INDUSTRY REPORT

COMPUTER SERVICES MARKETS IN THE SERVICES INDUSTRIES

PART II – ARCHITECTS, ENGINEERS, AND RESEARCH AND DEVELOPMENT ORGANIZATIONS

INPUT

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Computer Services Markets in the Services Industries Part II - Architects,

Engineers and E

INDUSTRY REPORT

No. 3

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JANUARY 1977

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COMPUTER SERVICES MARKETS

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AND RESEARCH AND DEVELOPMENT ORGANIZATIONS

LIST OF EXHIBITS

I. INTRODUCTION

INPUT

I INTRODUCTION

- This report is produced by INPUT as part of the Market Analysis Service (MAS).

- Research carried out for this report was based on a series of telephone interviews and contacts as specified in Exhibit I-1.

- Preliminary research was carried out during the summer of 1976; most interviews were completed in November, 1976.

- Prior to the research activity, clients were asked to suggest particular questions and specific areas of interest to be incorporated into the study.

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

EXHIBIT I-1

INTERVIEW PROGRAM	
USERS	
Architects + Engineers	33
Research & Development	12
TOTAL USERS	45
VENDORS	12
OTHERS	
American Institute of Architects	
American Consulting Engineers Council	
National Science Foundation	

II. MANAGEMENT SUMMARY

II MANAGEMENT SUMMARY

A. INDUSTRY STRUCTURE

- There are over 25,000 architectural and engineering firms in the United States. Four-fifths of the firms are small businesses with fewer than 20 employees; only 15 firms have more than 500 employees.

- There is, however, a large market for computer services among those architectural and consulting engineering firms that employ more than 25 people. More than 2,000 of these firms are candidates for computer services.

- There are over 5,600 research organizations cited in the 1970 U.S. census.

- Over 4,400 have fewer than 20 employees, with 1,100 estimated firms with more than 30 employees which are sufficiently large to be potential candidates for computer services.

- There are 70,000 architects and 700,000 engineers in the U.S., and the number of people employed by architectural and engineering firms, according to the 1970 census, was 303,000. (The other engineers work in manufacturing firms, etc.)

- The number of people working for non-commercial research agencies was 116,000, and the number of people working for commercial R&D laboratories was 78,000. (See Exhibit II-1)

EXHIBIT II-1

DISTRIBUTION OF ARCHITECTS AND ENGINEERS AND RESEARCH AGENCIES

INDUSTRY	NUMBER OF REPORTING UNITS BY EMPLOYMENT SIZE CLASS							
	1-20	20-49	50-99	100-249	250-249	500+	Total Units	Total Employment
ARCHITECTS & ENGINEERS	21,724	2,344	579	299	58	15	25,019	303,647
COMMERCIAL & NON-COMMERCIAL RESEARCH INSTITUTIONS	4,417	836	416	191	67	53	5,980	194,362

B. COMPUTER SERVICES EXPENDITURES

- Computer services expenditures by architects, engineers and R&D institutions will grow from $132 million in 1976 to $242 million in 1981, an average annual growth rate of 12.9%.

- The major portion of the expenditures is accounted for by architects and engineers, who, by proportion, spend more than any other professional group on computer services. The expenditures for computer services by architects and engineers will grow from $106 million to $202 million between 1976 and 1981, an average annual growth rate of 13.8%.

- The reason for this growth in A&E expenditures is fourfold.

  - The project orientation of the industry allows A&Es to charge the customer for computer services.

  - An increasing number of small A&E firms will use computer services.

  - The computer services firms will continue to provide faster turnaround time and more sophisticated packages than in-house systems.

  - The small A&E firms do not have the resources to purchase the large systems or programming support staffs required to solve many A&E problems.

- Nonprofit R&D firms obtain their funding from the Government or other nonprofit sources. Their budgets for computer equipment tend to be large.

- Large R&D firms tend to have the latest and most power computer equipment and large, competent and knowledgeable staffs. Very large R&D firms use computer services only as an adjunct to in-house computers.

- Large and medium-sized institutes are potential clients when the project leader is familiar with the software and services offered by an outside company.

- The smaller R&D firms are potential clients for computer services.

- Remote computing is the largest segment of the business with scientific and engineering applications such as NASTRAN, ANSYSS, PIPEFLEX, COGO, etc. being the moving forces in the market.

- Revenues to the vendors of scientific and engineering services will be considerably greater than the revenues derived entirely from the A&E and the R&D institutions, since such services are also used by the construction, petroleum, utility, manufacturing and other industry segments.

- Expenditures for software products will increase from $12 million to $30 million in the 1976 to 1981 period, an annual growth rate of 20.1%. This growth can be attributed to the fact that there is an increasing need for efficient scientific software. A variety of suppliers, ranging from software houses to universities, are responding to this need.

- Batch processing expenditures will increase from $22 million to $30 million between 1976 and 1981, peaking out at $33 million in 1979. Although this mode of processing is still lowest in cost, the quick turnaround, the larger processor, and the interactive capability of remote processing will make it worth the higher price; and a growing number of users will switch to the RJE mode.

- Professional services in this industry are relatively small; they are used primarily on an interim basis on government-funded projects.

C. VENDOR SPECIALIZATION REQUIRED

- One of the most important criteria for success in this market, in addition to large CPUs, is an understanding of the special requirements of the A&E users. The vendor with the highest user rating is MCAUTO.

- The reasons for the high level of user confidence are apparent even from MCAUTO'S applications brochures; they are well-organized and easily usable. For example, a mechanical or an electrical engineer can find the programs applicable to the solution of his problem categorized in the appropriate section.

- Control Data Corporation, the second most frequently-mentioned vendor, also provides a complete library of applications programs in addition to large mainframes.

- A&E and R&D firms tend to use multiple vendors to obtain the optimum mix of price and problem solving effectiveness. One user indicated that he used twelve different vendors during the course of a year.

- Even in firms with tightly controlled, centralized in-house data processing operations, field offices occasionally use competent, locally hired data processing vendors without consulting the central EDP function. The D.P. manager is informed of the fact only after the vendor has been hired, and then the transfer of the work to a central data processing site would clearly delay the completion date on the project.

D. HIGHLY COMPETITIVE MARKETPLACE

- The A&E market is very competitive, especially among companies pursuing the large users. On the other hand, the medium-sized or small firms, especially if they are in remote areas, are often neglected. Part of the reason for this neglect is that the small firms, having small budgets, rely on outdated IBM 1130s for all of their data processing. Having small staffs, they are forced to scrounge for programs from universities, associations, libraries and vendors. The small companies which have an old system get by and do all of their business and most of their scientific processing in-house.

- However, as the software on the larger systems becomes more efficient and manual pre- and post-processing are eliminated, the "low-cost system" gradually will become more costly because of its inability to process the newer, more efficient programs.

- In addition to the traditional vendors, universities, A&S spinoffs, petroleum and aerospace company spinoffs and even manufacturing companies, such as U.S. Steel and ALCOA, compete in this market.

- With the exceptions of IBM 1130 compatible, General Automation 18/30 and the Digital Scientific Meta 4, the minicomputers have not made a major penetration into the A&E market. R&D companies are using a multitude of minicomputers dedicated to specific applications or to data collection and communications tasks.

E. RECOMMENDED STRATEGIES FOR VENDORS

- Vendors who are already providing services to the A&E industry should explore some of the following strategies:

- Develop a strong support group to help small and medium-sized first time users solve their problems efficiently without their having to learn all about computer programming.
- Provide a variety of service levels by unbundling and pricing "raw time" differently from "supported processing."
- Provide volume discounts to give the user an incentive for "one-stop service shopping."
- Target specific industry segments, i.e., small or medium-sized A&E shops or R&D institutions, and provide a "turnkey package" consisting of a mix of processing services, problem solving support, and software at a fixed price.
- Use terminology familiar to that industry, develop specific industry-oriented pre- and post-processing interfaces.
- Develop easy-to-use integrated packages which guide the new user of an interactive mode in the selection and utilization of application software. These "instruction packages" can be dispensed with after the user becomes familiar with the available programs.
- Provide a working, interactive, expandable index of the available software and aids, indicating alongside each the appropriate support person to contact.
- Provide low cost training in the use of terminals and software for users who have not had computer experience.

• Vendors not in the industry but who would like to participate must:
  - Acquire or adapt industry-oriented packages which perform project planning, scheduling control and management, as well as mechanical and structural packages from petroleum companies, aerospace companies,

universities or software vendors.

- Acquire large (preferably CDC) mainframes.

- Develop a team of industry knowledgeable marketing and support individuals. Acquire a company that has industry expertise as a quick way to establish presence and credibility in the industry.

- A company which has generic programs applicable to the A&Es could get into this market by hiring one or two industry specialists and targeting a narrow segment of a particular industry. By targeting such a narrow market, a small company can become visible very quickly if it provides integrated, efficient software packages and responsive support.

- Although there is no strong vendor loyalty, users become accustomed to using certain packages. A slightly lower price will not motivate a user to change from one vendor to another. Only a 30% to 40% price reduction on a familiar package is sufficient incentive to cause a user to switch vendors.

III. INDUSTRY STRUCTURE

III INDUSTRY STRUCTURE

A. STRUCTURE OF THE INDUSTRIES (OVERVIEW)

- This study covers three major professional groups:
  - Architects
  - Consulting Engineers
  - Research and Development Laboratories and Institutions

- The SIC codes for each group are given in Exhibit III-1.

- To standardize the meaning of size throughout the Market Analysis Service (MAS), size from now on is defined according to EDP expenditures, rather than by revenues or number of employees. Exhibit III-2 shows the segmentation of size according to the EDP expenditures.

- Exhibit II-1 shows the distribution by size of the architectural, consulting engineers, and research and development firms. A firm with multiple offices is counted as 1.

B. ARCHITECTS

- There are about 70,000 architects in the U.S. as compared to 700,000 engineers. Of the architects, 43% belong to the American Institute of Architects. Over two-thirds of the professionals are proprietors or partners

EXHIBIT III-1

SIC CODES FOR SELECTED PROFESSIONALS

MAJOR CODE	GROUP NO	INDUSTRY NO	DESCRIPTION
73	739	7391	Research and Development Laboratories*
89	891	8911	Engineering and Architectural Services**
89	892	8922	Non-commercial Educational Scientific and Research Organizations***

*Research and Development Laboratories: Establishments primarily engaged in laboratory or other physical research and development on a contract or fee basis. Nonprofit research agencies funded by investments, grants or contributions are classified in Industry 8922. Establishments engaged in economic, educational, operations, systems or other nonphysical research on a contract or fee basis are classified in Industry 7372 or Industry 7392. Research and development laboratories of companies which manufacture the products developed from their research activities are classified as auxiliary to the manufacturing establishments served. (7391)

** Engineering and Architectural Services: (8911)
- Designing ship, boat, machinery, and products
- Industrial, civil
- Electrical and mechanical
- Marine
- Petroleum
- Surveying land, water, aerial
- Photogrammetric engineering

*** Non-commercial Educational Scientific and Research Organizations: Establishments primarily engaged in non-commercial research and dissemination of information for public health education or general welfare. Establishments operate from endowments, contributions, and grants. (8922)
- Educational Research
- Medical Research
- Scientific
- Research Institutes
- Social Research

EXHIBIT III-2

SEGMENTATION BY SIZE OF ARCHITECTURAL AND CONSULTING ENGINEERING FIRMS BY EDP EXPENDITURES

SIZE	ANNUAL EDP EXPENDITURES	TOTAL ANNUAL REVENUE RANGE	NUMBER OF COMPANIES R&D	NUMBER OF COMPANIES A&E
small	less than $250K	less than $20M	1,000	1,000
medium	$250K-1M	$20M-50M	67	58
large	$1M-5M	$50M-100M	45	15
very large	more than $5M	more than $100M	3	0

in a firm with less than 10 people.

- A corollary to these characteristics is that members, particularily owners, perform many duties besides pure architectural ones. Clearly a large portion of architects practice their profession on a small scale.

- The A&E company goes through three different stages:
  - the individual proprietorship
  - the medium-sized firm
  - the large firm.

- A single practitioner generally requires three key skills - design, engineering, and the ability to sell his services. In addition, he has to be a business manager and has to keep up with the latest design techniques and materials.

- According to a recent survey, most architects are poor managers:
  - 17% make no effort to schedule workloads
  - 20% maintain no job cost sheets
  - 23% make no effort to control costs
  - 36% get financial reports only twice a year.

- The results indicate that many small practitioners are not able to combine high professional service standards with adequate business practices and a satisfactory level of personal compensation.

- Part of this dilemma is due to the rising costs of outside services which have increased sharply during the late sixties and early seventies.

- Another factor is that the single practitioner or the small firm pays a higher proportion of its revenues for indirect expenses.

- There are several medium to large A&E firms performing the full spectrum of design, engineering, and sometimes even construction. Most of these firms have offices in all the major U.S. cities and may also have offices overseas. For example, Parsons Brickendorf has offices in New York, New Jersey, Georgia, Massachusetts, Brazil, Bolivia, Venezuela, etc.

- One of the characteristics of the large A&E firm is its ability to take on and complete large scale design and planning assignments anywhere in the world.

- A typical breakdown of the overhead of an architect who is a sole proprietor may look like this:

-	Salary or draw	35%
-	Secretarial & bookkeeping	10%
-	Supplies & stationary	9%
-	Taxes	9%
-	Rent	7%
-	Unproductive labor	7%
-	Travel & transportation	6%
-	Attorney, bad debts	5%
-	Clubs, charities, depreciation	5%
-	Publicity, photographs	4%
-	Telephone	2%
-	Insurance	2%

- Because the one-man shop is so inefficient, there is a growing trend among architects to associate into partnerships or larger firms. The medium-sized company can take advantage of the economics of scale in clerical expenses, rents, and other shared services. The larger firm has a critical mass which allows it to have its own engineering, photographic, surveying, and data processing departments which often perform services on a profit-center basis.

- As the firm grows, these expenses can be shared more efficiently. Thus, an architectural firm with less than $150,000 annual revenues will spend 46% of its gross receipts on indirect expenses and show an average 6.5% pre-tax income, while a firm with over $2,000,000 in revenues will only spend 33% on indirect expenses and show an average 9% profit.

