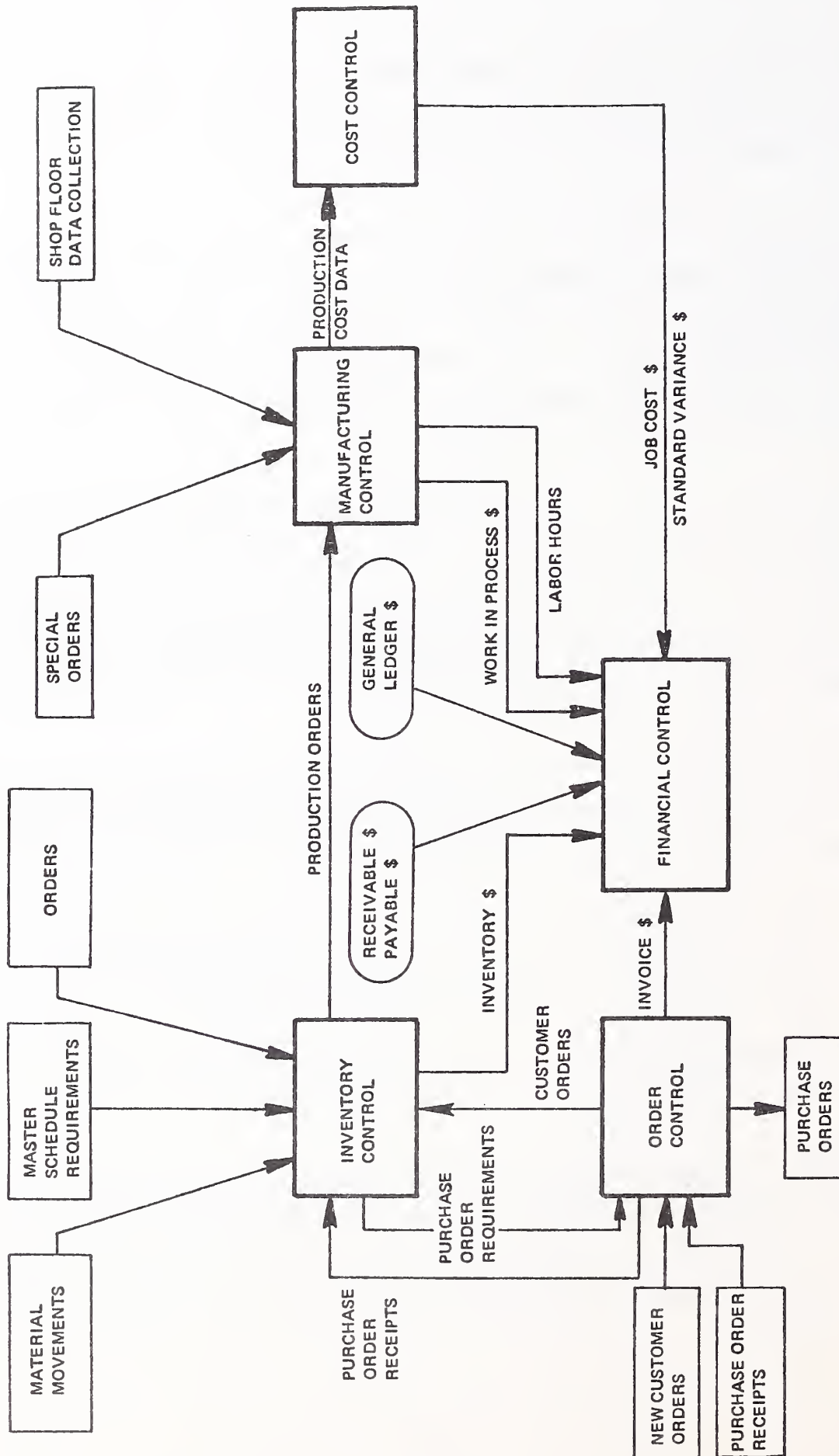
- Master Schedule
- Bill of Material (BOM)
- Inventory Positions

- IBM has COPICS, a conceptual system for use on 360 and 370 equipments and IPICS, a modular system for use with System 3 applications for discrete manufacturing companies.

- The choice of which mode of processing is used varies according to the manufacturing requirements and the concomitant necessary response time considerations, as shown in Exhibit V-5.

- To develop and implement a major manufacturing control system from scratch takes several years at least. It is this long lead time which offers a great opportunity to vendors whose standard products or services can be modified and implemented in a matter of months.

- "Time" is the crucial selling point. In some cases users will buy a product they cannot use simply to obtain design features which will shorten the development cycle.

## 4. DATA BASES

- One data base of interest to manufacturing firms relates to their product distribution functions. The determination of the cheapest route and the cost (rate) for freight sent via that route is made available by Distribution Sciences, Inc. (Schiller Park, IL).

- Generalized econometric data bases are used for modeling, forecasting the general business environment, and to assist in corporate long-range planning of production and investment.

## 5. PROBLEM AREAS

- Most vendors agree that the main problem in manufacturing is the management of material. It is also their consensus that many manufacturing

**INPUT**

EXHIBIT V-5

MANUFACTURING REQUIREMENTS

AND PROCESSING MODES

SYSTEM RESPONSE TIME CONSIDERATIONS (+)

| COMPANY CHARACTERISTIC | CONSIDERATIONS | MINIMUM ACCEPTABLE PROCESSING MODE(s) | | |
|---|---|---|---|---|
| | | BATCH | REMOTE BATCH | INTER-ACTIVE |
| Produce to Inventory | Safety Stocks should protect against most stockouts. Minor changes need not be reflected by system immediately. Ample opportunity to control production rate. | * | | |
| Produce to Customer Order | May want to update records promptly to assess impact of changes and take swift corrective action. | | | * |
| Long Manufacturing Cycle | Need for rapid response minimal. Changes can be absorbed comfortably. Risk of inefficient production low. | * | | |
| Short Production Cycle | May require fast response time to assure corrective action taken at most cost-effective time. | | * | |

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INPUT

EXHIBIT V-5 (CONTD)

MANUFACTURING REQUIREMENTS

AND PROCESSING MODES

| COMPANY CHARACTERISTIC | SYSTEM RESPONSE TIME CONSIDERATIONS (+) CONSIDERATION | MINIMUM ACCEPTABLE PROCESSING MODE(s) | | |
|---|---|---|---|---|
| | | BATCH | REMOTE BATCH | INTER-ACTIVE |
| Stable, Uniform Demand | Schedule changes will be minor and response time is not critical. | * | | |
| Stable Product Lines | Few engineering changes and ample notification when they do occur. Slow response okay. | * | | |

(+) Reproduced with permission by Mr. Robert Bonsack, from his article, printed in 2nd quarter 1976 issue of Production and Inventory Management, Computer Based Manufacturing and Control Systems. Minimum acceptable processing mode data supplied by INPUT.

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**INPUT**

managers do not have a good grasp of how EDP can be used to improve their cost performance, inventory build-up, and production efficiency. A major problem is seen as existing between corporate management, who would like to see more EDP generated controls and reports, and manufacturing management, who do not enthusiastically embrace EDP.

- This situation is least prevalent in electronics and aerospace manufacturing due to the nature of their management and rapidly changing, high-technology products.

- User comments regarding manufacturing problems mostly relate to inventory control. In high-technology electronics firms, the problem is compounded by frequent design changes in the product.

- Other user problems relate to efficient scheduling of labor and machines - shop floor control.

- A major problem in the implementation of new systems is often the coding, or recoding, of items such as parts, materials, operations centers, and routings.

    - This has to be accomplished while existing systems continue to operate and can only be accomplished by experienced staff in the departments concerned.

    - Further complicating the issue is that these people often resist the new systems and may, in fact, be unable to operate at a more sophisticated level.

- Staff problems can actually cause a technically sound system to be a complete failure.

- Management orders and directives are not the answer. These problems must be addressed by:

- Training and education.

- Re-staffing where necessary.

- Motivation of staff to understand and use the system.


## B.    TECHNICAL RESOURCE REQUIREMENTS


● The principal technical issues for manufacturing systems concern the avail-
ability of standard software packages, which can be modified to suit individual
requirements, and making the system to the size of firm.

- IBM software is available from System 3 levels all the way up to 370
levels, performing all the major tasks in the manufacturing area.

- Turnkey stand-alone systems are available to do the basic manufactur-
ing requirements in small companies.

● One problem relating to shop floor control is that of physically locating
terminals on the shop floor itself because of the conditions there and the
consequent cost of installations and maintenance.

● Users, when asked which currently unavailable product/service they would like
to have, commented:

- (Small SIC 35)-        "Netchange MRP, to perpetually update the sys-
tem."

- (Small SIC 34)-        "Purchasing module, not currently available with
IPICS."

- (Very large SIC 36)- "Computer aided manufacturing."

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**INPUT**

- Most respondents indicated that they either had everything they needed, or knew where to get it. This ties in well with vendor observations that manufacturing firms are relatively unaware of the value of EDP and the ways it can be used.

- The consequent problem for vendors is that of trying to sell a product or service to people who have not identified the need for it.

- Exhibit V-6 highlights system requirements of some of the major manufacturing applications.