- The reason for the decrease in outside or indirect expenses by the larger firm is that as the firm grows, an increasing amount of services are performed by in-house departments. Thus, most of the large architectural firms maintain engineering departments and, conversely, most of the large consulting engineering firms have architects on their payroll. In some instances, these may be spinoff architectural or engineering groups performing independent services, not only for internal, but for external clients as well.

C. CONSULTING ENGINEERS

- The variety of skills and areas of specialty among consulting engineers varies widely. Some of the areas of specialization are:

  - Marine structures: harbors, breakwaters, wharves, offshore drilling structures, terminals, marinas, docks, etc.

  - Petroleum handling and storage facilities: offshore drilling rigs

and structures, pipelines, tank farms, marine terminals, LPG and LNG terminals, etc.

- Electrical, mechanical and thermal systems: electrical power distribution, steam power plants, nuclear power plants, pressure vessels, piping systems, substations, etc.

- Consulting engineering firms tend to specialize in one or more of these areas. As the firm grows, the number of specialty areas increases.

- U.S. consulting engineering firms have worldwide dominance in engineering and designing projects. In Third World countries they have earned a reputation for on-time, on-budget performance, often working with multinational teams led by U.S. project leaders.

- A current irreverent story illustrating the reason for the U.S. success:

  - We go, do our job, and return home as soon as possible.

  - The British go and talk about it.

  - The French go and talk about it without knowing what they are talking about.

  - The Russians go and stay (to keep things running).

D. RESEARCH AND DEVELOPMENT INSTITUTES - (R&D)

- Since the beginning of World War II, independent research institutes have flourished.

- The six major groups of R&D institutions are: federal R&D centers, applied research institutes, operating foundations, endowed institutes, cushioned institutes, and project institutes. Federal R&D centers account for the largest

segment of R&D expenditures. (See Exhibit III-3)

- Nonprofit institutions account for 10% of the total national expenditures on R&D. However, almost 60% of the funds of the nonprofit sector go to basic research as opposed to development projects.

E. GROWTH OF R&D

- Expenditures in calendar year 1977 for research and development in the United States are expected to reach $42.9 billion. This represents an increase of $4.9 billion (12.9%) over the $38.0 billion that the National Science Foundation (NSF) estimates was to be actually spent for R&D in 1976. More than half of the anticipated increase is expected to be absorbed by continued inflation (7.2%).

- The most phenomenal growth period in federal R&D was from the late 1940s to 1967. The federal R&D expenditures grew from $250 million in 1940 to $1 billion in 1948, climbed to $3 billion in 1957, and jumped to $8 billion in 1960. Federal R&D expenditures have exceeded $16 billion since 1967 and are expected to almost exceed $23 billion in 1977.

- In 1977, a 12.5% increase in federal support for R&D, with funding close to $22.6 billion is expected. This represents 52.8% of the total R&D expenditures for 1977. Industrial funding is forecast to be $18.7 billion, up $2.2 billion (13.3%) from 1976. This sector is expected to account for 43.7% of the total R&D funding. Funding by academic institutions is

EXHIBIT III-3

RESEARCH AND DEVELOPMENT INSTITUTES

(BY TYPE OF SPONSORSHIP)

TYPE OF SPONSORSHIP		EXAMPLES
Federal R&D centers Owned or mostly financed by Federal Government and operated under contract by a university or an independent agency		JPL and Brookhaven
Applied Research Institutes Conduct proprietary work for industry & government		Batelle, SRI, MRI
Operating Foundations More than half of resources devoted to research		Carnegie Institute, Resources for Future, Institute for Advanced Study
Endowed Institutes Less than half but more than a tenth of funds for research		Brookings Institute Wistar Institute Sloan Kettering Institute
Cushioned Institutes Funds derived from membership or grants or sale of products		Jackson Laboratory American Institute for Economic Research
Project Institutes Subsisting on grants and projects		Hudson Institute Institute for Cancer Research American Institute for Research

expected to be $880 million (2.1% of the total), while nonprofit organizations will provide $640 million (1.5%).

- Despite the 1977 growth in federally-funded R&D, the percentage of the Gross National Product devoted to R&D expenditures has kept up with inflation, federal R&D spending has dropped from about 2% of the Gross National Product in 1966 to about 1.2% in 1976--remaining just about constant as total federal outlays doubled. The reduction of R&D funding--especially the reduction in support of basic research--is certain to reduce the longer-term viability of the U.S. economy.

- After World War II a variety of large and small institutions came into being. Some were well-known names with broad charters; others, less well-known, specialized in narrow areas of endeavor.

- The National Science Foundation estimates that there are between 11,000 and 12,000 R&D companies in The U.S.

- Seventy-five R&D centers attached to the Government by annual contract, a dozen R&D houses specializing in long-range planning and strategy, 5,000 nonprofit research groups, 300 to 500 profit making firms, and 4,200 captive industrial R&D centers constitute the bulk of R&D activity in the U.S.

- Exhibit III-4 is a listing of R&D laboratory expenditures by type of work.

- Exhibit III-5 lists selected R&D Institutes and their locations.

EXHIBIT III-4

SEGMENTATION OF EXPENDITURES BY TYPE OF WORK (PERCENT)

AGENCY AND CENTER	BASIC RESEARCH	APPLIED RESEARCH	DEVEL-OPMENT	SYSTEMS ANALYSIS*	SYSTEMS ENGINEERING+	%
ATOMIC ENERGY COMMISSION						
Ames Laboratory	80	5	15			100
Argonne National Laboratory	50	23	27			100
Brookhaven National Laboratory	80	10	10			100
Cambridge Electron Accelerator	100					100
Lawrence Radiation Laboratory, Berkeley	95	5				100
Lawrence Radiation Laboratory, Livermore	10	20	70			100
Los Alamos Scientific Laboratory	10	20	70			100
Pacific Northwest Laboratory	10	10	80			100
Princeton Pennsylvania Accelerator	100					100
Princeton Plasma Physics Laboratory	51	49				100
Stanford Linear Accelerator Laboratory	100					100
SECRETARY OF DEFENSE						
Logistics Management Institute		9		91		100
Institute for Defense Analyses	10			90		100

EXHIBIT III-4 (con't)

SEGMENTATION OF EXPENDITURES BY TYPE OF WORK (PERCENT)

AGENCY AND CENTER	BASIC RESEARCH	APPLIED RESEARCH	DEVEL-OPMENT	SYSTEMS ANALYSIS*	SYSTEMS ENGINEERING+	%
AIR FORCE						
Aerospace Corporation		10		20	70	100
Analytic Services				100		100
Electronic Compatibility Analysis Center		100				100
Francis Bitter National Magnet Laboratory	100					100
Lincoln Laboratory		90	10			100
MITRE		10		25	65	100
RAND	10	20		70		100
ARMY						
Center for Research in Social Systems		100				100
Human Resources Research Office	6		94			100
Research Analysis Corporation				100		100
NAVY						
Applied Physics Laboratory (Johns Hopkins U.)	10	20	60		10	100
Applied Physics Laboratory (U. of Washington)		38	41		21	100
Center for Naval Analyses				100		100
Hudson Laboratories	100					100
Naval Biological Laboratory	100					100
Ordnance Research Laboratory	20	20	40		20	100

EXHIBIT III-4 (con't)

SEGMENTATION OF EXPENDITURES BY TYPE OF WORK (PERCENT)

AGENCY AND CENTER	BASIC RESEARCH	APPLIED RESEARCH	DEVEL-OPMENT	SYSTEMS ANALYSIS*	SYSTEMS ENGINEERING+	%
NASA						
Jet Propulsion Laboratory		25	60		15	100
NATIONAL SCIENCE FOUNDATION						
Kitt Peak National Observatory	100					100
National Center for Atomspheric Research	100					100
National Radio Astron-omy Observatory	100					100

* Systems analysis and planning - "the conduct of strategic, tactical, and logistic studies and the initial design (through problem identification, synthesis of alternative solutions, the establishment of objectives, measures, and criteria) of systems for the solving of complex problems, and the furnishing of assistance with plans or planning."

\+ Systems engineering and technical direction - "the engineering and management effort required to design and develop a complex group of related components or subsystems, and the technical direction of their production and integration into a working system."

EXHIBIT III-5

THE NONPROFIT RESEARCH INSTITUTE

INSTITUTE	FOUNDED	LOCATION	1968 VOLUME ($ MILLION)
Stanford Research Institute	1946	Menlo Park, CA	$64.2
Batelle Memorial Institute	1929	Columbus,OH	49.8
Cornell Aeronautical Laboratory	1946	Buffalo, NY	32.8
Illinois Institute of Technology Research Institute	1936	Chicago, IL	26.6
Southwest Research Institute	1947	San Antonio, TX	16.1
Franklin Institute Research Laboratories	1946	Philadelphia, PA	7.9
Midwest Research Institute	1944	Kansas City, MO	7.0
Syracuse University Research Corporation	1957	Syracuse, NY	6.2
Southern Research Institute	1945	Birmingham, AL	5.7
Research Triangle Institute	1959	Research Triangle, NC	5.4
University City Science Institute	1964	Philadelphia, PA	3.0
Gulf South Research Institute	1964	Baton Rouge, LA	1.9
Spindletop Research	1961	Lexington, KY	1.2
North Star Research and Development Institute	1963	Minneapolis, MN	1.0

F. GEOGRAPHIC DISTRIBUTION

- Architectural and engineering consulting services tend to be distributed along population lines in the larger cities and in urban areas which are attracting new construction with relatively-pleasant living conditions. As shown in Exhibit III-6, the ten largest states account for almost 60% of the AIA membership.

- Geographic areas surrounding campuses are prime potential locations for R&D firms. Government funding is easy to obtain. For example, Flow Laboratories of Rockville, Maryland, near Johns Hopkins University, got organized as a result of a $3,000 contract from N.I.H. in 1962. By 1970 the firm had sales of over $4 million per year. The Merle Thomas Corporation founded by Merle Thomas, a professor at George Washington University, got started by analyzing data from satellites and is now employing over 200 people working on a wide variety of R&D projects.

- Along Boston's Route 128, there are over 300 R&D firms. The San Francisco, Los Angeles, San Diego corridor, which includes Berkeley, Stanford, UCLA, USC, etc., accounts for over 40% of the federal R&D expenditures. Geographic distribution of R&D funding is:

- West coast	44%
- Rocky Mountains	2%
- Midwest	15%
- Southcentral	2%
- Southeast	10%
- Northeast	27%

EXHIBIT III- 6

AIA MEMBERSHIP DISTRIBUTION

California	13.6%
New York	9.5%
Texas	6.9%
Florida	5.1%
Illinois	4.5%
Pennsylvania	4.3%
Ohio	4.0%
Michigan	3.6%
Massachusetts	3.2%
New Jersey	3.0%
TOTAL	57.7%

- California, with the Los Angeles and San Francisco urban and suburban areas; Boston; Washington; New York; and New Jersey account for over 50% of the R&D revenues.

G. INDUSTRY REVENUES

- Actual revenues earned by professionals are difficult to obtain because of the private nature of their firms and their reluctance to disclose revenue information. The estimates given in Exhibit III-7 were derived from Federal Government data and from surveys conducted by various associations and consultants.

- Revenues of architectural and consulting engineering firms include total revenues of a firm headed by one or more partners who may employ one or more draftsmen, junior engineers, technicians, etc.

- Revenues of R&D firms include, in addition to earnings, the accumulated value of laboratory equipment such as cyclotrons, linear accelerators, testing equipment, etc.

EXHIBIT III-7

ESTIMATED REVENUES OF SELECTED PROFESSIONAL GROUPS

($BILLION)

	1976	1981	AAGR
ARCHITECTS & ENGINEERS	18	30	10.7
R&D FIRMS	19	35	13.0

IV. USE OF EDP

IV USE OF EDP

A. THE UNIQUE ASPECTS OF EDP USE BY ARCHITECTS AND ENGINEERS

- Professionals, such as architects and consulting engineers, are somewhat unique in their use of EDP.

  - EDP is used by A&E firms for both internal and client applications.

  - The amount of EDP use varies greatly from one firm to another depending on the type of work performed for the clients.

  - Consulting engineering firms and consulting companies frequently provide computer services and software to their own industry, as well as to the business community at large.

  - EDP expenditures related to client work are often charged separately by A&E firms to the clients. (This practice is also common among accounting and consulting firms.)

  - The A&E professionals frequently develop a library of proprietary software which becomes a competitive tool when bidding for contracts. Programs may range from graphic "hidden line" algorithms to calculation of a pipe stress problem.

  - The worldwide nature of the consulting engineers' business makes telecommunication support a strong requirement.

- Consulting engineers, as a group, are proportionally the heaviest users of computer services. They constitute a significant portion of business for companies such as MCAUTO, CDC, Boeing, UCC and UCS.

- Because their business is project oriented, A&E firms, especially small and medium ones, prefer to use outside services for client work. In order to keep overhead costs low, in-house systems are often used for business applications such as general ledger, accounts payable and accounts receivable, payroll, project management, etc.

- The A&E firms which use an outside software or full computer services firm for their internal applications generally do so because their in-house computers are no larger than a mini, and few have programming staff available to develop new applications programs.

- Although most of the large A&E firms do their business data processing internally, 20% of the firms surveyed use computer services firms for all of their data processing, including administrative applications. There is a definite split in attitudes between the two groups: (See Exhibit IV-1)

    - Those who use services for everything typically respond: "We don't want to be in the computer business." "Outside services are faster and less expensive." "If they are not responsive, we will find someone who is."

    - Those who are pulling more work in-house say: "We like a close relationship between user and in-house EDP," "less expensive," "better control over proprietary programs and data."

EXHIBIT IV-1

RESULTS OF SURVEY OF USE
OF COMPUTERS AND COMPUTER SERVICES
BY ARCHITECTS AND ENGINEERS

	SMALL		MEDIUM		LARGE	
	YES	NO	YES	NO	YES	NO
IN-HOUSE COMPUTER SERVICES	5	6	6	0	6	1
INTERACTIVE TERMINALS	6	5	4	2	1	6
BATCH SERVICES	3	8	0	6	1	6
REMOTE BATCH	7	4	3	3	2	4
NO EDP	0	NA	0	NA	0	NA

- This strong divergency in opinions indicates that the issue is an emotional one and is frequently dependent on the level of computer know-how available in the company.