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# VI. COMPUTER SERVICES MARKETS

EXHIBIT V-6

APPLICATIONS PROCESSING REQUIREMENTS

| APPLICATION | INPUT VOLUME | | | DAILY TRANS-ACTION VOLUME | | | USE OF STORAGE | | | USE OF COMPUTER TIME | | | OUTPUT VOLUME | | | ON-LINE | TURN-AROUND REQUIRED | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H | M | L | H | M | L | H | M | L | H | M | L | H | M | L | | < 1 DAY | 1 DAY | > 1 DAY |
| 1. GENERAL BUSINESS | | | | | | | | | | | | | | | | | | | |
| SALES FORECASTING | | X | | | | X | | | X | | | X | | | X | | | | X |
| SALES ANALYSIS | | | X | | | X | | | X | | | X | | | X | | | X | |
| 2. SCIENTIFIC & ENGINEERING | | | | | | | | | | | | | | | | | | | |
| STRUCTURAL ANALYSIS | X | | | X | | | X | | | X | | | X | | | X | | X | |
| 3. INDUSTRY SPECIALTY | | | | | | | | | | | | | | | | | | | |
| ORDER-ENTRY | X | | | X | | | X | | | | X | | X | | | X | | X | |
| PLANNING & SCHEDULING | | | X | | | X | | | X | | | X | | | X | X | | | X |
| BILL OF MATERIALS | X | | | X | | | | | X | | | X | X | | | | | | X |
| INVENTORY CONTROL | X | | | X | | | X | | | | X | | X | | | | | | X |
| SHOP FLOOR CONTROL | | X | | X | | | | | X | | | X | | | X | X | | | X |
| CAPACITY PLANNING | | X | | X | | | X | | | | | X | | | X | X | | | |
| PRODUCT COSTING | | X | | X | | | | X | | | | X | | | X | | | X | |
| STANDARD COSTING | | | X | | | X | | X | | | | X | | | X | | | X | |
| COMPUTER AIDED DESIGN | X | | | X | | | | | X | X | | | | | X | X | | | |
| NUMERICAL CONTROL TAPE PREPARATION | X | | | X | | | X | | | X | | | X | | | X | X | | |

EXHIBIT V-6 (CONTD)

APPLICATIONS PROCESSING REQUIREMENTS

| APPLICATION | INPUT VOLUME | | | DAILY TRANS-ACTION VOLUME | | | USE OF STORAGE | | | USE OF COMPUTER TIME | | | ON-LINE VOLUME | | | ON-LINE | TURN-AROUND REQUIRED | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H | M | L | H | M | L | H | M | L | H | M | L | H | M | L | | < 1 DAY | 1 DAY | > 1 DAY |
| 4. DATA BASE | | | | | | | | | | | | | | | | | | | |
| ECONOMETRIC FORECASTING | N/A | | | | | X | | | X | | | X | | | X | X | | | |
| RATE AND ROUTE | N/A | | | | | X | | | X | | | X | | | X | X | | | |
| 5. UTILITY | | | | | | | | | | | | | | | | | | | |
| ENGINEERING PROGRAM DEVELOPMENT | | | X | N/A | | | | | X | | | X | | | X | X | X | | |

INPUT

# VI. COMPUTER SERVICES MARKETS

## A. MARKET FORECASTS

- While there is considerable opportunity for growth in computer services expenditures by the discrete manufacturing industry, manufacturing management tends not to be well versed in the capabilities and value which computer services can offer. In addition, many larger companies maintain the attitude that because of their "uniqueness," they must develop their systems in-house. As a consequence, expenditures by this industry, which will grow at the average rate for computer services overall (16% per year through 1981) will come primarily from services for other than the manufacturing function.

- In 1976, with services expenditures of $770 million, this industry sector contributed 13% of the total $6 billion computer services expenditures in the U.S. This share will remain constant over the forecast period as the industry's computer services expenditures reach $1.6 billion in 1981.

- Industry specialty is the fastest growing processing services sector, as shown in Exhibit VI-1. In part, this is due to modular, integrated, manufacturing software becoming available on national networks, such as Comshare, NCSS, and Tymshare. This is making the capability available to firms which do not wish to undertake major development programs and which might want to start slowly and enlarge the system as the company grows.
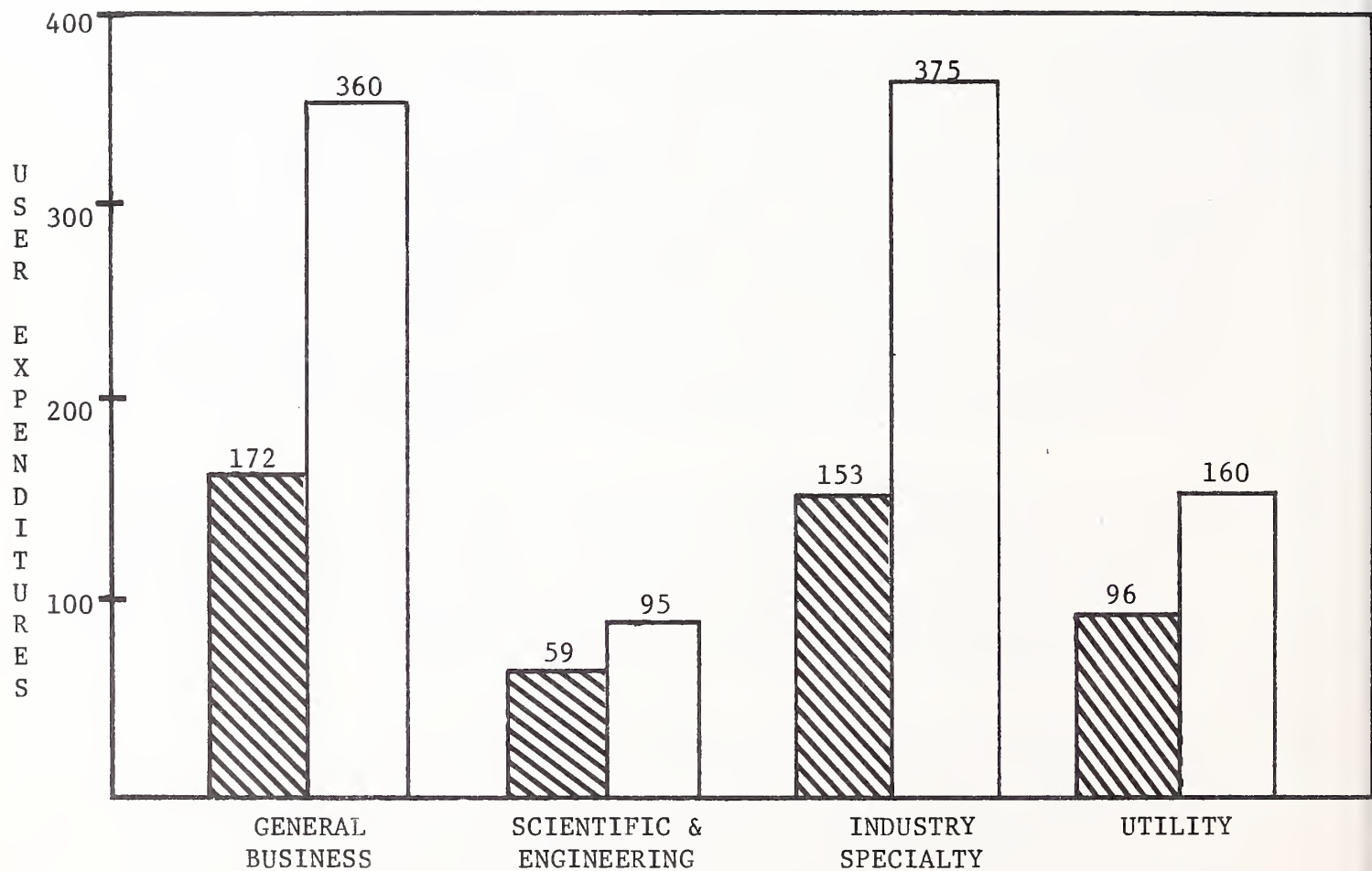
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EXHIBIT VI-1


PROCESSING SERVICES MARKET FORECAST

BY TYPE OF SERVICE,

1976-1981


($ MILLION)



| KEY | | TOTAL |
|---|---|---|
| 1976 | ▨ | $480M |
| 1981 | ☐ | $990M |

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- As transaction processing volumes increase with the use of manufacturing services, remote batch mode of processing will grow slightly faster, as shown in Exhibit VI-2.

- Facilities Management (FM) has not been successful in manufacturing and is growing slowly now. Future growth will come largely from expanded services in existing RCS and batch contracts. Also, as vendors with credible software become known to manufacturers in specific industries, some medium-sized companies will turn to them for all their processing requirements.

- Batch services will have little real growth from 1976 to 1981. Growth will come in the financial areas of payroll and general ledger with some increase in sales analysis. However, conversion of processing to RCS, RCS/batch combinations, and on-site processing will actually cause the pure batch market to shrink from 1980 on.

- As shown in Exhibit VI-3, the larger the user the more likely he is to purchase applications software. Often these packages are for specific financial or specialty applications not related directly to the production or manufacturing function.

- Even those companies that do not purchase applications software purchase systems software packages such as data base management systems.

- As some acceptable manufacturing applications software emerges, the Software Products market will grow rapidly (24% average growth per year) as shown in Exhibit VI-4.

- The market for manufacturing applications software will grow even faster (up to 35% per year) from a small base. Some available Software Products are listed in Exhibit VI-5.

**INPUT**

EXHIBIT VI-2

PROCESSING SERVICES MARKET FORECAST

BY MODE OF SERVICE,

1976-1981

($ MILLIONS)



| | KEY | | TOTAL |
|---|---|---|---|
| 1976 | ▨ | | $480M |
| 1981 | ☐ | | $990M |

MODE OF SERVICE

- 49 -
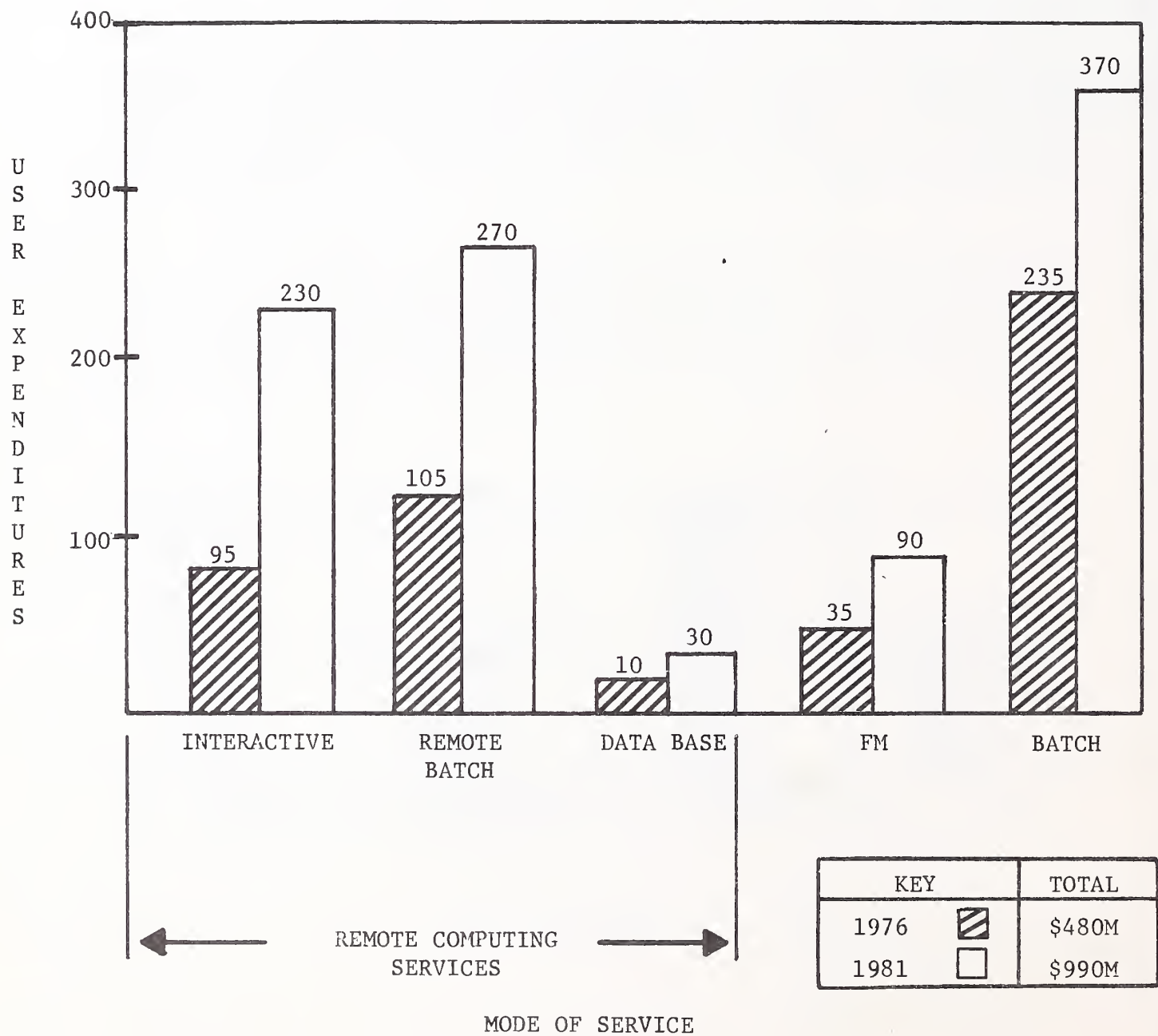
EXHIBIT VI-3

SOURCE OF APPLICATIONS SOFTWARE FOR RESPONDENTS WITH

IN-HOUSE COMPUTERS
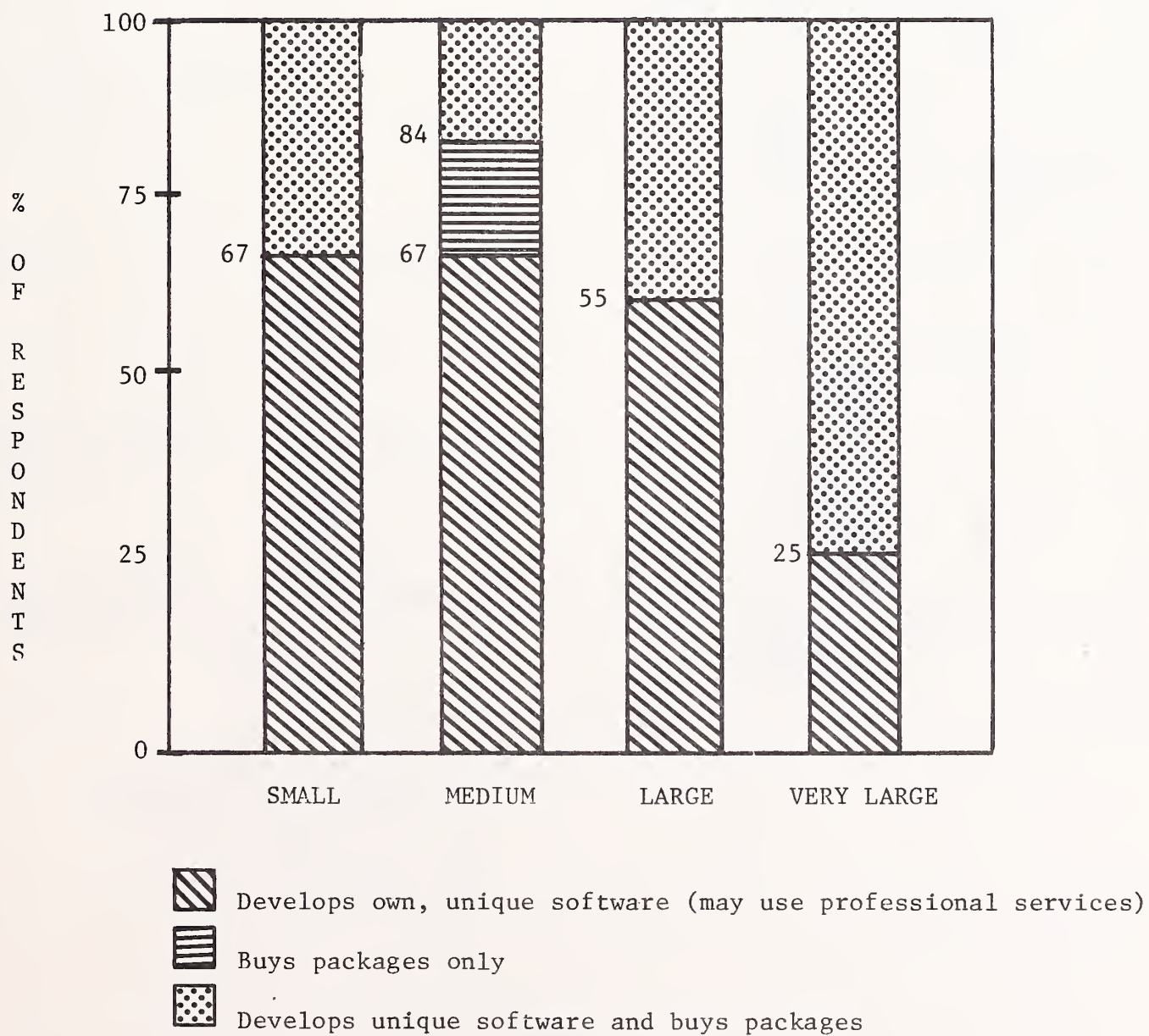
EXHIBIT VI-4

SOFTWARE PRODUCTS AND PROFESSIONAL

SERVICES MARKET FORECAST, 1976-1981

($ MILLION)
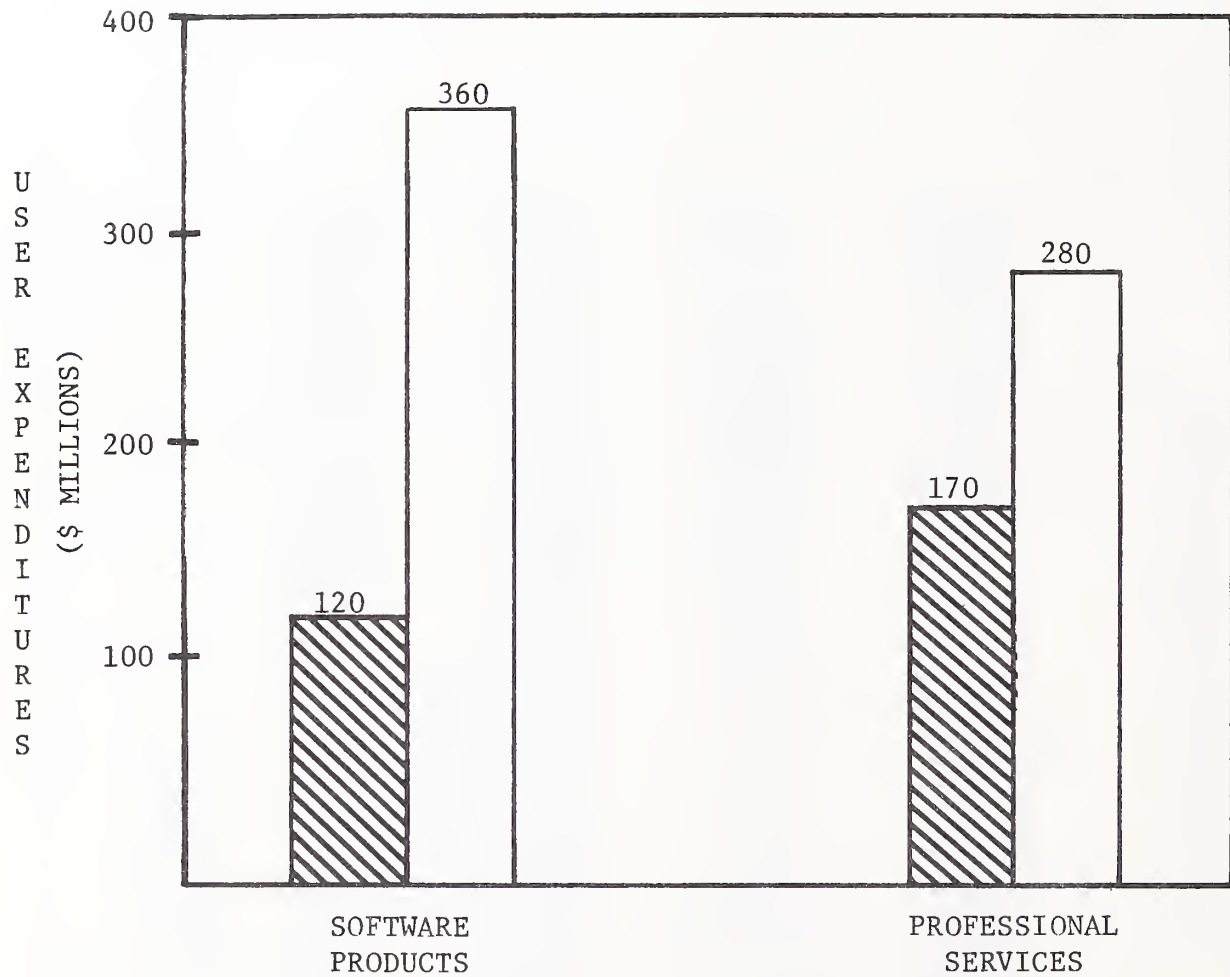


| KEY | | TOTALS |
|------|------|--------|
| 1976 | ◩ | $290M |
| 1981 | ☐ | $640M |

**INPU**

EXHIBIT VI-5

APPLICATION SOFTWARE PRODUCTS FOR THE DISCRETE

MANUFACTURING FUNCTION

| PRODUCT NAME | VENDOR | COMMENTS |
|---|---|---|
| MAC-PAC | Arthur Andersen & Company | • 60 Installations<br>• Integrated Mfg. Modules |
| IPICS | IBM | • System 3 Integrated Mfg. Modules |
| PRODUCTION IV | Informatics | • Over $1 Million Cumulative Sales<br>• Integrated Mfg. Modules |
| COMPACT II | Manufacturing Data Systems | • Available Tymshare & Comshare<br>• Numerical Control Tape Preparation Language |
| MODULAR APPLICATION SYSTEM (MAS) | Martin Marietta Data Systems (MMDS) | • Over $1 Million In Sales In 1976<br>• Integrated Mfg. Modules |
| MITROL INDUSTRIAL MANAGEMENT SYSTEM (MIMS) | Mitrol Company | • About 65 Clients<br>• Integrated Modular System, Available NCSS And Tymshare |

- Professional Services growth will be slower (11% average annual growth rate), although a large part will be derived from customizing and enhancing modular software products. Education and training will also be a major contributor to growth.