- Divergency of opinion may be found even within the same company, with partners and data processing managers seeing things in quite different ways.

  - The data processing manager generally wants more in-house control and a larger staff.

  - The general partner wants the job done fast and without headaches.

B. USE OF EDP BY RESEARCH INSTITUTIONS

- Most R&D institutions prefer in-house software development for long-term projects for three reasons:

  - the specialized, sometimes classified, nature of the work

  - the ability to develop in-house people with skills to handle dynamic evolution of the work

  - the continuity and control of personnel/resources.

- On short-term projects, where the development of skills is not integral to the institution and where the software is readily available, there is a tendency to use computer services.

- As the traditionally defense-oriented institutes diversify into commercial work, they will segment into two groups:

  - those who will buy more services on the outside

  - those who will go into competition with commercial data processing services companies.

C. IN-HOUSE COMPUTER USE

1. ARCHITECTS AND ENGINEERS

- Over half the firms surveyed with more than 30, but less than 250, employees or generating between $1 million to $8 million in annual revenues, utilize computer services exclusively. The others use small in-house systems.

- Medium-sized A&E firms in the survey, exceeding the $8 million mark, tend to have their own small in-house systems. (See Exhibit IV-2)

- The IBM 1130 is the most popular computer among medium-sized architectural and engineering firms. Other computers found among the surveyed users are:
  - General Automation 18/30 - IBM 1130 compatible
  - Digital Scientific Meta 4 - IBM 1130 compatible
  - IBM System 32
  - IBM System 3/15

- There is concern among the 1130 users that IBM is no longer supporting the 1130 and that information on the operating system is therefore increasingly difficult to obtain. Under these conditions the development of new in-house applications programs for the 1130 is very difficult to justify.

- There is only one PDP 11, one System 32 and one Xerox 560--hardly a major penetration by the minicomputer companies into this market.

- An exception to the small systems trend is the data processing spinoff of an A&E firm which uses an IBM 360/50 and a 360/40.

EXHIBIT IV-2

IN-HOUSE COMPUTERS REPORTED BY A&E USERS

COMPANY SIZE (INTERVIEW NUMBER)	TYPE OF COMPUTER
SMALL	
0	None
3	Logicon 1130
4	Burroughs
8	None
9	None
10	None
11	None
12	HP 9830
15	PDP 11/45
17	None
19	IBM System 32
MEDIUM	
2	GA 1830
5	IBM 1130
13	IBM 1130
14	IBM 1130
16	IBM 1130
18	XEROX 560
LARGE	
1	Harris 220
6	None
7	Honeywell 415
20	IBM 370/148
21	Univac 9060
22	Digital Science Meta 4
23	IBM 370/145

- The medium-sized firms tend to do all their computing on the one in-house system. As the computing requirements grow, the medium-sized firms tend to increase their use of computer services rather than upgrade the in-house mainframe. The large firm, on the other hand, tends to pull all the work in-house once it acquires a computer staff large enough to develop or adapt applications programs required for its own business as well as for customer requirements.

- There is no evidence from the survey that the management of the medium-sized A&E firms is disposed to upgrading the in-house mainframe. This attitude is a result of:

    - the project orientation of the business
    - the availability of packages from services vendors for external use
    - the internal work being done on the in-house low-overhead system.

- There is no evidence of migration from outside vendors to in-house processing among medium-sized users.

- New applications in small and medium firms tend to come from outside sources, while large firms often develop their new applications in-house by adapting or upgrading existing packages.

- Exceptions to outside development of new applications in small and medium-sized firms are specialized applications such as rust-proofing and hydrology where the market is so small that an outside vendor cannot recover his investment.

- The need to upgrade the system with terminals and data communications is just being realized as data processing managers attend professional conferences and are increasingly exposed to the available hardware.

- None of the medium-sized companies interviewed indicated any plans to replace their present mainframes with a newer model by 1981, although 25% of the medium-sized respondents indicated a desire to upgrade the system by adding more memory, more disks, terminals or more tape drives. The large companies were upgrading their mainframes.

- Software is of greater concern than hardware to the in-house data processing manager. He is continually searching for new applications available from various sources including software houses, universities or even other A&E firms for the purpose of expanding administrative systems or streamlining existing programs by making them easier to use.

- As computer services vendors such as MCAUTO, CDC, UCC and others develop large libraries of engineering programs, it will be increasingly economical for medium-sized A&E firms to utilize outside vendors.

- According to the survey, FORTRAN is the most common language used by the A&E users followed by COBOL, BASIC, and RPG II.

2. RESEARCH AND DEVELOPMENT

- Exhibit IV-3 shows that 10 out of the 11 research and development firms interviewed have their own in-house computer systems in addition to using outside computer services firms.

EXHIBIT IV-3

IN-HOUSE COMPUTERS REPORTED BY R&D USERS

COMPANY SIZE (INTERVIEW NUMBER)	TYPE OF COMPUTER
SMALL	
3	None
8	DEC PDP 15
MEDIUM	
2	PDP 10
6	HP 2100
9	Honeywell 2015
LARGE	
0	Burroughs 6700, CDC 6400
1	CDC 6400, Cyber 73/60
7	IBM 370/168, IBM 360/91
10	Burroughs 6700
VERY LARGE	
4	2 CDC Star 100, 4 CDC 7600, 1 CDC 6600, 2 GE 415, 1 IBM 1401, 20+ DEC minis
5	CDC 7600, CDC 6400, IBM 370/155 II

- R&D firms tend to use their in-house computers for both administrative and customer projects. Computer services are, however, occasionally used to supplement in-house capability or to process special one-time customer jobs.

- When computer services are used, it is generally because:

  - There is faster turnaround

  - The project leader may be familiar with the programs

  - The programs are only available from a computer services vendor.

- Because the R&D houses are heavily involved in scientific and engineering calculations, their in-house installations are generally large CDC and IBM mainframes. In fact, being the first to order the largest and fastest mainframe is often a status symbol among R&D houses.

- The research institute which does not have its own computers may utilize the computer facilities of a nearby university. The programming is done by the research institute personnel, utilizing on-line interactive terminals as well as remote batch terminals.

- The data processing staff employed by the R&D establishments is generally very competent and capable of developing pioneer applications in a variety of industries. For example, some of the most advanced three-dimensional graphics software has been developed by Lawrence Research Laboratories, a government-oriented R&S institution.

- Minicomputers are used extensively as dedicated laboratory systems, satellite computers, or in communications networks.

- Most R&D houses are also interconnected through the ARPA or the EDUNET networks and can share selected research results with colleagues throughout the U.S.

- As illustrated in Exhibit IV-4, the array of computers utilized by R&D firms shows that the expenditures for data processing equipment in this environment proportionally exceeds the expenditures for any other industry.

- The 11 R&D companies surveyed spend over $1 million per year for computer services and almost $16 million for in-house data processing.

- Two organizations, Lawrence Labs and Aerospace Corporation, account for almost 73% of total in-house EDP expenditures.

EXHIBIT IV-4

EDP EXPENDITURES BY SURVEYED R&D INSTITUTIONS

COMPANY SIZE (INTERVIEW NUMBER)	\$M IN-HOUSE DATA PROCESSING	\$K SERVICES EXPENDITURES
SMALL		
3	\$ - M	\$ 60K
8	.2	50
MEDIUM		
2	.5	250
6	.3	180
9	.5	80
LARGE		
0	2.4	240
1	2.7	12
7	4.2	75
10	1.7	48
VERY LARGE		
4	22.	50
5	12.	90
TOTAL	\$15.9M	\$1,135K

V. APPLICATIONS ANALYSIS

V APPLICATIONS ANALYSIS

A. INTRODUCTION

- Applications can be segmented into internal, business-oriented applications and external, client-oriented scientific applications. With minor variations, internal business applications are common to all three professional categories and are primarily project management and accounting oriented, e.g., time management, accounts payable/receivable, C.P.M. PERT, payroll, etc.
  - External applications vary according to the service each company offers. For example, architects have structural analysis, equation solvers, piping and sheer wall analysis applications; R&D firms may use these same applications or they may also have specialized nuclear codes, forecasting models, statistical analysis packages or graphic design programs. (See Exhibit V-1)
  - Selected A&E and R&D firms believe that the software they have developed to solve clients' problems is an integral part of their expertise. The in-house software development capability is also considered a unique salable asset by these companies.

- Expenditures for business management increase with the size of the firm. Small A&E firms tend to use CPAs and other professional accounting services to perform their internal accounting function.

EXHIBIT V-1

EDP APPLICATIONS MENTIONED BY R&D FIRMS

INTERVIEW	MAJOR AREA OF RESEARCH	EMPLOYEES	PRESENT APPLICATIONS	FUTURE APPLICATIONS
0	Engineering Social Science	3000+	Social Sciences Spec. Programs Survey Process	Specialized Programs
1	Product Evaluation	2500	Special Programs Business	New Sp. Prog. Project Dependent
2	Engineering	500	Data Base Accounting	Project Dependent
3	Acoustic Medical	750	Medical Acoustic Geological	Expand Proj. Management Software
4	Nuclear Engineering	500	Meteorological Nuclear	R&D Funding Dependent
5	AEC Research	6000	Personnel Statistical Graphics Classified	More of same
6	Materials Research	250	Simulations Material Analy.	Client Dependent
7	Particle Physics	750	High Energy Physics Applic.	Expansion of Present Progs.
8	Biological Research	N.A.	Biological Statistics & Correlations	Data Base Manage. Timesharing Applications
9	USAF/DOD	N.A.	Data Base	Classified
10	Engineering	1400	Structural Programs	Integration of Pres. Progs.

- The small firms with fewer than ten people process their work manually.

- Two-thirds of all expenditures by A&E firms are for scientific or customer projects. (See Exhibit V-2) Over the next five years the expenditures for scientific applications will grow at a faster rate than the expenditures for internal business processing. (See Exhibit V-3)

- R&D institutions, especially the large and medium ones, spend most of their computer services dollar on non-recurring customer projects for which software packages are readily available. (See Exhibit V-4 and Exhibit V-5)

B. BUSINESS APPLICATIONS

- Project management is the most important business application used by architects and engineers. The construction costs, profit planning, scheduling, material requirements cash flow planning, and overall resource management rest with the ability to organize and monitor the progress of each project.

- Project management applications were frequently mentioned by survey respondents in conjunction with large building projects such as flood control analysis, high rise buildings, manufacturing plants, and flood control construction projects.

- Reasons cited for utilizing the project management programs were:
  - ability to analyze and identify critical project points
  - ability to improve cash flow forecasting requirements
  - checklist of critical activities continually updated, enabling realtime monitoring

EXHIBIT V-2

ARCHITECTS AND ENGINEERS

SEGMENTATION OF COMPUTER SERVICES EXPENDITURES

($M)

	SMALL	MEDIUM	LARGE	VERY LARGE	TOTAL
Business	9	14	8	-	31
Scientific	20	37	18	-	75
TOTAL	29	51	26	-	106

EXHIBIT V-3

FORECAST OF A&E EXPENDITURES

FOR COMPUTER SERVICES

BY TYPE 1976-1981

	1976 ($M)	1981 ($M)	AAGR %
BUSINESS			
Payroll	$ 9	$15	10.8%
Accounting	10	18	12.5
Project Management	12	25	15.8
TOTAL	$31M	$58M	13.4%
SCIENTIFIC			
Structural Engineering	$33	$ 68	15.6%
Electrical Engineering	8	10	4.6
Chemical & Nuclear Engineering	17	35	15.5
Civil Engineering	6	6	-
Hydrology & Pollution	2	5	20.2
Graphics	9	20	17.3
TOTAL	$75M	$144M	14.0%

EXHIBIT V-4

R&D INSTITUTIONS

SEGMENTATION OF COMPUTER SERVICES EXPENDITURES

	SMALL	MEDIUM	LARGE	VERY LARGE	TOTAL
Business	2	2	1	-	5
Scientific	5	8	5	3	21
TOTAL	7	10	6	3	26

EXHIBIT V-5

FORECAST OF R&D EXPENDITURES
FOR COMPUTER SERVICES
BY TYPE 1976-1981

	1976	1981	AAGR %
BUSINESS			
Accounting	$ 2	$ 3	7.7%
Payroll	1	2	15.1
Personnel	1	2	15.1
Other	1	1	-
TOTAL	$ 5M	$ 8M	9.9%
SCIENTIFIC			
Structural Engineering	$ 4	$ 6	8.5
DBMS	4	6	8.5
Economics	3	4	6.0
Medical and Biomedical	4	6	8.5
Graphics	2	4	-
Other	4	6	8.5
TOTAL	$21M	$32M	8.8%

- contingency plans can be implemented early to avoid project delays
- ability to use reports as a communication tool among foremen and project leaders.

- Small and medium-sized companies are learning to use this management tool not only for monitoring projects, but also as an aid in bidding projects and obtaining loans from banks.

- Most large companies and many medium-sized companies do their business data processing on old in-house systems with programs supplied by the manufacturer or obtained through a user or industry association.

- The management of A&E firms, in addition to keeping track of each project, frequently needs to keep track of the billable time of each individual on the project. Since professionals may work on more than one project at a time, and various individuals in the firm may have differing billable rates according to skill and seniority, personnel accounting and scheduling in a large firm is a complex problem. Engineering firms are the most frequent users of project scheduling programs. (See Exhibit V-6)

- Payroll accounting is a very complex process for a multinational engineering construction company. The temporary nature of projects and personnel requires that employees be paid in a variety of currencies. Most of the large companies do this work internally, while many of the small and medium-sized companies indicated that banks and services companies perform this function on a local basis.