## B.    USER ANALYSIS

## 1.    REASONS FOR THE USE OF COMPUTER SERVICES

- All services user respondents indicated the main reason for using computer services was the lower cost, compared to internal implementation.

  - One user indicated that the company had no capability to develop its own programs and a vendor's package (MMOS) did the job.

  - One user is looking at a small business computer for future use.

  - One user commented, "We originally had a Univac computer in-house...went outside for all DP services...proved to be too expensive...will be installing System 3/15 next month and bringing it all back in-house." This user, with $18 million in sales, is spending over $600,000 per year (3% of sales) with a computer services vendor (XCS) for financial and manufacturing applications, nearly twice the amount budgeted for the year.

- All medium, large, and very large services using respondents went outside because of the higher cost and long lead time required to develop manufacturing systems internally. (Long lead time to develop systems was not cited by small users as a reason for going to outside services.)

  - One large user added he is "tired of constantly modifying programs for users...the only way the (purchased) package can be changed is to contract with Arista (the vendor). This forces the users to make better decisions at the beginning as to what they want..."

- Seventy percent of the respondent users of computer services had in-house computers, as shown in Exhibit VI-6. As might be expected, the larger firms have substantial EDP capability and yet choose to go outside for manufacturing software products and processing services.

2. COMPUTER SERVICES VENDOR SELECTION

- In choosing a computer services vendor, only the largest users tend to do formal surveys and competitive analyses.

- Some specific user comments include:

    - "OSI had the best packages, and the best support," (small company).

    - "Manufacturing selected XCS," (small company).

    - "Needed package quickly - couldn't wait to develop internally. MMDS package was best one available," (small company).

    - "XCS has more MRP features - more bang for the buck," (medium sized electrical manufacturer).

    - "GE is the leader in timesharing and engineers liked their applications," (medium sized fabricated metal manufacturer).

    - "Arista's MRP is more or less a stand-alone system...did not have to change anything else...IDMS interfaces with it," (large company).

    - "Extensive survey of what is available whenever packages are bought. Timesharing vendors selected on basis of software available on their networks," (very large machinery manufacturer).

    - "Surveyed several companies - MMDS had modular system, easily modified," (very large company).

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**INPUT**

EXHIBIT VI-6


IN-HOUSE COMPUTERS USED BY COMPUTER SERVICES USER RESPONDENTS


| % OF RESPONDENTS WITH COMPUTERS | RESPONDENT SIZE | | |
|---|---|---|---|
| | SMALL 38% | MEDIUM 50% | LARGE AND VERY LARGE 100% |
| Computer Types Mentioned | • PDP-8L<br>• HP-2100<br>• 370/125 | • Nova 1200<br>• PDP 11/45 and<br>• IBM-1620<br><br>• 360/30<br><br>• 370/125 | • 370/145<br>• 370/145 and 370/158<br>• (2) 370/158s<br>• Multiple 370/168s & 370/158s<br>• 370/158 and (5) 370/145s<br>• 370/158 and 370/168<br>• 370/158 and System 3 |


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# 3. APPLICATIONS REQUIREMENTS

- Users were asked, "What would be the next manufacturing application you would be most interested in implementing?"

    - Most small users had no plans or ideas regarding increasing the scope of their applications. The 3 small users who did comment were planning:

        - Work-in-process
        - Sales order-entry system
        - Bill of materials processor, routing, engineering change control, sales analysis, and inventory forecasting.

- While 2 medium users were currently inplementing new applications, only one had any future plans and that was for MRP.

- Large and very large users were divided 50/50 among those with new applications plans, and those without. Those planning new applications included:

    - Raw material inventory, for over 100 plants (apparel company).

    - Integration of material management and purchasing into the manufacturing control system; energy (water, electricity, etc.) and environmental (pollution) management (transportation equipment manufacturer).

    - Shop floor control and capacity planning - considering buying Arista package in 1979 (machinery manufacturer).

- Then respondents were asked, "What manufacturing support products or services would you like to have which are not currently available?" None of the respondents was able to come up with a requirement for which there is no product/service currently available; although many possibilities were suggested

by them  again suggesting the truth of vendor opinion that education of manufacturers is required to inform them of the availability and value of computer services.

- Asked about the need for data bases, no respondent indentified any commercial data base which might be of value.

    - Several were confused between "data base" and "data base management systems," and spoke of TOTAL, IDMS, etc., as being of value.

- Respondents indicated the precedence of installation for manufacturing applications. All responses giving more than one mention for first, second, or third place are shown in Exhibit VI-7. It is apparent, as expected, that materials management, including bill of materials and inventory control, are of primary interest in this industry. The responses were essentially independent of firm size.

EXHIBIT VI-7

RESPONDENTS' PREFERRED ORDER OF INSTALLATION OF

MANUFACTURING APPLICATIONS

| APPLICATION | NUMBER OF MENTIONS | | |
| --- | --- | --- | --- |
| | FIRST | SECOND | THIRD |
| Bill of Materials | 7 | 2 | 1 |
| Inventory Control | 5 | 6 | 6 |
| Planning/Scheduling/Forecasting | 2 | 3 | 2 |
| MRP | 1 | 4 | 2 |

# VII. COMPETITIVE ENVIRONMENT

# VII.  COMPETITIVE ENVIRONMENT

## A.  IN-HOUSE USER ATTITUDES

- Users of in-house computers tend to see computer processing services as an intermediate step between a small business computer system and the large integrated manufacturing-financial system.

    - The small specialty systems are purchased as turnkey systems.

    - The large integrated systems are generally the result of purchased applications packages, modified and run on in-house computers, or systems developed entirely in-house.

- Obvious exceptions to the above include clients of MITROL Co., consultants and vendors of discrete manufacturing software products.  Only one of MITROL's clients have converted MIMS (MITROL Industrial Management System) from remote computing service to an in-house system.  MIMS is available via NCSS and Tymshare.

- Comments by in-house users on why they are not using computer services include:

    - (Small)  "Make or buy decision - outside services would be too expensive."

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- (Small) "People who write packages don't understand manufacturing. Service bureaus don't give good turn-around."

- (Medium) "Used to use outside service. Cost effective to go in-house as company grew larger."

- (Medium) "Too much of a hassle to tailor our systems to services vendors' needs."

- (Medium) "Software packages are poorly documented. Previously used a service and found it too expensive for what we were getting."

- (Large) "VP of Data Processing is against buying outside services."

- (Large) "Most packages are designed for off-the-shelf use and are not applicable. A lot of manufacturing is customized."

- (Very large) "Most manufacturing applications are at a primitive level of design;companies have no options but to develop their own."

- (Very large) "Most packages are unreliable."

- (Very large) "Vendor software is too general."

- (Very large) "Too expensive to go outside for everything."

- (Very large) "Outside couldn't handle it - we use 10 billion bytes of disk storage with high levels of use and interaction."

- When in-house users were asked under what circumstances they would increase their use of outside services, most responded "none" or "if costs were dramatically reduced." In fact, more in-house users expressed intentions of reducing their outside expenditures. Only 3 very large respondents gave helpful information for services vendors:

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- "More sophisticated products and integrated products. Currently have to go to multiple vendors to obtain a line of applications. Will probably utilize more outside consultants and programmers who have design experience...engineering and marketing applications are becoming more important. Will become more involved with CAD/CAM (Computer Aided Design/Computer Aided Manufacturing). Word processing is also gaining."

- (SIC 36) "Our use of services is always dependent upon time - if there is enough time and it is cost effective, we'll do it in-house. Computer aided manufacturing is what is needed."

- (SIC 37) "Financial market forecasting applications would be purchased outside if available."

   NOTE: The survey by Fogarty, quoted earlier, found users gave forecasting software the poorest evaluations.

## B.   IN-HOUSE COMPETITION AND COMPUTER SERVICES

- In very large companies, the attitude of "we are unique" stimulates most users to develop their systems in-house. There is, however, a substantial use of computer services for overflow work, and for expansion of existing software systems.

- Among the very large companies interviewed, one still does its national payroll at local service bureaus and another does all keypunching outside.

- Competition for computer services is mainly for the medium and large manufacturers.

- Small companies are becoming computer users with small computer systems for manufacturing, sometimes in addition to doing payroll and/or financial

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applications outside. Penetration in this size group is low and moving rather slowly.

- In one industry, apparel manufacturing, turnkey systems for pattern layout seem to be without competition from services companies. The leaders in this field are CAMSCO (Richardson, TX) and Hughes Aircraft (Baltimore, MD). Hughes also offers a laser cutter for cutting 40-50 layers of material after the pattern is laid out.

- In many major manufacturing companies - particularly aerospace firms -the EDP requirements are filled by a "spin-off" which usually, but not always, is required to meet all of its parent's needs. Aerospace firms in this category include Boeing, Martin-Marietta, McDonnell Douglas, and Grumman.

- The major commercial product manufacturer in this category is General Electric, who provides GE Information Services Business Division (GEIS) with about 10% of its revenues. However, other General Electric divisions have their own data processing and GEIS operates virtually as an independent.

## C.    IMPACT OF SMALL COMPUTERS

- Computer services vendors interviewed all believe that small computers will have a significant impact on revenues in the next few years. If they don't act to offer small business computers themselves, the impact will be negative. Hence, many vendors are currently offering, or planning to market, systems in stand-alone mode or in conjunction with their RCS service. Vendor comments include:

    - "Potential threat to revenues currently at \$10K to \$12K per month level of user."

    - "Competition will increase as minis get better software. The market is opening up so fast now that growth will exceed losses to competition from minis."

- "Minis are our main competition, although hard to quantify."

- "We are converting our existing software to minis and expect to increase revenues by getting to smaller companies ($2-3 million sales) who could not previously afford our service. First product will be stand-alone; distributed processing later."

- "We will definitely be offering a mini system in 5 years, although it doesn't really solve the manufacturer's problems. Currently we offer distributed processing with terminals."

- "We are looking at hooking up minis with our service. May get into distributed processing. Aggressively pursuing this path."

- "Now offering turnkey systems (not yet announced), both stand-alone and connectible to RCS."

- "Will be significant in specialized applications (MRP, etc.) when software is available. Can be combatted with distributed processing. Many company managements will not want to have their manufacturing organization having to bother with minicomputer systems."

## D.    MARKET GROWTH EXPECTED BY COMPUTER SERVICES VENDORS

- All computer services vendors interviewed which specialize in discrete manufacturing expect their growth rates to be 40% to 50% per year. They also expect the average growth to be 20% to 30% per year.

- Thus, there appears to be confidence in the potential market and over optimism on the extent of penetration.

- Vendors expect growth in revenues to come mainly from those discrete manufacturers in Fabricated Metal Products (SIC 35), Electrical and Electronic (SIC 36), Transportation Equipment (SIC 37), and Instruments (SIC 38).

- Some vendor comments include:

  - "Big manufacturers, more oriented toward solving problems. Not so much in clothing, transportation, aerospace. Aerospace companies think they know it all."

  - "Electronics and electrical machinery and equipment - Large number of smaller firms, with increased awareness of availability of MRP, and lower cost now available to handle their problems."

  - "SICs 34 and 36 (Fabricated Metal, Electrical and Electronics) are most amenable to EDP solutions to manufacturing problems."

## E. COMPUTER SERVICES VENDORS' REVENUES FROM DISCRETE MANUFACTURING

- There are few large vendors specializing in the discrete manufacturing industry. The largest revenues accrue to ADP, whose general business payroll and financial applications services yielded an estimated $51 million in 1976 from this industry sector, as shown in Exhibit VII-1.

- The major specialized processing services vendor to the industry is Xerox Computer Services (XCS) with $14 million in revenues.

- The competition is much greater in the specialized software area where Informatics, with $10 million, and Martin Marietta Data Systems (MMDS), with $8 million, compete with Authur Andersen and Co., Arista Manufacturing, CompuServe Inc. and Mitrol, each of whom has under $3 million in revenues. These vendors all provide specialized, modular manufacturing systems which can be integrated into the client's financial systems.

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EXHIBIT VII-1

COMPUTER SERVICES REVENUES BY KEY

VENDORS IN DISCRETE MANUFACTURING

| VENDOR | 1976 COMPUTER SERVICES REVENUES | ESTIMATED DISCRETE MANUFACTURING REVENUES (U.S.) |
|---|---|---|
| *Automatic Data Processing | $    245M | $    51M· |
| Manufacturing Data Systems, Inc. | 16 | 15 |
| *Tymshare | 56 | 20· |
| *Xerox Computer Services | 21 | 14 – |
| *Informatics, Inc. | 60 | 10· |
| *GE Information Services | 120 | 10 |
| Statistical Tabulating | 30 | 10 |
| *Martin Marietta Data Systems | 8 | 8· |
| *Itel Data Services | 40 | 8· |
| *Data Resources, Inc. | 17 | 8· |
| System Development Corporation | 110 | 8· |
| NCSS | 36 | 6 |
| *Boeing Computer Services | 50 | 5 |
| *MCAUTO | 90 | 5· |
| Keydata | 15 | 4· |
| *Software International | 6 | 3 |
| *Pryor Corporation | 14 | 3· |
| *CompuServ | 11 | 3 |
| *Arista Manufacturing Systems | 2 | 1· |
| *Optimum Systems, Inc. | 35 | 1 |
| *Arthur Andersen & Company | – | 1 |
| *Mitrol, Inc. | 2 | 1 |
| 17 Other respondents | 80 | 20 |
| TOTAL | $ 1,064M | $ 215M |
| TOTAL COMPUTER SERVICES INDUSTRY (1976) | $ 5,900M | $ 770M |
| % ACCOUNTED FOR | 18% | 28% |

* = Vendors interviewed, by mail or by phone, for this report.

–    Manufacturing Data Systems, Inc. is the unique exception to the lack of dominance in this industry.    MDSI provides a software language (COMPACT II) and processing services via other vendors' networks (Tymshare and Comshare) for the preparation of numerical control machine tapes.  MDSI has 50% of the total market with revenues just over $16 million in 1976 and is expected to grow at 40-50% per year! About 80% of MDSI's revenues come from RCS and the remainder from software sales, including turnkey systems.

## F.    PROFILES OF KEY COMPUTER SERVICES VENDORS TO DISCRETE MANUFACTURING

- **ARISTA MANUFACTURING SYSTEMS** (Winston-Salem, NC) is a recently split off division of Arista Information Systems and has just been sold to Xerox Computer Services.    Arista's main product is software for manufacturing planning and control, oriented toward IBM 360 and 370 users.  A joint venture is now underway to put their software on a Hewlett Packard mini.  With 1976 revenues of $1 to $2 million, Arista expects to double in size in 1977 and then average 50% per year growth for several years.  Arista is a major competitor of ComServ and Martin Marietta Data Systems

- **ARTHUR ANDERSEN & CO.** is one of the "Big 8" accounting firms.    They offer an integrated modular package for manufacturing and accounting systems in RPG and COBOL.  The COBOL version is a modified version of AMAPS, which AA& Co. purchased from ComServ.

  –    AA has installed about 60 systems on 8 or 9 different computers in the past 2 years.

  –    AA says they find timesharing firms to be more competition on the West Coast than on the East Coast and then mainly for clients with sales under $5 million.

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- **AUTOMATIC DATA PROCESSING, INC. (ADP)** (Clifton, NJ) is the largest supplier of payroll and other financial services to the manufacturing industry. Some 25% of ADP's total services revenues are derived from discrete manufacturing firms, yielding about $50 million during 1976.

  - ADP is currently building a capability in manufacturing applications based on existing ADP forecasting and statistical software packages.

  - ADP recently acquired Eastern Systems Management which has offered processing services, including FM, to manufacturers for several years; clients included Armstrong Cork and Kern Glass.

- **BOEING COMPUTER SERVICES, INC. (BCS)** (Dover, NJ) is a wholly owned subsidiary of the Boeing Company, with over 75% of its revenues derived from the parent company. Most of BCS's interest in the manufacturing industry (outside of its parent) is in the engineering and financial aspects of the business.

- **COMSERV CORP.** (Minneapolis, MN) is a leader in manufacturing software with its product AMAPS (manufacturing, Accounting, Production System) comprising 9 manufacturing modules.

  - Arthur Andersen & Co. purchased AMAPS and certain marketing rights for $850,000. Arthur Andersen modifies AMAPS and markets it as part of its COBOL version of MAC-PAC.

  - MCAUTO recently concluded a licensing agreement for AMAPS worth at least $750,000 and will market it in North America and Europe.

  - Comserv also offers DOES (Distribution Order Entry System) and other general software products as well as batch and remote computing services.

  - About 60% of Comserv's 1076 revenues of $2.2 million derives from discrete manufacturing.

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- **DATA RESOURCES, INC.** (Lexington, MA). With over 450 clients, nearly half of DRI's $17 million in revenues come from discrete manufacturing companies. Over 1/3 of the company's revenues are derived from subscription fees to its computer accessible economic data banks, econometric models and forecasting; over 1/2 the revenues are derived from associated data processing services; the balance derives from consulting servces. DRI maintains one of the largest installations of Burroughs computers in the world and its own telecommunications network.

- **GENERAL ELECTRIC INFORMATION SERVICES (GEIS)** (Rockville, MD), a division of the General Electric Company, has computer services revenues estimated to be over $125 million. Perhaps 25-30% of all of GEIS's revenues come from discrete manufacturing, including those from its parent company.

  - GEIS's main external sales derive from financially oriented products and services and utility "timesharing."

  - GEIS also offers N/C machine tool services.

  - With its IBM System/370 capability, GEIS is concentrating more on transaction processing, including manufacturing applications.

- **HUGHES AIRCRAFT COMPANY, INDUSTRIAL PRODUCTS DIVISION** (Oceanside, CA) offers the AUTOGRAPHICS cutting room system to the apparel industry.

  - AUTOGRAPHICS allow for layout of one standard size clothing article on a CRT, using a light pen. The system then automatically generates all other sizes and lays out patterns with a plotter on a 60 inch wide, 100 yard long "marker," taking material utilization efficiency into account. A laser cutter (optional) can then be used to cut 40 or 50 layers of cloth.

- The system is designed around a HP21 system and sells for approximately $250 thousand plus the laser cutter. In business for 3 years now, the division has installed about 60 systems, yielding cumulative revenues of more than $15 million for AUTOGRAPHIC.

- **IBM** offers its large machine users a series of concepts that outline an approach to an integrated computer-based manufacturing control system called COPICS (Communications Oriented Production Information and Control System).

  - For the smaller System 3 user there is IPICS (Initial Production and Information Control System), a series of programs which may be modularly installed. IPICS runs in conjunction with other IBM program products such as the Manufacturing Management Accounting System which covers financial and sales activities in the manufacturing company. Few users actually use all of the 10 IPICS modules available.

  - By use of a questionnaire, the user's requirements and options are determined and the software modified by IBM, as required, to meet the user's specific needs. Hence, the product has wide industry sub-sector applications and can be catered to the differring needs of an auto manufacturer, an aerospace firm, or an electrical parts fabricator.

- **INFORMATICS, INC.** (Woodland Hills, CA), completing 15 years in business in 1976, reported $59.3 million in worldwide revenues, making it the largest independent supplier of software products with $21 million in product sales.

  - In 1974, Informatics became a subsidiary of Equitable Life Assurance Society of the U.S., giving it the necessary capital to support its growth. Commercial revenues account for 74% of the total and are derived from timesharing services, custom software services, and consulting, in addition to software products. At NASA, Informatics also performs facilities management.

- Informatics Manufacturing System Division designs, develops, and/or implements total manufacturing systems, utilizing a library of predeveloped software modules called PRODUCTION IV. In 1977, PRODUCTION IV was cited at the ICP Annual Million Dollar Awards Ceremony for exceeding total sales since inception of $1 million.

- Other Informatics products, such as MARK IV, with sales to date exceeding $30M, are also used by discrete manufacturing companies.

- **ITEL DATA SERVICES** (White Plains, NY) receives about 20% of its total revenues from manufacturing companies, nearly all discrete, with anticipated 1977 revenues of about $80 million. This will yield some $15 million from manufacturing, mainly in general business applications.

  - Specialty services for manufacturing include on-line interactive sales order processing, MRP, and other functions.

  - ITEL will soon announce a mini-computer based turnkey system which will operate either stand-alone or as a remote computing services terminal and which will perform all the applications mentioned above.

- **MARTIN MARIETTA DATA SYSTEMS (MMDS)** (Baltimore, MD) is one of the leaders in providing computer software and services to the manufacturing industry. Its MAS (Modular Application System) package reached $1 million in sales in one year, 1976.

  - MAS comprises 95 system modules covering 6 major areas of application: business planning, manufacturing control, financial control, cost control, order control, and inventory control.

  - MAS is running on IBM, Honeywell, Univac and ICL machines as well as on the MMDS 370/168 Remote Job Entry Network.

- MAS is very flexible and can be installed as required in any sequence and, if urgent, can be running in-house within 2 weeks.

- When MAS is used on the MMDS network, there is no charge for the use of the standard software. If used in-house, a license fee of about $250,000 is charged.

- MMDS also offers facilities management capability but has not been successful with it due to a variety of factors.