EXHIBIT V-6

CLIENT-RELATED EDP APPLICATIONS OF SELECTED PROFESSIONALS

PROFESSIONAL GROUP	Application		In-House or Client's Computer	Computer Services Mode of Processing		
	Primary	Secondary		Batch	Remote Batch	Inter-active
Architects	• Structural & Stress Analysis & computation		X	X	X	
	• Project Management				X	
	• Design Optimization				X	X
	• Project Cost Accounting				X	X
		• Specification Writing	(WP)			X
		• General Ledger	X	X		
		• Payroll	X	X		X
Engineers	• Water Resources Planning				X	
	• Dam Design				X	
	• Soil Analysis				X	
	• Construction and Design of Power Lines				X	X
	• Business Applications		X	X	X	
		• Air Quality Analysis			X	X
		• Highway Design	X	X	X	
		• Hydrology			X	X
		• Business Applications	X		X	
Research and Development Institutes	• Survey Analysis					X
	• Structural Engineering				X	
	• Medical and Biomedical Analysis				X	X
		• Accounting	X	X		
		• Personnel Planning				X

- The R&D firms surveyed indicate that the most frequently used applications are financial analysis and project cost accounting. Other applications cited included the use of data base management programs (such as Total) for fiscal analysis and retrieval and for personnel file analysis.

C. SCIENTIFIC CUSTOMER APPLICATIONS

- Exhibits V-3 and V-5 show a forecast of scientific computer services expenditures by architects and engineers and R&D institutions, respectively.

- Structural engineering applications, including programs like NASTRAN, account for almost 50% of the external expenditures by architects and engineers. These applications account for less than 20% of expenditures among the surveyed research and development institutes.

- The growth in this market will be encouraged by the increase of availability of large systems at reduced cost, by easy to use new programs, and by the graphics capability of these programs.

- The chemical and nuclear engineer expenditures include applications intended to facilitate the design of processing plants, flow analysis, pressure calculations, and nuclear codes. The availability of proven software from industry sources such as Phillips Petroleum, Sun Oil and others is encouraging small and medium-sized companies to utilize remote computing to solve their project-oriented problems.

- In fact, when the program requirements are more complex, it is more likely that an A&E firm would utilize a computer service.

D. PLOTTING AND GRAPHICS

- Many engineering and R&D applications programs require plotting at a central site or remote plotting utilizing either the batch terminals or demand terminals with plotters as output devices. Visual display of computer generated data is a powerful design and planning tool. Some typical applications are shown in Exhibit V-7.

E. R&D INSTITUTIONS

- The type of computer work done by the R&D institutions is dependent on the type of client projects or the mission of the particular institution. There are areas of commonality among the institutions. For example, most R&D institutions:

  - have large scientific computer systems
  - have the latest hardware
  - have very competent people.

- After the surface commonalities are bypassed, the specific type of work is quite different. For example, defense-oriented institutes like RAND in Santa Monica have totally different applications from AEC-oriented research labs like Lawrence Laboratories in Berkeley. In one instance, the bulk of the work is strategy-oriented and requires planning and modeling tools. Programs need to be developed and utilized which can process nuclear codes, pressure vessel calculations, meteorological studies, radiation propagation, maps, and particle studies.

EXHIBIT V-7

PLOTTING AND GRAPHICS APPLICATIONS

APPLICATION	AREA OF PRIMARY UTILIZATION		
	ENGINEERING ARCHITECTS	R&D	INDUSTRIAL
Mechanical and structural design	X	X	X
Network and circuit analysis	X	X	X
Mechanization and design drafting	X		X
Mechanical, electrical and architectural drawing	X		
Finite-element analysis	X		
Aerodynamic flow	X		
Dimension drawing	X		
System dynamics	X	X	
Tooling, part design and production			X
Numerical control			X
Logic design	X		X
Industrial control	X		X
Molecular structure analysis		X	
Business and financial reporting	X	X	X
Data analysis, including evaluation reduction and forecasting	X	X	X
Cartographic studies and maps	X		X

- The medical and biological research done by the Cancer Research Institute requires data collection and analysis tools, while the acoustic and geological research performed at Bolt, Beranek and Newman requires soil analysis, erosion models, and acoustic propagation models. The work done by the Aerospace Corporation in the weapons area is classified.

- Despite the diversity, there are some overlaps. For example, Bolt, Beranek and Newman performs medical research and has effectively developed, with the Massachusetts General Hospital, patient monitoring and data base management software to be utilized in hospital management systems. The Cancer Institute can use some of the data base management tools developed by BB&N to search through large masses of data for cancer clues.

- Data base management systems are also used in social science research where large amounts of data have to be stored, manipulated, and retrieved on a selective basis.

VI. COMPUTER SERVICES MARKETS

VI COMPUTER SERVICES MARKETS

A. AVERAGE GROWTH OF 12.9%

- Expenditures by A&E companies and R&D institutions in the aggregate will grow from $132 million in 1976 to $242 million in 1981 at an average growth rate of 12.9%, as shown in Exhibit VI-1.

- The future growth in this market will be generated by:
  - sale of presently available software and services to smaller and medium-sized users
  - development of new and improved packages to be sold to the present and future client base, including large companies
  - growth of revenues from present user base.

- The loss of business to remote computer services companies in this market will occur as a result of:
  - migration to in-house systems
  - competition from minicomputer manufacturers and systems houses.

- As users migrate to in-house systems, the software vendors' revenues from end users will grow at a faster rate than revenues from remote computing services vendors. (20.1% vs. 11.9%) (See Exhibit VI-2)

EXHIBIT VI-1

INDUSTRY CATEGORY: ARCHITECTS, ENGINEERS, NON-PROFIT R&D INSTITUTIONS

CATEGORY OF SERVICE	1976	1977	GROWTH RATE %	1979	1981	AAGR %
Remote Computing Services	$ 93	$104	12	$ 131	$ 168	12.6
Batch Processing Services *	22	25	14	33	30	6.4
Facilities Management	0	0	0	0	0	0
Professional Services	5	7	40	11	14	22.9
Software Products	12	16	33	25	30	20.1
TOTAL	$132M	$152M	15%	$ 200M	$ 242M	12.9%

*Includes Graphic Processing.

EXHIBIT VI-2

COMPUTER SERVICES EXPENDITURES
1976 - 1981
BY MAJOR SERVICE MODE
(ARCHITECTS AND ENGINEERS AND R&D INSTITUTIONS)

COMPUTER SERVICE CATEGORY	EXPENDITURES				
	1976 $M	1977 $M	GROWTH %	1981 $M	AAGR %
Remote Computing Services					
• Interactive	27	29	7	38	7.1
• Remote Batch	54	59	9	97	12.5
• Data Base	3	4	33	12	32.0
Sub-Total	84	92	10	147	11.9
Batch Processing	22	25	14	30	6.4
Facilities Management	-0-	-0-	-0-	-0-	--
Professional Services	5	7	40	14	22.9
Graphic Processing*	9	12	33	21	18.5
Software Products					
• Systems Packages	3	4	33	9	24.6
• Applications Packages	9	12	33	21	18.5
Sub-Total	12	16	33	30	20.1
TOTAL	$132	$152	15%	$242	12.9%

*Graphic Processing is included under Remote Computing Services elsewhere in the report.

- According to the current users interviewed, the expected rate of growth of the industry between 1976 and 1981 is 10% to 15% per year. However, the computer services firms interviewed saw the growth of the A&E and R&D market to be 15% to 30%. The reason for this discrepancy is that the use of the sophisticated new programming tools by small and medium-sized firms is still limited. New users from this group will provide the impetus for the additional growth.

- In projecting the rate of growth in both markets, a positive marketing attitude was assumed by computer services vendors.

- Both large and small A&E firms are major users of computer services. Almost 70% of the total expenditures among A&E firms are for computer services; of the $150 million per year spent by A&E firms, over $100 million goes to services. This high proportion of computer services utilization is due to two key factors:

  - project nature of the business which allows firms to charge the customer for outside services
  - firms with in-house systems use outside services for special factors and obtain some of their software from external sources.

- Although R&D firms spend more per capita on computers than A&E firms, only one-tenth of their expenditures of $260 million is spent on services.

1. ARCHITECTS AND ENGINEERS

- Architects and consulting engineers spend more for computer services than R&E organizations. The rate of growth forecast for this group assumes

no major worldwide economic slumps over the next five years.

- Because of the international nature of their business, the revenue sources for many A&E firms (and construction firms) have shifted during the last three years to oil producing countries. This compensates for the decline in the domestic construction business.

- The main remote computing services expenditure is for structural analysis-type work. This is followed by chemical, petroleum and nuclear engineering expenditures.

- Project management and design optimization programs are increasingly used by the larger firms. Young project engineers, who have learned how to use the computer tools in school, also use these programs.

- The continuing influx of computer-trained people into the A&E firms will expand the use of computers and increase the firms' productivity.

- This trend can be accelerated by offering to train and update the older architects in the use of computers. The cost of the training can be amortized over the first year's use of a terminal by offering educational credits to terminal users. CDC is the company which is in the best position to take advantage of this approach. (See Marketing Requirements - Chapter VIII)

2. R&D INSTITUTIONS

- There are few instances in which R&D institutions use computer services. In fact, only one-tenth of the total expenditures of R&D firms is for computer services.

- A significant portion of computer services expenditures for R&D firms goes to institutions such as universities or hospitals with which the R&D firms may be affiliated.

- In the case of defense-oriented firms, the expenditures tend to stay in-house because of security reasons.

- When R&D firms perform work for industrial clients on a project basis, the need for remote batch services may arise even though in-house computers exist.

- Outside computer services vendors are sometimes used because a certain model may be required by the bidder, and the vendor has to comply for competitive reasons.

B. ANALYSIS OF COMPUTER SERVICES BY MODE OF DELIVERY

1. REMOTE COMPUTING SERVICES

- Since many of the professional problems dealt with by the A&Es require large computation capability, they have the tendency to use remote batch as the predominant mode of processing. The interactive mode is often used in preliminary data entry and manipulation, taking up frequently 10% to 15% of a scientific or engineering job.

- Some large A&E companies rely on the network to collect and process data from field offices or to enable a geographically-dispersed team to work on the same problem.

2. AVAILABILITY OF SOFTWARE PRODUCTS

- Except for some of the better known software products such as NASTRAN and ANSYS, software products in this industry are distributed mainly by remote batch vendors as part of their network services.
  - The sale or leasing directly to the user is still a minor effort when compared to software distribution using a network vendor.
  - Structural Dynamics Research Corporation (SDRC), in addition to selling applications directly to users, sells software through the G.E.I.S., CDC, CSS and the Comshare networks.

- Some of the software used by the industry was developed under government auspices and is in the public domain (i.e., NASTRAN). However, many companies have taken the publicly available software and have improved it; consequently, the improved version is salable. For example:
  - NASTRAN - CDC and others
  - ANSYS - Swanson Analysis System
  - STARDYNE - MRI Systems
  - ADL PIPE - A.D. Little

- Petroleum companies such as Phillips have contributed many programs to the A&E industry. Other petroleum companies are exploring ways to capitalize on their internally-developed programs without compromising their proprietary know-how.

- Universities are also sources of programs and sometimes provide a less expensive alternative to a software house. The University of California at

Berkeley and MIT have provided their programs to remote computing services vendors. Other institutions are less aggressive in providing programs to the industry.

- Architects and engineering firms also offer packages which they have developed. However, they are in a position similar to that of petroleum companies. They don't want to compromise their competitiveness in their core businesses but would still like to amortize program development costs.

3. NO FACILITIES MANAGEMENT

- There is no interest among A&Es surveyed in using facilities management. Only one user indicated that they almost tried it six years ago. This user decided against it and has since built good internal capability and sees no reason to reexamine it.

- One R&D institution surveyed indicated that it had a quasi-FM relationship with a university data processing center. However, the arrangement was closer to a joint management than a facilities management relationship.

- Although special relationships may exist in this industry among users and specialized vendors, INPUT does not see FM companies doing a thriving business in this industry.

4. BATCH PROCESSING NOT A GROWING MARKET

- The small companies who cannot afford a computer frequently use local

batch facilities for their business data processing. These companies are potential clients either for small business computers or remote computer services companies.

- Another type of company buying batch services is a medium-sized or large company having a project which cannot be scheduled in a timely fashion on an in-house system. An example of this is an A&E firm in New York using Thomas National as a backup, while another in the same area uses Grumman Data Systems. In both instances, geographic proximity and price are the key factors.

- The lower prices and increasing capability of small and medium systems, the availability of lower cost terminals, improved remote batch software, and reliable communication links are gradually eroding the standard batch processing market.

C. ANALYSIS BY TYPE OF SERVICE

1. GENERAL BUSINESS APPLICATIONS ACCOUNT FOR LESS THAN 15%

- The tendency for the companies in the A&E industry to do their business data processing in-house is very strong. The fact that this expenditure cannot be charged to the client gives the companies an incentive to keep the costs as low as possible. This is evidenced by the old equipment still in use.

- New applications are being developed in-house and by vendors which go beyond the classic general business applications such as accounts payable and payroll. These new applications integrate bidding, planning, budgeting, billing,

project control and management, cost accounting, and profit planning.

- Most of these developments are still internal. However, there are computer services vendors such as Boeing, Tymshare, CDC/SBC, CSC, ADP, and others who are beginning to offer segments of the total package by integrating two or more functions. These same firms may be developing the capability to provide a fully-integrated service.

2. SCIENTIFIC AND ENGINEERING APPLICATIONS

- Scientific and engineering applications in this industry segment account for 77% of the total expenditures. If utility is added, the total exceeds 85%.

- The market for these applications is growing as a result of an increased awareness among the smaller firms who cannot afford their own large scale systems. Specialty applications, such as graphic output and nuclear codes, are growing at an even faster rate.

- The share of this industry segment will decrease by one percent between 1976 and 1981. (See Exhibit VI-3)

3. SCARCITY OF SPECIALTY APPLICATIONS

- There are few applications which can be classified as R&D or A&E specialty applications. This is due to the fact that the computer tools used by these professions can also be used by industry in general.

- For example, a structural analysis calculation can be applied to a variety of structures and becomes specialized only when the graphic output is used as the blueprint for a building, a ship, or an airplane.