- MMDS revenues from computer services have been estimated at $43 million, 50% of which is captive to the parent company and 20% of which is derived from users outside the U.S. Concentrated in manufacturing, banking and distribution, the remaining 30% ($13 million) contains about $5 million annually in manufacturing revenues, nearly all of which is from discrete manufacturing firms.

- **MANDATE CORP.** (Cleveland, OH) markets a combination on-line and batch service to small and medium manufacturing firms. The application software comprises 12 modules covering factory, marketing and financial needs. The company has over 50 manufacturing clients, and most of its revenues (estimated at $2 million) derive from discrete manufacturing.

- **MC DONNELL DOUGLAS AUTOMATION COMPANY (MCAUTO)** (St. Louis, MO). MCAUTO, a "spin-off" of McDonnell Douglas, is the major supplier of hospital services in the U.S. and the supplier of significant captive services to its parent company.

  - In discrete manufacturing, MCAUTO offers material management (MRP, shop floor control), technical (N/C, CAD), and accounting applications, mainly to firms over $20 million.

  - McDonnell Douglas Corp. also has a subsidiary, Actron (Monrovia, CA), which manufacturers plotters and controllers for the discrete manufacturing industry.

**INPUT**

- MCAUTO also offers IBM's product ABS (Apparel Business Systems).

- A large part of MCAUTO's revenues from discrete manufacturers is from IMS-based services, including the use of applications packages (such as an order-entry system, COOP) based on IMS.

● **MITROL, INC.** (Lexington, MA) specializes in the provision of integrated manufacturing and financial software for discrete and process manufacturing firms. Their products are available on a combined interactive timesharing and batch service, via NCSS, GEIS and, recently, Tymshare. Mitrol has about 65 users of MIMS (Mitrol Industrial Management System), only one of whom has asked to have the software modified to run on its own in-house computer. Mitrol has 36 employees, has been in operation since 1972, and has estimated revenues of $1-2 million.

● **PRYOR CORPORATION** (Chicago, IL) offers an on-line manufacturing order processing, cost accounting and inventory control service which is oriented primarily toward chemical manufacturers, but which can be used by discrete manufacturers as well.

- The company also offers RC/BASIC, an on-line billing, accounts receivable, sales analysis, and inventory control service.

- With over $15 million in annual sales, 50% of which derive from manufacturers, the company's estimated discrete manufacturing revenues are about $3 million.

● **SYSTEM DEVELOPMENT CORPORATION** (Santa Monica, CA) traditonally has emphasized the role of prime contractor for large government military systems and major government non-military study projects. In 1976, SDC had increased its non-government business to 50% of its total of $110M in revenues, concentrating mainly in facilities management work.

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- Two major commercial industries were targeted - newspaper publishing and the financial community. SDC has sold 20 TEXT II automated newspaper production and accounting turnkey systems.

- MAY AND SPEH (Oak Brook, IL), one of the country's oldest data processing centers is an SDC subsidiary which provides traditional batch services to manufacturers, among others.

- SDC also offers an on-line information retrieval service (SDC Search Service) and data bank in science, technology, engineering, patents, and commerce.

- Combined SDC revenues in discrete manufacturing are estimated at $8 million including its subsidiary, Applied Information Development (Oak Brook, IL).

- **TYMSHARE INC.** (Cupertino, CA) is one of the largest revenue producers from the discrete manufacturing industry with an estimated $20 million in 1976, derived from manufacturing and accounting services as well as general purpose data management and financial planning.

  - Tymshare addresses two distinct market segments: general services to the Fortune 1000, and more industry specific services to smaller manufacturers.

  - The company expects its manufacturing revenue growth to exceed 40% per year in the next 5 years.

  - A significant new trend is the development of manufacturing applications software in its proprietary DBMS, such as MAGNUM.

- **XEROX COMPUTER SERVICES (XCS)** (Los Angeles, CA), a wholly owned subsidiary of Xerox Corporation, is the largest supplier of RCS, specializing in manufacturing with 1976 discrete manufacturing services revenues estimated at $13 million.

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-   Applications include the full range of financial and manufacturing operations requirements. Small business computer systems are their main competition, not software oriented companies like Martin Marietta Data Systems, Arista (being acquired by XCS), Arthur Andersen & Co., and ComServ.

-   The financial services are applicable to process manufacturing as well and to distribution which is XCS's other major industry strength.

APPENDIX A: DATA BASE

EXHIBIT A-1

FORECAST USER EXPENDITURES FOR COMPUTER SERVICES

BY MODE OF SERVICE

INDUSTRY NAME: <u>DISCRETE MANUFACTURING</u>

SICS INCLUDED: <u>23, 25, 27, 31, 34-38</u>

| MODE OF SERVICE | EXPENDITURES ($ MILLIONS) | | | | | AVERAGE ANNUAL GROWTH RATE, 1976-1981 |
|---|---|---|---|---|---|---|
| | 1976 | 1977 | GROWTH RATE (%) | 1979 | 1981 | |
| INTERACTIVE | $ 95 | $115 | 21% | $ 170 | $ 230 | 19% |
| REMOTE BATCH | 105 | 129 | 23 | 190 | 270 | 21 |
| DATA BASE | 10 | 11 | 10 | 20 | 30 | 25 |
| REMOTE COMPUTING SERVICES TOTAL | $210 | $255 | 21% | $ 380 | $ 530 | 20% |
| FACILITIES MANAGEMENT | 35 | 40 | 15 | 55 | 90 | 21 |
| BATCH SERVICES | 235 | 255 | 9 | 310 | 370 | 9 |
| TOTAL PROCESSING SERVICES | 480 | 550 | 15 | 745 | 990 | 16 |
| SOFTWARE PRODUCTS | 120 | 150 | 25 | 230 | 360 | 24 |
| PROFESSIONAL SERVICES | 170 | 190 | 11 | 230 | 280 | 11 |
| TOTAL MARKET | $770 | $890 | 16% | $1,205 | $1,630 | 16% |

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EXHIBIT A-2

FORECAST USER EXPENDITURES FOR PROCESSING SERVICES

BY TYPE OF SERVICE

INDUSTRY NAME:  DISCRETE MANUFACTURING

SICS INCLUDED:  23, 25, 27, 31, 34-38

SICS EXCLUDED:  NONE

| APPLICATIONS AREA | EXPENDITURES ($ MILLIONS) | | AVERAGE ANNUAL GROWTH RATE (%) |
|---|---|---|---|
| | 1976 | 1981 | |
| 1.  GENERAL BUSINESS | $172 | $360 | 16% |
| 2.  SCIENTIFIC AND ENGINEERING | 59 | 95 | 10 |
| 3.  INDUSTRY SPECIALTY | 153 | 375 | 20 |
| 4.  UTILITY | $ 96 | 160 | 11 |
| TOTAL | $480 | $990 | 16% |

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EXHIBIT A-3

DISTRIBUTION OF USER EXPENDITURES FOR PROCESSING SERVICES, 1976,

BY MODE AND TYPE OF SERVICE

INDUSTRY NAME: DISCRETE MANUFACTURING

SICS INCLUDED: 23, 25, 27, 31, 34-38

SICS EXCLUDED: NONE

| TYPE OF SERVICE | MODE OF SERVICE (EXPENDITURES: $ MILLIONS) | | | | | TOTAL ($ M) |
|---|---|---|---|---|---|---|
| | INTER-ACTIVE | REMOTE BATCH | DATA BASE | BATCH | FM | |
| GENERAL BUSINESS | 10 | 20 | 0 | 130 | 12 | 172 |
| SCIENTIFIC AND ENGINEERING | 5 | 30 | 0 | 21 | 3 | .59 |
| INDUSTRY SPECIALTY | 48 | 35 | 10 | 42 | 18 | 153 |
| UTILITY | 32 | 20 | 0 | 42 | 2 | 96 |
| TOTAL | 95 | 105 | 10 | 235 | 35 | $480M |

EXHIBIT A-4

DISTRIBUTION OF USER EXPENDITURES FOR PROCESSING SERVICES, 1981

BY MODE AND TYPE OF SERVICE

INDUSTRY NAME: DISCRETE MANUFACTURING

SICS INCLUDED: 23, 25, 27, 31, 34-38

SICS EXCLUDED: NONE

| TYPE OF SERVICE | MODE OF SERVICE (EXPENDITURES: $ MILLIONS) | | | | | TOTAL ($ M) |
|---|---|---|---|---|---|---|
| | INTER-ACTIVE | REMOTE BATCH | DATA BASE | BATCH | FM | |
| GENERAL BUSINESS | 50 | 55 | 0 | 225 | 30 | 360 |
| SCIENTIFIC AND ENGINEERING | 10 | 55 | 0 | 20 | 10 | 95 |
| INDUSTRY SPECIALTY | 100 | 115 | 30 | 85 | 45 | 375 |
| UTILITY | 70 | 45 | 0 | 40 | 5 | 160 |
| TOTAL | 230 | 270 | 30 | 370 | 90 | $990M |

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EXHIBIT A-5

FORECAST USER EXPENDITURES FOR COMPUTER SERVICES

BY SIZE OF USER[1] GROUP

INDUSTRY NAME: DISCRETE MANUFACTURING

SICS INCLUDED: 23, 25, 27, 31, 34-38

SICS EXCLUDED: NONE

| SIZE OF USER | EXPENDITURES 1976 | | AVERAGE ANNUAL GROWTH RATE |
| --- | --- | --- | --- |
| | ($ MILLION) | (% OF TOTAL) | |
| VERY LARGE | $350M | 45% | 12% |
| LARGE | 60 | 8 | 15 |
| MEDIUM | 190 | 25 | 30 |
| SMALL | $170M | 22% | 10% |
| TOTAL | $770M | 100% | 16% |

[1]USER SIZE DEFINITIONS GIVEN IN APPENDIX B.