EXHIBIT VI-3

COMPUTER SERVICES EXPENDITURES
1976 - 1981
BY MAJOR SERVICE MODE
(ARCHITECTS AND ENGINEERS)

COMPUTER SERVICE CATEGORY	EXPENDITURES				
	1976 $M	1977 $M	GROWTH %	1981 $M	AAGR %
Remote Computing Services					
• Interactive	21	22	5	30	7.5
• Remote Batch	45	49	9	85	13.6
• Data Base	2	3	50	9	35.1
Sub-Total	68	74	9	124	12.8
Batch Processing	16	19	19	22	6.6
Facilities Management	-0-	-0-	-0-	-0-	-0-
Professional Services	5	7	40	14	22.9
Graphic Processing	9	11	22	19	16.2
Software Products					
• Systems Packages	2	3	50	7	28.5
• Applications Packages	6	9	50	16	21.7
Sub-Total	8	12	50	23	23.5
TOTAL	$106	$ 123	16	$202	13.8%

- Specialty applications in Exhibit VI-4 include nuclear codes, as well as a portion of graphic output which has arbitrarily been classified as a specialty application.

D. GEOGRAPHIC DISTRIBUTION

- Expenditures among architects and engineers can be correlated with population density, construction activity, proximity to schools and urban centers, and proximity to university centers. California, New York, Illinois, and Pennsylvania each have a large number of architectural firms. Only the ten largest firms have offices in more than three or four U.S. cities. It is quite common, however, for many R&E firms to have offices in several overseas locations.

EXHIBIT VI-4

USER EXPENDITURES

BY A&E AND R&D INSTITUTIONS

(BY TYPE OF SERVICE)

PROCESSING SERVICES	EXPENDITURES ($M) 1976	1981	AAGR %
General Business	12	16	5.9
Scientific	72	127	12.0
Specialty	8	12	8.5
Sub Total	92	155	11.0
Raw Time	23	43	13.3
TOTAL	$115M	$198M	11.5%

VII. TECHNICAL REQUIREMENTS

VII · TECHNICAL REQUIREMENTS

A. ARCHITECTS AND ENGINEERS

- Over 80% of the architects and engineers interviewed indicated that the most important factor in evaluating a computer services vendor was the quality of the service. The specifics mentioned by users as important in evaluating a computer services vendor were:
  - responsiveness to inquiries
  - fast turnaround
  - help when it is needed
  - quality and ease of software use.

- The second consideration was the vendor's expertise. The vendor must do more than provide a service. He must show a knowledge of the applications of his software and hardware and also demonstrate a general understanding of what the user wanted to do.

- Geographic proximity was the third most frequently mentioned requirement. This could be fulfilled either by having access to a nearby facility and support staff or having access to support people through a remote batch terminal. (See Exhibit VII-1)

EXHIBIT VII-1

ARCHITECTS AND ENGINEERS
TECHNICAL REQUIREMENTS AS PERCEIVED
BY THE SURVEYED SAMPLE

	MOST IMPORTANT	VERY IMPORTANT	IMPORTANT	NOT VERY IMPORTANT	UNIM-PORTANT
Responsiveness	18	3	-	-	-
Expertise	12	4	1	2	1
Geographic Proximity	9	2	3	3	2
Price	5	4	8	4	-
Network	4	5	5	3	3
Hardware/Software	3	3	6	3	2

- Although price is listed as the fourth consideration, it is a strong motivating force among users to change vendors.

- The criterion for choosing the decision maker who selects the computer services vendor is the company's ownership of in-house EDP equipment.

- When the company has its own EDP equipment, the DP manager, either directly or as part of a selection committee, is heavily involved in the decision.

- When a company has no EDP equipment, the decision maker is either a principal of the firm or the engineer or architect responsible for the specific project.

- The persons in the surveyed companies who make the decision to buy services are indicated in Exhibit VII-2.

- In one company surveyed, a committee of three, consisting of the data processing manager, a project leader, and a financial man, make the decisions. They decide what computer resources to use, at what time to use them, and for which projects they are needed. All three functions should be considered when selling services in this market.

- Two large firms strongly indicated that they wanted a vendor who was either willing to help them integrate their in-house system with a network resource or who had sufficient hardware know-how to integrate hardware, including terminals and communications facilities, from various manufacturers.

- Another user commented that the computer vendor should provide an integrated, industry-oriented set of packages which can be easily understood

EXHIBIT VII-2

SURVEYED DECISION MAKERS
SEGMENTED BY EDP & NON-EDP USERS

TITLE	WITH EDP	WITHOUT EDP
Data Processing Manager	10	
Project or Principal Engineer		7
Controller		2
Committee	1	

and used. These packages would have appropriate pre- and post-processors with an interactive graphic capability. The user envisions sitting at a terminal, describing his problem in his own language, and having the program give him a series of available solution methods to choose from. The program should be able to continue guiding him, editing his input, and providing output in a format specified by the user.

B. R&D FIRMS

- R&D firms require not only responsiveness, reliability, and expertise but also specialized hardware and software (scientific mainframes and data base management software). Availability of the network does not seem to be an important consideration.

- Technical requirements as perceived by the surveyed sample are shown in Exhibit VII-3.

EXHIBIT VII-3

R&D FIRMS

TECHNICAL REQUIREMENTS AS PERCEIVED

BY THE SURVEYED SAMPLE

	MOST IMPORTANT	VERY IMPORTANT	IMPORTANT	NOT VERY IMPORTANT	UNIM-PORTANT
Responsiveness	8	2	-	-	-
Expertise	4	4	2	-	-
Geographic Proximity	1	1	4	3	1
Price	-	2	4	3	1
Network	-	3	4	2	1
Hardware/Software	4	3	3	-	-

VIII. MARKETING REQUIREMENTS

VIII MARKETING REQUIREMENTS

A. GENERAL

- The most important marketing requirement is for the vendor to have a well-trained marketing support staff to assist users in understanding and efficiently utilizing the available software packages. This assistance is most beneficial when it focuses on:
  - pointing out the potential savings of utilizing specific packages
  - helping project engineers use available programs
  - instructing project engineers in the utilization of graphic output.

- Any computer program that helps the architect or engineer expedite his work can be sold to a firm if it helps to achieve a significant savings over present methods of operation.

- A specific requirement mentioned was for a graphic design capability which can, when coupled with a computer model, calculate the cost of alternate designs and generate a plan for the whole project.

- Direct mail and newsletters are effective information vehicles. Advertisements in the AIA Journal or the Construction Engineering Magazine are good methods for seeking new clients.

B. UNBUNDLED SERVICE

- Most A&E firms do business with between two and five vendors. The reasons for the multiple vendors are:
  - Required software is available only from a specific vendor
  - Turnaround time requirements vary
  - Cost levels vary.

- For example, a respondent uses MCAUTO for a special program but believes that MCAUTO is too expensive for his general data processing work. He uses Grumman when he wants a less expensive and less responsive system that is still capable of solving his problem.

- Two A&E firms mentioned they would like to use fewer vendors. They would like to see computer services vendors be more flexible in their pricing, provide several levels of service, and give quantity discounts or other price concessions to large users.

- Most vendors have already adopted varied levels of service and pricing. For example:
  - Prime time
  - Deferred processing
  - Time + vendor software
  - Separate support pricing

- Examples of incremental support pricing include:
  - Support time on hourly basis (minimum flat charge)
  - Education and training surcharge
  - Books, manuals, supplies, etc.

C. HOW A VENDOR IS SELECTED

- Vendors are usually selected on the basis of either applications software or support. This is especially true of the small and medium-sized companies who need the high level of support to fulfill their professional obligations.

- These professionals have learned to use EDP as a sophisticated problem solving tool. If the firms are to remain competitive, jobs can no longer be done manually.

- The project orientation of the business requires that the vendor:
  - maintain a continual presence with the potential user
  - provide excellent service, because a deviation could cause a user to switch vendors.

- Both these requirements increase the cost of marketing to the A&E users.

- Users change vendors according to their application needs. User comments as to satisfaction with the service and the support provided by a vendor are the primary criteria for choosing between vendors offering similar products.

D. STRATEGIES AND RECOMMENDATIONS

- Provide trained personnel who can help the users solve their problems. This requirement is evident from the responses from the surveyed users. They indicate that:
  - Service support is, to them, by far the most important issue.
  - Availability of a network is not a major issue.
  - Engineering and scientific processing cost is not always a major

issue, primarily because it is passed on to the client. and secondarily because the project engineer feels the task cannot be done without this service.

- One of the respondents indicated that a vendor must know the client's applications requirements and must be willing to develop or acquire the applications which the professional will need.

- Geography is not a major consideration among users unless:

  - There is a significant time zone difference between the vendor support location and the client, and the supporting people are not easily available when they are most needed.

  - A batch processing bureau can provide personal on-sites support to clients who are in close geographic proximity. This personal relationship can give them a major marketing advantage.

- Since the A&E business is competitive and project-oriented, being aware when a large new project is awarded or being ready to offer support to price a bid competitively puts a vendor in a very favorable light. Thus, in addition to software tools and general responsiveness, an awareness of the critical elements of a client's business is extremely important because ultimately vendor selection in a competitive market is an emotional decision based on trust and common "language."

- The small A&E company tends to do the highway construction, cut-and-fill grading, and simple bridge building projects which can be solved with small computers and publicly available programs. These companies often go to local service bureaus because of convenience and low price. Marketing to these

companies must be done by showing them that they can compete for larger jobs if they use the more sophisticated tools available from the large computer services companies.

- It is important for a vendor to have a sufficient number of support people readily available to answer client questions. If this type of person is not available regionally, the headquarters staff should be available to answer such inquiries during regular working hours across all time zones.

- A computer services vendor dedicated to the A&E industry should consider providing the Digital Scientific Meta 4 or General Automation's SPC 18 on OEM basis.

- This approach would allow the computer services company to become the focal point for all the applications written for the 1130. It would also allow the vendor to upgrade, maintain, and charge for applications programs on a system which IBM is gradually abandoning.

- This strategy would permit the computer services vendor to take advantage of the following facts:
  - The IBM 1130 is a very popular computer among A&E firms.
  - The IBM 1130 has a large library of available software.
  - The General Automation SPC 18 and the Digital Scientific Meta 4 are plug compatible with the IBM 1130 but have 3 to 4 times better price performance.

- Vendors selling to the R&D institutions need to be aware of funding cycles and project deadlines. With such information the vendor will know when to expect overflow work from the institutions.

- Another good strategy for a services vendor is to become consultant to the EDP manager or the treasurer of the R&D institutions. In this capacity he could advise the R&D institution on available software and services and on ways to make the total operation more cost-effective by using services to lighten the seasonal or project peaks.

- It is possible that such a close relationship with a computer services company could eventually result in a facilities management contract where all EDP for the R&D institution is performed by an outside agency.

- If the R&D or A&E firm has developed specialized programs, the possibility of acquiring or licensing the software should be explored. This mutually-beneficial arrangement can strengthen the service relationship.

- A strategy which could be used with both A&E firms and R&D firms is offering a "free seminar" to train the professional without computer experience. This could be a two-tier approach:

    - A two to three hour free introductory seminar on the benefits and efficiencies of using computer services in client problem solving. The seminar could consist of a demonstration on how to use terminals plus 2-3 simultaneous applications-oriented demonstrations, e.g., project management, structural analysis and graphic outputs.

- One-day to two-week courses with hands-on experience. Courses could be provided for a standard fee. The fee could be deducted from the bill at a rate of 10% of the monthly remote computing services charge.

- The above approach ties marketing, training and service into a salable package.

- The following chart summarizes the key benefits and costs of using computers in the A&E and R&D firms. (Exhibit VIII-1)

EXHIBIT VIII-1

BENEFITS AND COSTS OF USING COMPUTERS

BENEFITS:

Time of professionals can be freed for other productive tasks, with the correlative impact of increased productivity.

Professional services are improved through ability to analyze more alternative solutions in a given time period and through offering new services.

Sale of computer-based services can help support R&D efforts.

Information with fewer errors is available faster to decision makers.

More strongly systemized approaches to structuring problems, organizing data and making decisions can lead to clearer decision making, to new approaches for problem solving and even to undertaking problems previously not considered possible.

Interaction and cooperation can be enhanced among design disciplines.

COSTS:

Personnel time must be devoted to developing, documenting, using and updating applications.

Machine operators must be available for data preparation, processing and maintenance.

Hardware costs and items such as lease payments, data and program storage and use charges, maintenance costs and telephone lines (for teleprocessing).

Overhead costs involve space, utilities, paper, computing supplies, etc.

Educating personnel to understand, accept and use computing.

COST CONTROL: COSTS CAN BE CONTROLLED BETTER WHEN A COMPUTER SERVICES COMPANY IS USED.

IX. COMPETITIVE ENVIRONMENT

IX COMPETITIVE ENVIRONMENT

A. INCREASING COMPETITION

- Providing computer services to architects, engineers and R&D institutions is a major source of income for the largest computer services vendors, as well as for many small system and software houses. Several consulting engineering companies, many R&D firms, universities, petroleum companies, and steel and aluminum companies are also providing computer services to these professional groups.

- The major vendors tend to provide a full range of services to the A&E professionals including raw time, a variety of structural and construction packages, graphics and plotting packages, simulation, seismic and structural packages, foundation design packages, project management, critical path, energy conservation, etc.

- Most large vendors consider this market sufficiently important to justify employing one or more dedicated support specialists. These specialists are thoroughly familiar with user applications and are available to support present clients or impress prospective clients with their ability to solve problems by quickly and efficiently utilizing specialized software.

- Since most of the vendors who sell to the A&E and R&D industry are large, most of them have nationwide capabilities. Several vendors have European and Australian facilities and are able to offer worldwide client support.

- MCAUTO, BCS, and CDC have vigorously targeted the A&E market. Structural Dynamics Research Corporation, specializing in applications programs for the A&E industry, has one of the largest applications libraries in the industry. They provide applications through G.E.I.S., CSC, CDC and Comshare. UCC's scientific and engineering group is trying to catch up with competitors by filling out and updating its applications program library. The company is also currently upgrading its level of support and its network. After several years of neglect, this effort is starting to reverse the downward trend. BCS emphasizes project management; it also emphasizes that the user can operate in a batch and interactive mode in the same environment. Tymshare emphasizes its network and data base capabilities.

- Selected R&D firms, formerly entirely dedicated to government projects, are now beginning to compete in the commercial DP services and products market. For example:

    - Systems Development Corporation, formerly devoted to government and defense-oriented work, has entered the commercial market. SDC is providing computer software through its subsidiary, Mechanics Research, specialists in engineering software; is selling special purpose remote batch terminals; and is the marketing agent for Terrabit, a mass storage device developed by Ampex Corporation. SCD has also taken on the responsibility for system integration and coordination in several government R&D installations. It is also facilities manager for the Knickerbocker Federal Savings and Loan bank in New York.

B. EXPANDING THE MARKET

- Currently, the pricing of the services is resource rather than transaction-oriented. However, several vendors are investigating the practicality of transaction pricing. One vendor indicated that as long as there was a quick turnaround requirement, he made enough money on prime time resource pricing and was not concerned about transaction pricing. Vendors utilize transaction pricing either as a competitive tool or as a way to expand the market.

- All the remote computing vendors interviewed buy or license software from a variety of software vendors. Software vendors, on the other hand, purchase time to develop programs from the computer services companies.

- A list of software packages commonly used in the A&E industry is found in Exhibit IX-1. The availability of software from a multiplicity of sources is a force that is expanding the services market.

- Vendors do not presently agree on where new business in this market will come from. Some of the firms are marketing primarily to big users while others are concentrating on the small and medium-sized users. As a result, some vendors are only visible in selected portions of the market.

- To increase market penetration and to be competitive in all segments of the market, established vendors must expand their marketing effort to:
    - sell available software to firms regardless of size
    - acquire additional packages from outside sources.

EXHIBIT IX-1

SOFTWARE PACKAGES IN COMMON USE IN A&E INDUSTRY

PACKAGE	DEVELOPER
NASTRAN	NASA (Perfected by MacNeal-Schwengler)
TESS	TRW Systems Group
TRIFLX	AAA Technology & Specialities Company
GASPX	Swan Wooster Engineering Company, Ltd.
CEC1	Bowles Taddeo & Associates
DYNAFLEX	Auton Computing Corporation
GPS, HEP, Piping POS, PDA, Separation	Phillips Petroleum Company
SSI/DR-01, SSI/100 Process Simulators	Simulation-Sciences Incorporation
HYDRAULIC NETWORK	Consumer Gas Company
ADL PIPE	Arthur D. Little Company
COMPAID	D. A. Computer Services Ltd.
ANSYS	Swanson Analysis Systems, Incorporated
NISA	Engineering Mechanics Research Corp.
SAP4, LUSH	U. C. Berkeley

C. MINICOMPUTERS AS COMPETITION

- None of the small A&E users interviewed felt that minicomputers were a viable alternative for solving their engineering and design problems. This is due to two factors:

  - lack of software
  - insufficient memory capacity and processing speed.

- Because of the high level of computation required, the project orientation of the business, and the availability of specialized software developed for large systems, the sale of minicomputers to the small and medium-sized architectural and engineering firms has been relatively unsuccessful so far.

- Many medium-sized and large A&E users felt that the use of minicomputers for commercial applications was a reasonable alternative. They felt that having a minicomputer which could serve as an RJE terminal to one or more networks was the ideal solution.

- The minicomputer firms have not yet focused on the A&E market. There are several computer services vendors, however, who are considering providing minis on their network. Some of these minis could be used to serve this market. (See Marketing Strategies - Chapter VIII)

- R&D institutions, on the other hand, are excellent customers of mini-computer manufacturers. They use minis in communications applications, specialized dedicated laboratory applications, in-house timesharing and data base applications.

D. OTHER COMPETITIVE CONSIDERATIONS

- Facilities management was unattractive to all A&E users interviewed. Users felt that a computer services vendor offering remote batch or time-sharing services, and providing adequate training in the use of hardware and applications software, is all they need to fill their data processing requirements.

- One user who evaluated FM five or six years ago remembers that the vendor did not understand his problem. The user has since built up in-house EDP competence and would no longer consider FM.

- The vendors mentioned most frequently by the surveyed sample of A&Es were MCAUTO, CDC and BCS. Generally, MCAUTO received the highest score on performance of software, CDC received the highest on support, and BCS received the highest on price. There were twelve other vendors mentioned. Some users purchased services from as many as twelve vendors but could only remember one or two vendors.

- The most important competitive issue was responsiveness to inquiries. Among the most frustrating experiences related by users were the vendors who repeatedly did not return phone calls. Two vendors were cited as delinquent in this regard, namely UCC and BCS.

1. MCAUTO - ST. LOUIS, MISSOURI

- MCAUTO generated the most favorable reaction among users and seems to be very responsive to user needs in the A&E area. The company has over 3,500 employees and generated almost $170 million revenues in 1975. MCAUTO has a vast array of computers, including six 370/168s, seven 370/158s and four large CDC systems. There are a total of 80 mainframes distributed as follows:
  - 37 in St. Louis
  - 19 in Huntington Beach
  - 19 in Long Beach

- MCAUTO has one of the largest libraries of engineering programs offered by any vendor. It also has more than 300 people dedicated to supporting this market, 190 of whom are consultants available to clients. These two factors have made MCAUTO the most frequently mentioned and the most widely utilized remote computer firm in the A&E market. One user commented that "MCAUTO was the only vendor who knew how to connect our G.E. in-house computer to their network."

- MCAUTO segments its software library into the following major categories:
  - Chemical Engineering Program utilized by the petroleum, hydrocarbon, process control industries, and chemical consulting engineers. These programs account for about 15% of scientific revenues.
  - Civil Engineering Programs utilized by construction firms, manufacturing companies, municipalities, real estate companies, utilities, and civil engineering firms. These programs account for 10% of revenues.

- Electric Power Engineering Programs utilized by utility companies, municipalities, and engineering firms. This group of programs accounts for less than 10% of revenues.

- Electronic Engineering Programs utilized by electronic manufacturing companies and electronic engineering firms for design and analysis of electronic circuits, transient analysis and circuit performances. These programs account for less than 5% of revenues.

- Project Management Programs used by construction companies, manufacturing companies, architects, and engineers to plan and keep track of large and complex construction projects. These programs account for 20% of revenues.

- Structural Engineering Programs used by construction companies, utilities, manufacturing companies, aerospace companies, construction companies, and engineering and architectural firms to design and test responses of static and dynamic structures. These programs account for 50% of revenues.

- Other programs such as linear programming and statistical and mathematics packages account for less than 10% of revenues.

2. CONTROL DATA CORPORATION (CDC) - MINNEAPOLIS, MINNESOTA

- The critical factors in selected CDC over other vendors were its network, as well as its software. The total service revenues of CDC are projected to surpass $500 million in 1976. The total is somewhat distorted by the maintenance and engineering groups which account for over $150 million of revenues. CYBERNET accounts for $75 million, while SBC is responsible for $100 million.

- CDC concentrates on six applications areas. Each applications area has its own product manager. These areas include:

  - structural analysis
  - management sciences
  - electrical engineering
  - data base management
  - graphics and management analysis.

- Structural analysis is the major revenue generator for CDC. A graphics capability was built into the structures product in 1975 and allows the user to graphically enter a model for analysis using pictures of the structure under investigation.

- An automatic substructuring capability for CDC/NASTRAN enhances CDC's conventional structures applications. This capability was exclusive to Control Data until October 1976, at which time the contract allowed MacNeal-Schwendler to release the feature to competing data services vendors.

- Graphics Programs, a standard plotter interface for all CYBERNET Data Centers, was implemented in 1975. These programs allow most users to access the graphics plotter through the CYBERNET network via a common format.

- Electrical engineering - using INIS with TESS and SYSCAP - CDC offers the user a complete product line from circuit or logic analysis through microprocessor simulation, automatic logic test generation, and printed circuit board layout. CDC provides interactive capability for data entry and batch processing for production runs. With CYBERLINE and INIS, a user can easily switch back and forth.

- Other products include SYSCAP II, TESS, and CC-TEGAS 3:

  - SYSCAP II (System of Circuit Analysis Programs) - Directed to solving circuit analysis problems. Available through a licensing agreement with Rockwell International Corporation, this interactive and/or batch program set is used in component design and analysis.

  - CC-TEGAS 3 (Test Generation and Simulation System) - Designed to solve logic design and test generation problems. Available in both batch and timesharing versions, this program was developed by Comprehensive Computer Systems and Services of Austin, Texas.

  - TESS is a computer tool designed to solve circuit and system analysis problems. This program was developed by TRW Systems Group of Redondo Beach, California.

3. BOEING COMPUTER SERVICES (BCS) - DOVER, NEW JERSEY

- Boeing Computer Services is a subsidiary of Boeing Corporation. It utilizes a computer services network to sell computer services throughout the U.S. Over two-thirds of BCS's revenues of over $130 million are derived from captive sources. The computers utilized by BCS include IBM's 370/168s and 158s, as well as CDC's Cyber 74 and 6600.

- BCS provides MAINSTREAM-EKS - Enhanced Kronos Service - for scientific/engineering applications. Exxon, a client, uses the system to solve nuclear fuel fabrication problems.

- MAINSTREAM-TSO, adapted from IBM's TSO, is BCS's nation-wide remote data handling and RJE system. With this capability, BCS offers information

management (MARK IV, TCTAL, RE-ACT), project management, simulation, modeling, math and statistics packages, and economic forecasting (SIMPLAN) to all industries. Of specific interest to architects and engineers are ICES/STRUDL II, an engineering structural design package, and NASTRAN Structural Analysis System. The BIG (BCS Interactive Graphics) System has applications in architecture, construction, and other display output-oriented requirements. BCS uses the direct mail approach to reach potential clients.

- CTS is a conversational/terminal language written for the 370/168. The CTS applications program library contains COGO, ECAP, SURVEY, CUTFILE and CPM.

4. UNIVERSITY COMPUTING COMPANY (UCC) - DALLAS, TEXAS

- University Computing Company's revenues for fiscal year 1976 are projected at $65 million. INPUT projects that the Scientific and Engineering Division (SED) will have revenues of $15 million in 1976. It is currently employing 217 people. The division has consolidated its operation in one "super center" in Dallas and uses five UNIVAC 1108s and one CDC 6600.

- Sixty-five percent of the division's business is raw time sales, and thirty-five percent is associated with various applications programs.

- There are 38 sales people in the division and a similar number of support personnel. Seventeen percent of the personnel of the division is dedicated to R&D.

- SED has recently begun an extensive sales and marketing training program. This program is designed to improve the sensitivity of the personnel to

customer requirements in areas such as response and turnaround time, technical competence, and product knowledge.

- SED supports several generalized finite element analysis programs. These were acquired on a non-exclusive basis from third parties and include ANSYS, NASTRAN, STRUDL, NISA, SAP IV, SPACE V and MARRS.

- UCC (GB) Ltd. obtains 55% of its revenues from the processing of scientific and engineering problems. Scientific and engineering packages developed in the U.S. give UCC Ltd. unique advantages in Europe. Only CDC offers similar capabilities to architects and engineers in the European market.

5. NATIONAL CSS (NCSS) - NORWALK, CONNECTICUT

- National CSS's sales at the end of fiscal year 1976 were $35.6 million. The management expects to have sales of $42 million in fiscal year 1977. The company uses IBM 370, 158 and 168 Systems, as well as a recently-installed Amdahl 470V/6 The firm has over 600 employees and 70 to 75 consultants available, at no charge, to customers who need help.

- NCSS has electrical engineering programs such as:
    - ISPICE - an interactive simulation program with integrated circuit analysis.
    - LOGCAP II - an interactive program simulating behavior of logic networks.
    - SCI-CARDS - to generate printed circuit card layouts
    - GASS - gas steady-state piping system simulator
    - GASUS - gas unsteady-state piping system simulator
    - STRUPAK - a collection of 31 separate programs used to solve a wide variety of structural analysis/design problems.

6. INFORMATION SYSTEMS DESIGN INCORPORATED (ISD) - SANTA CLARA, CALIFORNIA

- Although ISD was specifically mentioned by only one user, it was also mentioned by three vendors as a source of engineering software. In the A&E market, ISD's influence goes far beyond its relatively modest size. Started in 1966, ISD has slightly over 100 employees and generates around $5 million in revenues, 90% in California. ISD has 16 employees fully dedicated to the A&E market, 6 in sales plus 10 product support people.

- ISD is primarily a computer utility providing computer services in a batch and conversational mode utilizing one dual 1108 plus a single 1108. The library contains a variety of programs with heavy emphasis on engineering and architectural, as well as data base applications.

- Examples of available software are MARC, AUTOSOLVING, NASTRAN, ANSYS, NISA, SAP 4, and ICES/STRUDL-II.

7. TYMSHARE INCORPORATED - CUPERTINO, CALIFORNIA

- Tymshare, one of the fastest growing remote computing vendors, is now emphasizing business and financial applications rather than scientific ones. The company is reaching $80 million in sales and has almost 2,000 employees. The strength of the company lies in its network which covers the U.S. and Europe. Tymshare has the following computers on its network:

  - an IBM/158
  - a Burroughs 4700
  - 10 DEC Systems 10s
  - 25 SDS 940 Systems.

- The Tymshare applications packages utilized by A&E and R&D houses provide data base and data analysis capabilities, as well as financial planning packages. Tymshare has packages in the civil, electrical, and chemical engineering areas.

8. AUTOMATIC DATA PROCESSING INCORPORATED (ADP) - CLIFTON, NEW JERSEY

- Automatic Data Processing had revenues of almost $200 million in 1975. Batch services account for 85 percent of ADP revenues, while remote computing constitutes the remaining 15 percent. The A&Es who use ADP use them primarily for payroll and other commercial data processing services, rather than because of any industry or applications expertise.

- Automatic Data Processing uses IBM and DEC Systems, as well as Burroughs, Honeywell, and a UNIVAC communications processor.

9. COMPUTER SCIENCES CORPORATION (CSC) - EL SEGUNDO, CALIFORNIA

- Computer Sciences Corporation, one of the largest companies in the computer services industry, does not specialize in the A&E industry. However, the company provides computation services on its network to the A&E clients. In addition, CSC offers a mechanical design library of 20 packages developed by SDRC and a proprietary data base.