INTERVIEW PROGRAM FOR DISCRETE

MANUFACTURING INDUSTRY SECTOR

| TYPE OF ORGANIZATION | TYPE OF INTERVIEW | | | |
|---|---|---|---|---|
| | MAIL | PHONE | ON-SITE | TOTAL |
| INDUSTRY FIRMS | | | | |
|    1.  Users of Processing Services | 0 | 25 | 2 | 27 |
|    2.  Non-Users of Processing Services | 0 | 43 | 0 | 43 |
|         SUB-TOTAL | 0 | 68 | 2 | 70 |
| COMPUTER SERVICES VENDORS | 20 | 21 | 0 | 41 |
| ASSOCIATIONS | 0 | 6 | 0 | 6 |
|   •  Society For Manufacturing Engineers (SME) | | | | |
|   •  American Production And Inventory Control Society (APICS) | | | | |
|   •  National Association of Manufacturers (NAM) | | | | |
|   •  Western Electronic Manufacturers Assn. (WEMA) | | | | |
|   •  American Institute of Industrial Engineers (AIIE) | | | | |
|   •  Computer Aided Manufacturing, International, Inc. (CAMI) | | | | |
| MAGAZINES | 0 | 2 | 0 | 2 |
|   •  Production | | | | |
|   •  Industrial Engineering | | | | |
|   •  Sales And Marketing Management | | | | |

INTERVIEW PROGRAM FOR DISCRETE

MANUFACTURING INDUSTRY SECTOR

| TYPE OF ORGANIZATION | TYPE OF INTERVIEW | | | |
|---|---|---|---|---|
| | MAIL | PHONE | ON-SITE | TOTAL |
| CONSULTANTS | 0 | 2 | 0 | 2 |
| TOTAL | 20 | 99 | 2 | 121 |

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  - American Production and Inventory Control Society

# APPENDIX B: DEFINITIONS

## APPENDIX B: DEFINITIONS

- **COMPUTER SERVICES**

  These are services provided by vendors which perform data processing functions using vendor computers, or assist users to perform such functions on their own computers.

- The following are the definitions of the modes of service used in this report:

  - **REMOTE COMPUTING SERVICES (RCS)**

    Provision of data processing to a user by means of terminals at the user's site(s) connected by a data communications network to the vendor's central computer. The three sub-modes of RCS are:

    - **INTERACTIVE** (timesharing) is characterized by interaction of the user with the system, primarily for problem solving time-sharing, but also for data entry and transaction processing -the user is on-line to the program/files.

    - **REMOTE BATCH** is where the user hands over control of a job to the vendor's computer which schedules job execution according to priorities and resource requirements.

    - **DATA BASE** is characterized by the retrieval of information from a vendor-maintained data base - this may be owned by the vendor or a third party.

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- **BATCH SERVICES**

  This includes data processing performed at vendors' sites of user programs and/or data which are physically transported (as opposed to electronically by telecommunications media) to and/or from those sites. Data entry and data output services, such as keypunching and COM processing, are also included. Batch services include those expenditures by users which take their data to a vendor site which has a terminal connected to a remote computer used for the actual processing.

- **FACILITIES MANAGEMENT (FM)** (also referred to as "Resource Management" or "Systems Management)"

  The management of all or a part of a user's data processing functions under long-term contract (not less than one year). To qualify as FM, the contractor must directly plan and control, as well as operate, the facility provided to the user on-site, through communications lines, or in mixed mode. Simply providing resources even though under a long term contract and/or for all of a user's processing needs does not necessarily qualify as FM.

- **PROFESSIONAL SERVICES**

  Mangement consulting related to EDP, systems consulting, systems design and programming, and other professional services are included in this category. Services can be provided on a basis of: "Time and Materials," whereby the user pays for the time used of an individual on a daily or other fixed rate, or "Fixed Price," where the user pays a fixed fee for a specific task or series of tasks.

- **SOFTWARE PRODUCTS**

  This category is for users' purchases of systems and applications packages for use on in-house computer systems. The figures quoted include lease and purchase expenditures, as well as fees for work performed by the vendor to implement and maintain the package at the users' sites. Fees for work performed by organizations other than the package vendor are counted in Professional Services. The two sub-categories are:

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- **SYSTEMS PACKAGES** are operating systems, utilities, and language routines that enable the computer/communications system to perform basic functions. This software is provided by the mainframe manufacturers with their hardware; other vendors provide improved versions of this and special-purpose routines. This classification includes compilers, data base management software, communications packages, simulators, performance measurement software, diagnostic software, and sorts.

- **APPLICATIONS PACKAGES** are software which perform processing to serve user functions: they consist of general purpose packages, such as for accounting and inventory controls, and special purpose packages, such as personal trust, airline scheduling, and demand deposit accounting.

- **PROCESSING SERVICES**
  Encompasses FM, RCS, and Batch Services: they are categorized by type of service, as distinguished from mode of service, bought by users as follows:

  - **GENERAL BUSINESS** services are processing services for applications which are common to users across industry categories. Software is provided by the vendor; this can be complete package, such as a payroll package, or an application "tool," such as a budgeting model, where a user provides much of the customizing of the finished product it uses. General Business Processing is often repetitive and transaction oriented.

  - **SCIENTIFIC AND ENGINEERING** services are the processing of scientific and engineering problems for users across industries. The problems usually involve the solution of mathematical equations. Processing is generally problem solving and is non-repetitive, except in the sense that the same packages or 'tools' are used to address different, but similar, problems.

**INPUT**

- **SPECIALTY APPLICATIONS** services provide processing for particular functions or problems unique to an industry or industry group. The software is provided by the vendor either as a complete package or as an application 'tool' which the user employs to produce its unique solution. Specialty applications can be either business or scientific in orientation; data base services where the vendor supplies the data base and controls access to it (although it may be owned by a third party) are also included under this category. Examples of Specialty Applications are: seismic data processing, numerically-controlled machine tool software development, and demand deposit accounting.

- **UTILITY** services are those where the vendor provides access to computer and/or communications network with basic software that enables any user to develop its own problem solution or processing system. These basic tools include terminal handling software, sorts, language compilers, data base management systems, information retrieval software, scientific library routines, and other systems software.

EXHIBIT B-1

DEFINITION OF USER ORGANIZATION SIZE GROUPS

| CHARACTERISTICS | SIZE GROUP | | | |
|---|---|---|---|---|
| | SMALL | MEDIUM | LARGE | VERY LARGE |
| SIZE IN ANNUAL SALES <u>OR EQUIVALENTS</u> | < $20 MILLION | $20 MILLION-$100 MILLION | $100 MILLION-$300 MILLION | > $300 MILLION |

*INCLUDES THE FEDERAL GOVERNMENT AND ITS 6,000 INSTALLATIONS.

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**INPUT**

EXHIBIT B-2

DISCRETE MANUFACTURING ORGANIZATIONS

DISTRIBUTION BY SIZE

| SIC | INDUSTRY NAME | ANNUAL SALES | | | |
|-----|--------------|--------------|--------------|--------------|--------------|
| | | < $20 M<br>SMALL | $20-100 M<br>MEDIUM | $100-300 M<br>LARGE | > $300 M<br>VERY LARGE |
| 23 | APPAREL | 18,745 | 4,262 | 18 | 9 |
| 25 | FURNITURE | 8,542 | 133 | 8 | 2 |
| 27 | PRINTING | 40,059 | 244 | 22 | 9 |
| 31 | LEATHER | 2,885 | 59 | 2 | 1 |
| 34 | METAL | 28,399 | 363 | 47 | 26 |
| 35 | MACHINERY | 40,063 | 681 | 64 | 61 |
| 36 | ELECTRONICS | 11,548 | 709 | 42 | 41 |
| 37 | TRANSPORTATION | 7,921 | 454 | 29 | 28 |
| 38 | SCIENTIFIC AND CONTROL INSTR. | 5,770 | 161 | 21 | 14 |
| 39 | MISCELLANEOUS MANUFACTURING | 14,483 | 21 | 12 | 3 |
| | TOTAL | 178,415 | 7,087 | 265 | 194 |

EXHIBIT B-3

DISCRETE MANUFACTURING INDUSTRY SECTOR

DEMOGRAPHIC DATA

| INDUSTRY SIC | INDUSTRY NAME | TYPE OF STATISTIC | DATA |
|---|---|---|---|
| ALL | ALL | VALUE OF SHIPMENTS (1973)<br>NUMBER OF ESTABLISHMENTS (1974)<br>NUMBER OF EMPLOYEES (1974) | $408 BILLION<br>186,000<br>11.6 MILLION |
| 23 | APPAREL | VALUE OF SHIPMENTS (1973)<br>NUMBER OF ESTABLISHMENTS (1974)<br>NUMBER OF EMPLOYEES (1974) | $ 30 BILLION<br>23,000<br>1.4 MILLION |
| 25 | FURNITURE | VALUE OF SHIPMENTS (1973)<br>NUMBER OF ESTABLISHMENTS (1974)<br>NUMBER OF EMPLOYEES (1974) | $ 12.6 BILLION<br>9,000<br>494,000 |
| 27 | PRINTING | VALUE OF SHIPMENTS (1973)<br>NUMBER OF ESTABLISHMENTS (1974)<br>NUMBER OF EMPLOYEES (1974) | $ 33 BILLION<br>40,000<br>1.1 MILLION |
| 31 | LEATHER | VALUE OF SHIPMENTS (1973)<br>NUMBER OF ESTABLISHMENTS (1974)<br>NUMBER OF EMPLOYEES (1974) | $ 6 BILLION<br>3,000<br>266,000 |
| 34 | METAL | VALUE OF SHIPMENTS (1973)<br>NUMBER OF ESTABLISHMENTS (1974)<br>NUMBER OF EMPLOYEES (1974) | $ 59 BILLION<br>29,000<br>1.6 MILLION |

EXHIBIT B-3 (CONT'D)