- Programs for A&E type applications are offered on Infonet.

10. UNITED COMPUTING SYSTEMS (UCS) - KANSAS CITY, MISSOURI

- United Computing Systems has over $25 million in sales and over 500 employees. The company offers business and scientific applications support to the A&E and R&D firms. The A&E segment of the industry represents an estimated 15% to 20% portion of UCS revenues. The UCS computer network consists of nine CDC Systems, as well as one Honeywell, and an old IBM computer. UCS has offices in the 30 major metropolitan areas in the United States.

- UCS offers a complete range of structural, civil, mechanical, chemical, and electrical engineering packages.

- In addition, UCS offers FORESIGHT, a business planning language used for financial planning and modeling and for management reports.

- UCS has acquired a variety of software packages which make it an effective competitor in the Midwest.

11. GENERAL ELECTRIC INFORMATION SERVICES (GEIS) - ROCKVILLE, MARYLAND

- GEIS is the largest U.S. remote computing services vendor with sales estimated at around $200 million. However, it is not the most frequently mentioned company, primarily because its computers are not the number crunchers that are generally needed by the A&E and R&D firms.

- GEIS has the most extensive integrated network of all the remote computing companies, as well as excellent financial and manufacturing packages. In addition, it has statistical modeling, simulation and operations research aids.

- In the A&E area GEIS has a licensing relationship with Structural Dynamics Research Corporation (SDRC) which provides structural packages for architects.

- Because of its extensive network, GEIS is capable of serving those small and medium-sized users located in remote areas.

12. OPTIMUM SYSTEMS INCORPORATED (OSI) - SUNNYVALE, CALIFORNIA

- OSI has total sales around $30 million and over 1,000 employees. The company has two major data centers equipped with large IBM 370/158 and 168 computers. OSI markets facilities management remote computing and batch processing to the Federal Government, municipal agencies, health care organizations, insurance companies and manufacturing firms.

- The A&E market effort is a recent development, and it is a rapidly growing one with some 50 clients. A new product manager has been appointed to serve the industry with the aid of two support specialists. OSI has a licensing and royalty agreement with Project Software and Development Inc. for the Project II and I.C. STRUDL software packages.

- The products OSI sells to the industry are:
  - SUPER WYLBUR - an interactive text processing program
  - PROJECT II - A project planning tool.
  - I.C. STRUDL - A very efficient proprietary version of STRUDL for which OSI charges twice the standard price.
  - CIS - Construction Information System which provides financial management and inventory cost estimation to construction engineers and architects.

- PROJECT II and CIS are also used as documentation tools by the contractor when he goes to the bank to obtain a loan.

13. STRUCTURAL DYNAMICS RESEARCH CORPORATION (SDRC) - CINCINNATI, OHIO

- Structural Dynamics Research Corporation is a software company totally dedicated to supporting the architect and engineering market. The company has $6 million in sales and employs about 120 people. It has over 200 clients worldwide including companies like GEIS, CSC, CDC and Comshare. The company projects a 30% per year growth.

- Their major emphasis is on mechanical rather than structural analysis. Applications include design of foundations, graphics plotting, as well as testing of mechanical equipment.

- Revenues from clients range from $100 to $100,000 per month.

- The company considers itself the foremost specialist in its area of endeavor. Its sales force is 100% dedicated to the A&E market.

14. MIDSTATE COMPUTING SERVICES INCORPORATED - HARRISBURG, PENNSYLVANIA

- Midstate Computing Services, Incorporated is wholly owned by Gannett, Fleming, Cordry and Carpenter - Harrisburg, Pennsylvania. It is a spinoff of the data processing capabilities of an engineering and architectural firm.

- The firm generates around $2 million in revenues doing batch, remote batch, inquiry, and FM processing and employs 14 programmers and analysts. The firm is equipped with a 360/50 and a 360/40. The work load is segmented as follows:

- Commercial - 60%
- Engineering - 40%

- The firm does data processing work for local manufacturers, wholesalers and retailers, and state and local governments, as well as commercial work for small local A&E firms.

- Applications include labor distribution, general ledger, accounts payable and receivable, inventory control, etc.

15. KIMBALL COMPUTER COMPANY - EBENSBURG, PENNSYLVANIA

- Kimball Computer Company is a subsidiary of Robert Kimball Consulting Engineers - Ebensburg, Pennyslvania. It is a small services bureau using an IBM System 3 and an IBM 1130. This group has a small marketing effort with 3 sales people.

- The commercial business is primarily oriented to the state and local government and has the following applications:
  - Payroll
  - Real estate mapping and valuation
  - Domestic relations accounting
  - Jury selection
  - Voter registration
  - Plus in-house applications such as job costing and financial processing.

- The engineering group specializes in automated design and engineering applications.

APPENDIX A. SOFTWARE AVAILABLE FROM SELECTED COMPUTER SERVICES VENDORS

APPENDIX A

SOFTWARE AVAILABLE FROM SELECTED COMPUTER SERVICES VENDORS

- The following are some of the software packages available from computer services vendors: (Additional detail is available in the Chapter on "Competition" which describes each vendor separately.)

- STRUCTURAL ENGINEERING

  - AISC-AISI COLUMN DESIGN PROGRAM (1969) - Designs steel columns.

  - ANSYS (ENGINEERING ANALYSIS SYSTEM) - Using finite element technology, performs static and dynamic (elastic and plastic) structural analysis and fluid flow and heat transfer analysis.

  - BOSOR4 - Makes stress stability and vibration analysis of complex branched shells of revolution; has extensive plotting capability.

  - DANUTA - Provides static and dynamic analysis of two-dimensional, axisymmetric, and three-dimensional structures.

  - MITAS(CINDA) - Solves a wide variety of heat transfer problems, including spacecraft and missile systems.

  - NASTRAN (NAsa STRuctural ANalysis) - Solves extremely large structural models including statics, dynamics, heat transfer and a wide range of non-linear features; general processes - simulation, correlation and optimization - static response to concentrated and distributed loads, thermal expansion, enforced deformation; dynamic

response to transient loads, steady-state sinusoidal loads, random excitation; determination of real and complex eigenvalues for use in vibration, dynamic stability and elastic stability analysis; steady-state heat transfer analysis; acoustic analysis of enclosures.

- NISA (Numerically Integrated Elements for Systems Analysis) - a general purpose program developed by Engineering Mechanics Research Corporation to analyze complex structural problems. The program offers significant improvements in solving static and dynamic problems under a wide range of loading conditions.
- PORTLAND CEMENT ASSOCIATION PROGRAMS - Provide analysis and design of flat plates and continuous concrete frames, concrete wall-beam frames, and foundation mats and combined footings.
- SAAS II - Performs finite element stress analysis of axisymmetric solids with orthotropic temperature-dependent material properties.
- SABOR - Analyzes thermal and pressure loads, either axisymmetric or asymmetric, on shells of revolution with or without branches.
- SAP IV - Performs finite-element structural analysis of linear, three-dimensional systems for both static and dynamic loading on structures idealized as combinations of element types.
- SEAL SHELL - Analyzes shells of revolution under axisymmetric pressure loads and temperature loads.

- ICES/STRUDL-II (Integrated Civil Engineering System/STRUctural Design Language) - An analysis system developed at MIT utilizing a problem-oriented language which can be used for a wide variety of data manipulations. STRUDL may be applied to a wide range of structural problems and provides a nominal amount of design capability.
- STRUDL DYNAL - Determines natural frequencies and mode shapes, and computes vibrational response of structures to forced or shock excitation. (STRUDL option.)
- STRUDL PLOTS - Produces graphical output on an incremental line plotter; capabilities include geometrical output (including three-dimensional views) member performance plots and deflected shapes. (STRUDL option.)
- STRUDL TOWER - Used for analysis and automatic member selection/code checking of transmission towers. (STRUDL option.)
- SAP 4 (Structural Analysis Program) - Finite element program for static and dynamic analysis of linear systems developed at U.C. Berkeley.
- TABS (Three Dimensional Analysis of Building Systems) - A finite element program for the structural analysis of frame and shear wall buildings subjected to both static and earthquake loadings. Developed at the University of California, Berkeley, and used by civil engineers.
- STAGS (STructural Analysis of General Shells) - a finite difference code developed by the Lockheed Palo Alto Research Laboratory to perform structural analysis of general shells.

- BOSOR - A computer program for the stress, stability and vibration analyses of segmented, ring-stiffened, branched shells of revolution. The program includes non-linear prestress effects.
- SPACE (Structural Preprogrammed Analysis Capability for Engineers) - A large capacity computer program developed by Digital Analysis Consultant, Inc. for the static linear elastic analysis of two or three-dimensional structures. SPACE is capable of analyzing problems ranging from very small to very large.
- LUSH - U.C. Berkeley developed program designed to determine the response of a soil structure system.
- MARC - A structural engineering package designed to solve a wide variety of problems ranging from linear elastic analysis, shells, beams, geometric effects.

- CIVIL ENGINEERING
  - ANALYTIC AEROTRIANGULATION - Determines ground coordinates from photographic coordinates.
  - COMPUTER AIDED RAILWAY ENGINEERING SYSTEM (CARES)
  - COGO (ICES) - Describes and analyzes geometric problems included in the design of highways, waterways, railways and subdivisions.
  - COORDINATE TRANSFORMATION - Converts ground coordinates from one base system to another.
  - EARTHWORK - Used for large area grading projects; uses average end area method.

- GAS NETWORK DESIGN AND ANALYSIS PROGRAMS - Determine pressure and flow characteristics for existing systems; size pipe to specified condition for proposed systems. (Programs developed by Consumer's Gas Company of Toronto, Ontario)
- HYDRAULIC NETWORK DESIGN AND ANALYSIS PROGRAMS - Design or analyze water distribution networks. (Programs developed by Consumer's Gas Company of Toronto, Ontario)
- LAND - Allows automatic subdivision of areas of land.
- NETWORK ADJUSTMENT (NOS) - Adjusts survey networks for closure errors.
- ROADS (ICES) - For design of roads and highways.
- SEPOL (ICES) - Analyzes stress and settlement characteristics of loaded soil profiles.
- SEWER (ICES) - Analyzes or designs storm or sanitary networks.
- SIGOP - Optimizes traffic networks for cycle lengths and phase splits.
- SLOPE (ICES) - Allows estimation of safety factors against sliding.
- SURMAP - Interpolates and extrapolates from defined points to develop data for plotting contour maps.
- TOWER SPLOTTING - Determines an economic configuration for a transmission line over a given right-of-way based on user-supplied costs, tower types, loads and terrain characteristics.

- MECHANICAL ENGINEERING

  - ADLPIPE - Provides static and dynamic analysis of piping systems. (Developed by Arthur D. Little Co.)

  - COMPAID® - Produces piping system isometrics and correlates piping system planning, engineering, estimating, purchasing, costing, stock control, accounting and construction for functional control. (COMPAID is a registered trademark of D-A Computer Services Ltd.)

  - GENERAL HEAT TRANSFER - Analyzes steady-state or transient temperature response of a thermal model.

  - HEAT LOADS - Analyzes buildings to determine heating/cooling loads resulting from solar radiation, conduction, lighting, occupants, etc.

  - PIPEFLEX - Computes piping system deflections, rotations, forces, moments and stresses resulting from various external and internal loads.

  - TRIFLEX - Determines deflections, forces, moments and stresses in piping systems under various loading conditions and checks results for compliance with established piping codes. (Developed and maintained by AAA Technology)

- CHEMICAL PROCESS ENGINEERING

  - GENERAL PROCESS SIMULATOR (GPS) - Performs process heat and material balance calculations. (Developed by Phillips Petroleum Company)

  - HEAT EXCHANGE PROGRAMS - Used for design of seven different heat exchange equipment types. (Developed by Phillips Petroleum)

  - PIPELINE PROGRAMS - Includes routines for design of gas gathering and liquid distribution systems, pressure flow analysis of liquid piping systems, and simulation of two-phase flow. (Developed by Phillips Petroleum Company)

- PROCESS DATA SYSTEM - Supplies thermodynamic and transport data on demand to all Phillips simulation and equipment routines. (Developed by Phillips Petroleum Company)
- PROCESS DESIGN ANALYSIS PROGRAM (PDA) - Permits the development of a complete process model. The program also provides for capital cost estimation, utility requirements calculation and economic analysis. (Developed by Phillips Petroleum Company)
- SEPARATIONS PROGRAMS - Design and rate fractionators, absorbers, reboiled absorbers, and strippers. (Developed by Phillips Petroleum Company)
- SSI/DR-01 COMPONENT PROPERTIES - Translates stream assays given in terms of TBP or ASTM distillation curves into pseudo-components with specified TBP cut points. (Developed by Simulation Sciences, Inc.)
- SSI/100 PROCESS SIMULATOR - Calculates process heat and material balances. (Developed by Simulation Sciences, Inc.)

- ELECTRIC POWER ENGINEERING
  - FAULT - Determines electrical power flow and distribution in transmission lines in the neighborhood of a fault.
  - LOAD FLOW - Determines transmission line power flows and bus voltages for large distribution systems under specified generation and loading conditions.
  - NETWORK REDUCTION - Develops an equivalent network by selecting certain modes to be retained as terminals.
  - TRANSIENT STABILITY - Studies transient behavior of a network based on simulated operating conditions.

- ELECTRONICS ENGINEERING
  - ECAP - Aids in the design and analysis of electronic circuits.
  - LISA - Analyzes electrical networks, transfer functions and two block-control systems of linear equations.
  - NET 2 - Performs a non-linear transient analysis of an electronic circuit; performs optimization.
  - PANE - Evaluates AC and DC nominal, statistical and worst-case electrical circuit performance.
  - SCEPTRE II - Determines initial and steady-state conditions, and transient response in electrical circuits.

- LINEAR PROGRAMMING AND MATHEMATICS
  - MATHEMATICAL PROGRAMMING SYSTEM EXTENDED (MPSX) - Finds solution to linear programming models of up to 16,000 rows.
  - PROSE - Mathematical problem statement language and library of numerical solution methods.