DISCRETE MANUFACTURING INDUSTRY SECTOR

DEMOGRAPHIC DATA

| INDUSTRY SIC | INDUSTRY NAME | TYPE OF STATISTIC | DATA |
|---|---|---|---|
| 35 | MACHINERY | VALUE OF SHIPMENTS (1973) <br> NUMBER OF ESTABLISHMENTS (1974) <br> NUMBER OF EMPLOYEES (1974) | $ 78 BILLION <br> 41,000 <br> 2.2 MILLION |
| 36 | ELECTRONICS | VALUE OF SHIPMENTS (1973) <br> NUMBER OF ESTABLISHMENTS (1974) <br> NUMBER OF EMPLOYEES (1974) | $ 61 BILLION <br> 12,000 <br> 1.9 MILLION |
| 37 | TRANSPORTATION | VALUE OF SHIPMENTS (1973) <br> NUMBER OF ESTABLISHMENTS (1974) <br> NUMBER OF EMPLOYEES (1974) | $111 BILLION <br> 8,000 <br> 1.7 MILLION |
| 38 | SCIENTIFIC AND CONTROL INSTR. | VALUE OF SHIPMENTS (1973) <br> NUMBER OF ESTABLISHMENTS (1974) <br> NUMBER OF EMPLOYEES (1974) | $ 18 BILLION <br> 6,000 <br> 530,000 |
| 39 | MISCELLANEOUS MANUFACTURERS | VALUE OF SHIPMENTS (1973) <br> NUMBER OF ESTABLISHMENTS (1974) <br> NUMBER OF EMPLOYEES (1974) | $ 13 BILLION <br> 15,000 <br> 56,000 |
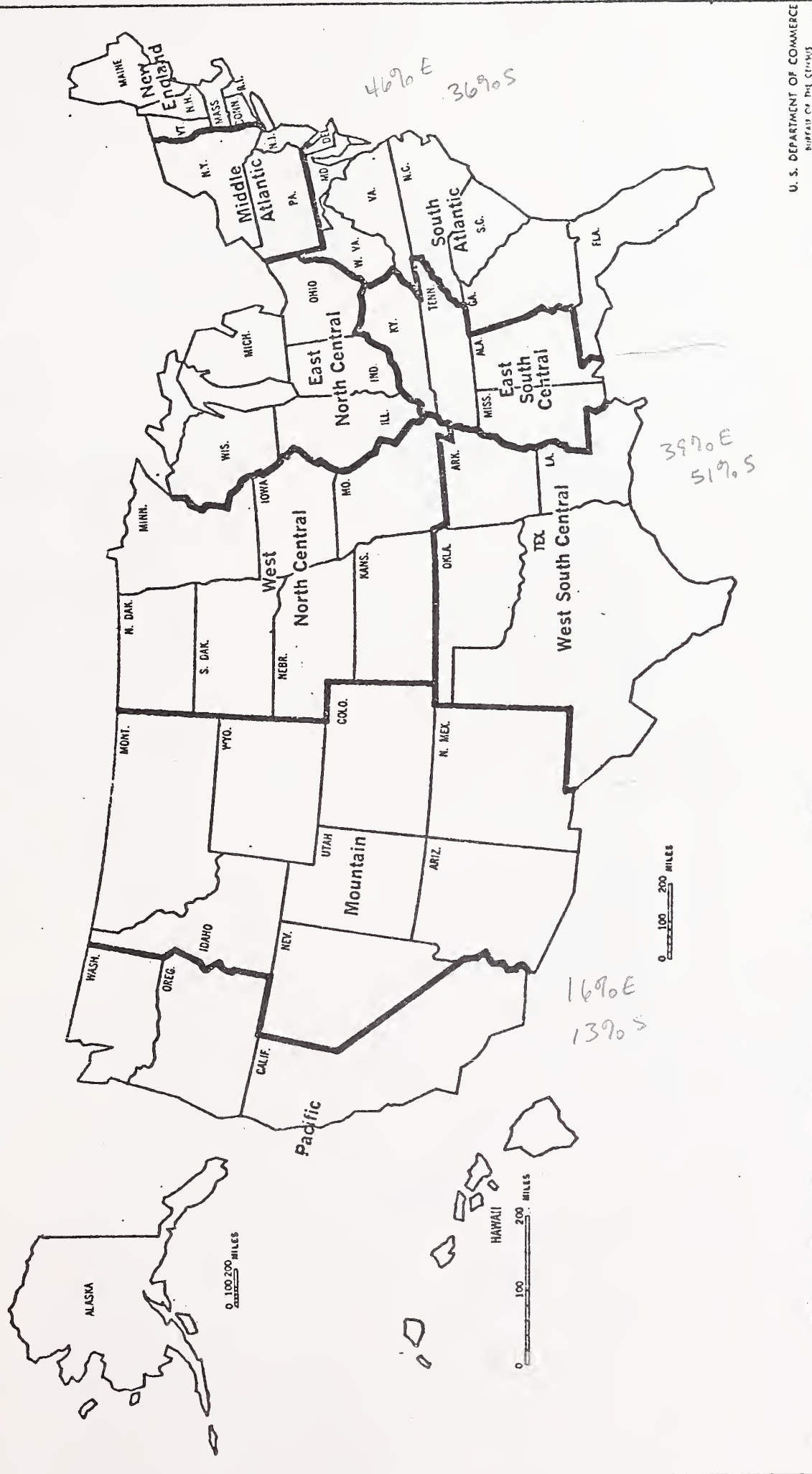
# GEOGRAPHIC DIVISIONS OF THE UNITED STATES

EXHIBIT B-5

GEOGRAPHIC DIVISIONS OF THE

UNITED STATES BY STATE

| STATE | |
|---|---|
| NEW ENGLAND | EAST SOUTH CENTRAL |
| MAINE | KENTUCKY |
| NEW HAMPSHIRE | TENNESSEE |
| VERMONT | ALABAMA |
| MASSACHUSETTS | MISSISSIPPI |
| RHODE ISLAND | WEST SOUTH CENTRAL |
| CONNECTICUT | ARKANSAS |
| MIDDLE ATLANTIC | LOUISIANA |
| NEW YORK | OKLAHOMA |
| NEW JERSEY | TEXAS |
| PENNSYLVANIA | MOUNTAIN |
| EAST NORTH CENTRAL | MONTANA |
| OHIO | IDAHO |
| INDIANA | WYOMING |
| ILLINOIS | COLORADO |
| MICHIGAN | NEW MEXICO |
| WISCONSIN | ARIZONA |
| WEST NORTH CENTRAL | UTAH |
| MINNESOTA | NEVADA |
| IOWA | PACIFIC |
| MISSOURI | WASHINGTON |
| NORTH DAKOTA | OREGON |
| SOUTH DAKOTA | CALIFORNIA |
| NEBRASKA | ALASKA |
| KANSAS | HAWAII |
| SOUTH ATLANTIC | |
| DELAWARE | |
| MARYLAND | |
| DISTRICT OF COLUMBIA | |
| VIRGINIA | |
| WEST VIRGINIA | |
| NORTH CAROLINA | |
| SOUTH CAROLINA | |
| GEORGIA | |
| FLORIDA | |

APPENDIX C: QUESTIONNAIRES

INPUT QUESTIONNAIRE

PROJECT CODE _____
AND NUMBER _____

STUDY TITLE: MARKET ANALYSIS SERVICE

TYPE OF INTERVIEW:  EDP USER

PURPOSE: To study the use ofcomputer services and the attitudes
of key users to future development.

1. Does your firm spend any money for outside data processing

   services, in support of manufacturing?   Yes_____ No_____

   (If YES, continue.  If NO, skip to Q#4).

   (Enter responses to the following questions in Table 1.)

   a. What kind of D.P. services do you use.(mode of service) ?

   b. What manufacturing related applications do you perform via
   these services?

   c. Which vendor(s) provide these services to you?

   d. Do any of these contracts go for more than one year at a time?

2. How did you happen to choose these particular vendors?

3. Why do you use computer services rather than get your own in-house
   computer? (If user also has an in-house computer, go to Q#5..If
   not, skip to question # 10.)

4. Do you have your own in-house computer?  Yes__ No___

   (If NO, end interview.)

5. What kind of computer is it? (Make, model)

6. How long have you had it (them)?

7. What manufacturing application(s) do you perform on your in-house computer(s)?

8. Why did you decide touse an in-house computer instead of using computer services for those applications?

9. Did you originally purchase your manufacturing applications software, or develop it yourself?

    a.(If purchased, from whom?)

    b. How come you decided to do it that way (inside, or outside, instead of the other).

10. Have you recently bought (or leased) any manufacturing related software products, or are you planning to do so in the near future? (If YES in 1977, enter product name, application, vendor, expenditure data in Table 1).    Yes_____    No_____

11. Do you use contract programming, or other consulting services? (If YES, enter application and vendor in Table 1)  Yes___ No___

12. Have you considered using facilities management? Yes___ No___ (If using, enter data in Table 1).

    Comments (e.g., Why not?):

13. Under what conditions might you consider an FM contract?

14. Approximately how much do you expect to spend for these (Table 1) services in 1977? (Try to get data by line item. Otherwise, get total.)

15. How does that compare with last year (1976)? (Enter % in Table 1).

16. What about next year (1978)? (Enter % in Table 1.)

17. Approximately what percentage of the manufacturing data processing budget goes for outside EDP expenditures? _____% in 1977

_____% in 1978

18. Roughly what share of the company's revenues goes for manufacturing data processing budgets? _____%

19. How does your company handle payroll and general business requirements (manual, in-house, outside service)? % spent for general business engineering, if possible.

20. Approximately how much gets spent outside for these services (if any) each month? $_____ per month.

21. What would be the next manufacturing application you would be most interested in implementing?

22. What manufacturing support products or services would you like tohave, which are not currently available?

23. Is there any particular data base which is, or would be important to you in manufacturing?

24. What impact do you expect minicomputers tohave in manufacturing operations?

25. Do you have any interest in distributed processing? Yes___ No___

26. How do you think you might use distributed processing in the future?

27. If you expect to use distributed processing, when might that be?

28. What would you say is the major manufacturing problem in your industry?

29. Is your manufacturing operation unionized?   Yes____ No____

    If Yes, does this have any effect on your use of EDP?

30. What developments might increase your use of outside data processig services?




31. If you were starting from scratch, in what order would you
.want to implement manufacturing EDP operations?




32. Do you know of any manufacturing company which uses services?

-------------------------------------------------------------------------

Interviewer Comments

TABLE 1

| TYPE OF SERVICE | MANUFACTURING APPLICATION | VENDOR(S) | 1977 Expenditures | 77/76 | 78/77 | Duration (years) |
|---|---|---|---|---|---|---|
| 1. Data Processing Svcs. | | | | | | |
|   Interactive T/S _____ | | | | | | |
|   Remote Batch _____ | | | | | | |
|   Batch _____ | | | | | | |
| 2. Software Products _____ (by name) | | | | | | |
| 3. Professional Svcs | | | | | | |
|   Contract Programming _____ | | | | | | |
|   Other consulting _____ | | | | | | |
| 4. Facilities Mgmt. _____ | | | | | | |
| | | | | | TOTAL, $ | |

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VENDOR QUESTIONNAIRE #1

## Discrete Manufacturing

1. What EDP products and/or computer services do you provide to the discrete manufacturing industry?

2. Do your products/services have applicability across all sub-sectors of discrete manufacturing (SIC 20-39)?

   Yes ___          No ___

   a) If "No", which ones do you serve (please list in order of importance)?

   i.    _____

   ii.   _____

   iii.  _____

   iv.   _____

   v.    _____

3. What share of your EDP-related revenues come from discrete manufacturing?

   _____%

4.  How does that break down among the following applications?

    a)  General business
        (Payroll, A/R, A/P, General Ledger, etc.)          _____%

    b)  Scientific and engineering
        (CAD, NC, Stress analysis, etc.)                   _____%

    c)  Specialty applications
        (Inventory control, MRP, scheduling, etc.)         _____%

    d)  Other
        (Please specify)                                   _____%

                                                    _____

                                            Total    100  %


5.  What size manufacturers (annual sales or number of employees) are
    the main users of your product/service?

    _____


6.  Whom may we contact for a telephone interview?

    Name: _____     Title: _____

    Phone: _____


7.  Is the above information confidential, or may we publish parts of it?

        CONFIDENTIAL ____        OK TO PUBLISH ____


Please send us a copy of applicable product literature and an annual report,
if available.  Thank you.