- PROJECT MANAGEMENT
  - AUTONET III - Drafts time-phased CPM networks on a CalComp plotter.
  - CompuNet™ - Drafts CPM and PDM networks on the CalComp, Gould or other plotters using relative coordinates.
  - CONTRACTOR'S EARLY WARNING SYSTEM (CEWS) - Simulates costs and profits to determine risk associated with various project types, including construction.
  - COST PLANNING AND EVALUATION SYSTEM (COPES) - Fulfills project

manager's requirements for quick response budget/cost information that is oriented to the project rather than to standard accounting data.

- MANAGEMENT SCHEDULING AND CONTROL SYSTEM (MSCS) - Supports CPM and PDM techniques; applies advanced resource leveling algorithms to time-phased networks.

- PROJECT/2 - Operates under ICES Executive System to provide CPM/PDM network processing; includes resource allocation and report flexibility (extension of Project/1).

- SUPPORT FUNCTIONS

  - OTHER PROGRAMS - A large number of additional programs for specific applications in the engineering disciplines are available from large program libraries provided by Federal Agencies such as NASA and the AEC. Computer services firms often assist the user in locating the correct program for the problem.

  - PLOTTING AND GRAPHICS - Most of the engineering applications programs require plotting at a central site or remote plotting utilizing either the batch terminals or demand terminals with plotters as output devices. Visual display of computer-generated data after the computer run is completed is a powerful design and planning tool.

APPENDIX B. DATA BASE

INPUT

DISTRIBUTION OF USER EXPENDITURES FOR
PROCESSING SERVICES IN 1976

BY MODE AND TYPE OF SERVICE

INDUSTRY CATEGORY: ARCHITECTS, ENGINEERS, AND NON-PROFIT R&D INSTITUTES*

TYPE OF SERVICE	MODE OF SERVICE						
	INTERACTIVE	REMOTE BATCH	DATA BASE	BATCH	FM	GP	TOTAL
General Business	5	4	3	0	0	0	$ 12M
Scientific	18	34	0	11	0	9	72M
Specialty	2	6	0	0	0	0	8M
Sub-Total	25	44	3	11	0	9	92M
Raw Time	2	10	0	11	0	0	23M
TOTAL	$27M	$54M	$3M	$22M	0	$9M	$115M

*These figures do not include construction companies such as: Fluor and Bechtel, most of which are large users of raw time remote computing.

COMPUTER SERVICES EXPENDITURES BY SIZE OF FIRM - 1976

SIZE	ARCHITECTS/ENGINEERS	R&D INSTITUTES	TOTAL
Very Large	$ 0	$ 1	$ 1
Large	3	11	14
Medium	29	20	49
Small	38	13	51
TOTAL	$70M	$45M	$115M

COMPUTER SERVICES EXPENDITURES
1976 - 1981
BY MAJOR SERVICE MODE
(ARCHITECTS AND ENGINEERS)

COMPUTER SERVICE CATEGORY	EXPENDITURES				
	1976 $M	1977 $M	GROWTH %	1981 $M	AAGR %
Remote Computing Services					
• Interactive	21	22	5	30	7.5
• Remote Batch	45	49	9	85	13.6
• Data Base	2	3	50	9	35.1
Sub-Total	68	74	9	124	12.8
Batch Processing	16	19	19	22	6.6
Facilities Management	-0-	-0-	-0-	-0-	-0-
Professional Services	5	7	40	14	22.9
Graphic Processing	9	11	22	19	16.2
Software Products					
• Systems Packages	2	3	50	7	28.5
• Applications Packages	6	9	50	16	21.7
Sub-Total	8	12	50	23	23.5
TOTAL	$106	$ 123	16%	$202	13.8%

COMPUTER SERVICES EXPENDITURES
1976 - 1981
BY MAJOR SERVICE MODE
(R&D INSTITUTIONS)

COMPUTER SERVICE CATEGORY	EXPENDITURES				
	1976 $M	1977 $M	GROWTH %	1981 $M	AAGR %
Remote Computing Services					
• Interactive	6	7	17	8	5.1
• Remote Batch	9	10	11	12	5.9
• Data Base	1	1	0	3	24.6
Sub-Total	16	18	13	23	7.5
Batch Processing	6	6	-0-	8	5.9
Facilities Management	-0-	-0-	-0-	-0-	--
Professional Services	-0-	-0-	-0-	-0-	--
Graphic Processing	-0-	1	100	2	19.0
Software Products					
• Systems Packages	1	1	-0-	2	14.9
• Applications Packages	3	3	-0-	5	10.8
Sub-Total	4	4	0	7	11.9
TOTAL	$26	$29	12%	$40	9.0%

RESULTS OF SURVEY OF USE OF COMPUTERS AND COMPUTER SERVICES

ARCHITECTS AND ENGINEERS

	SMALL		MEDIUM		LARGE	
	YES	NO	YES	NO	YES	NO
In-House Computer Services	5	6	6	0	6	1
Interactive Terminals	6	5	4	2	1	6
Batch Service	3	8	0	6	1	6
Remote Batch	7	4	3	3	2	4
No EDP	0	NA	0	NA	0	NA

RESULTS OF SURVEY OF USE OF COMPUTERS AND COMPUTER SERVICES

R&D INSTITUTIONS

	YES	NO
In-House Computer	10	1
Interactive Terminals	4	7
Batch Service	1	10
Remote Batch	3	8
No EDP	0	NA

APPENDIX C. DEFINITIONS

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

    - Remote Batch - 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 - characterized by the retrieval of information from a vendor-maintained data base. This may be owned by the vendor or a third party.

  - 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 key-punching 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 "Reserve Management" or "System Management"). The management of all or a part of a user's data processing functions under a 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. Management 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 the package at the users' sites. Fees for work performed by organizations other than the package vendor are counted in professional services. The two subcategories are:

- Systems Packages - operating system, 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 - software which perform processing to serve user functions. They consist of general purpose packages, such as a payroll, accounting and inventory controls, and special purpose packages such as personal trust, airline scheduling, and demand deposit accounting.
- Graphic Packages - provide an interface with any applications program requiring visual design or display of input or output data. This interface can be provided either on or off line. A CRT or a plotter can be used for output and a keyboard, a joystick, a Rand tablet, or a light pen can be used as input.

- 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 - processing services for applications which are common to users across industry categories. Software is provided by the vendor. This can be a 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 Applications Services - 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.

- 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 an 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 control development, and demand deposit accounting.

- Utility Services - those where the vendor provides access to a 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.

- All expenditures and revenues addressed are "available" in that they are open for competition. "Captive" figures, which refer to expenditures by a user for services from a subsidiary company, such as Boeing Aircraft with Boeing Computer Services (BCS), are not included. They may be referred to when examining our individual "spinoff" vendor, such as BCS.

- When any questions arise as to the place to properly count certain user expenditures, INPUT addresses the questions from the user's viewpoint and categorizes the expenditures according to the answer to the question, "What does the user perceive he is buying?"

APPENDIX D. SELECTED A&E FIRMS AND THEIR AREA OF SPECIALTY

SELECTED A&E FIRMS AND THEIR AREA OF SPECIALTY

			Area of Specialty					
Name and Address	No. of Employees	International	Structural	Geology	Water and Pollution	Urban Planning	Material Testing	Comments
A.C. ACKENHEIL & ASSOCIATES 1000 Banksville Road Pittsburg, Pennsylvania 15216 (412) 531-7111	30		x	x	x	x	x	
AIRWAYS ENGINEERING CONSULTANTS 1250 Connecticut Ave., N.W. Suite 200 Washington, D.C. 20036 (202) 659-2222	100	x	x			x		
ALLEN & HOSHALL 65 McCall Avenue Memphis, Tennessee 38103 (901) 525-0531	100		x		x			
AMMANN & WHITNEY 111 Eighth Avenue New York, New York 10011 (212) 924-8282	450	x	x	x		x		
MICHAEL BAKER, JR., INC. 4301 Dutch Ridge Road P. O. Box 280 Beaver, Pennsylvania 15009 (412) 495-7711		x	x		x	x	x	
BARR ENGINEERING COMPANY 6800 France Avenue South Minneapolis, Minnesota 55435 (612) 920-0655		x	x		x		x	

SELECTED A&E FIRMS AND THEIR

AREA OF SPECIALTY

Name and Address	No. of Employees	International	Area of Specialty					Comments
			Structural	Geology	Water and Pollution	Urban Planning	Material Testing	
R. W. BECK AND ASSOCIATES 200 Tower Building Seattle, Washington 98101 (206) 622-5000	200	x	x		x	x		
BENHAM-BLAIR & AFFILIATES, INC. 6323 North Grand Boulevard Oklahoma City, Oklahoma 73118 (405) 848-6631	260	x	x		x	x		
LOUIS BERGER, INC. 100 Halsted Street East Orange, New Jersey 07019 (201) 678-1960	500	x	x	x	x	x		
BLACK, CROW AND EIDSNESS, INC. 700 S.E. Third Street P. O. Box 1647 Gainesville, Florida 32601 (904) 378-1531		x			x		x	
BLACK & VEATCH INTERNATIONAL 1500 Meadow Lake Parkway Kansas City, Missouri 64114 ((816) 361-7000	1100	x	x		x		x	
JOHN A. BLUME & ASSOCIATES 612 Howard Street San Francisco, California 94105 (415) 397-2525	100	x	x	x	x		x	

SELECTED A&E FIRMS AND THEIR

AREA OF SPECIALTY

Name and Address	No. of Employees	International	Structural (Area of Specialty)	Geology	Water and Pollution	Urban Planning	Material Testing	Comments
BOYLE ENGINEERING 412 South Lyon Street Santa Ana, California 92702 (714) 547-4471	175	x	x		x			
CR&S INTERNATIONAL (Division of CALDWELL, RICHARDS & SORENSEN 118 First Avenue Salt Lake City, Utah		x	x		x			
CAMP DRESSER & McKEE INTERNATIONAL INCORPORATED One Center Plaza Boston, Massachusetts 02108 (617) 742-5151	470	x			x			
CAPITOL ENGINEERING CORPORATION 124 West Church Street Dillsburg, Pennsylvania 17019 (717) 432-9628	500	x	x		x			
CONSOER, TOWNSEND & ASSOCIATES 360 East Grand Avenue Chicago, Illinois 60611 (312) 337-6900	610	x	x		x			
DSS ENGINEERS, INC. 2701 East Sunrise Boulevard Fort Lauderdale, Florida 33304 (305) 564-6318		x	x	x	x			

SELECTED A&E FIRMS AND THEIR

AREA OF SPECIALTY

			Area of Specialty					
Name and Address	No. of Employees	International	Structural	Geology	Water and Pollution	Urban Planning	Material Testing	Comments
DALTON, DALTON, LITTLE, NEWPORT 3605 Warrensville Center Road Cleveland, Ohio 44122 (216) 283-4000	265	x	x					
LEO A. DALY COMPANY 8600 Indian Hills Drive Omaha, Nebraska 68114 (402) 391-8111	400	x	x		x	x		
DAMES & MOORE Suite 3500 445 South Figueroa Street Los Angeles, California 90017 (213) 683-1560	500	x	x		x			
DANIEL, MANN, JOHNSON & MENDENHALL 3250 Wilshire Boulevard Los Angeles, California 90010 (213) 381-3663	550	x	x			x		
E. D'APPOLONIA CONSULTING ENGINEERS, INC. 10 Duff Road Pittsburgh, Pennsylvania 15235 (412) 243-3200	100	x	x	x	x	x		
DE LEUW, CATHER INTERNATIONAL INC 165 West Wacker Drive Chicago, Illinois 60601 (312) 346-0424	1,350	x	x			x		

SELECTED A&E FIRMS AND THEIR

AREA OF SPECIALTY

Name and Address	No. of Employees	International	Area of Specialty: Structural	Geology	Water and Pollution	Urban Planning	Material Testing	Comments
W. A. DI GIACOMO ASSOCIATES 1133 Avenue of the Americas New York, New York 10036 (212) 757-1300	100	x	x					
EBNER-SCHMIDT ASSOCIATES 201 East 42nd Street New York, New York 10017 (212) 697-1250	50	x	x					
EDWARDS AND KELCEY 8 Park Place Newark, New Jersey 07102 (201) 621-8422	408	x	x					
ENGINEERING-SCIENCE INTERNATIONAL ("ES") Watergate 600 Building, Suite 888 Washington, D. C. 20037 (202) 338-8292		x	x		x			
FORREST AND COTTON, INC. 600 Mercantile Continential Bldg. Dallas, Texas 75201 (214) 748-2121	240	x	x		x			
FREESE, NICHOLS AND ENDRESS 811 Lamar Street Fort Worth, Texas 76102 (817) 332-4364	140		x		x			

SELECTED A&E FIRMS AND THEIR

AREA OF SPECIALTY

Name and Address	No. of Employees	International	Area of Specialty: Structural	Geology	Water and Pollution	Urban Planning	Material Testing	Comments
GANNETT FLEMING CORDDRY & CARPENTER P. O. Box 1963 Harrisburg, Pennsylvania 17105 (717) 238-0451	800	x	x		x			
GARVER & GARVER, INC. Eleventh and Battery Streets Little Rock, Arkansas 72202 (501) 376-3633	90	x	x		x			
GILBERT ASSOCIATES P. O. Box 1498 525 Lancaster AVenue Reading, Pennsylvania 19603 (215) 376-3873	1400	x	x		x			
THE GREEN ENGINEERING COMPANIES 504 Beaver Street Sewickley, Pennsylvania 15143 (412) 761-2770		x	x		x			
GREENLEAF/TELESCA, PLANNERS, ENGINEERS, AND ARCHITECTS 1451 Brickell Avenue Miami, Florida 33131 (305) 377-8411	60	x	x		x			
HARDING, MILLER, LAWSON & ASSOCIATES 55 Mitchell Boulevard P. O. Box 3030 San Rafael, California 94902 (415) 472-1400	100	x		x	x			

SELECTED A&E FIRMS AND THEIR

AREA OF SPECIALTY

Name and Address	No. of Employees	International	Area of Specialty					Comments
			Structural	Geology	Water and Pollution	Urban Planning	Material Testing	
FREDERICK R. HARRIS, INC. 300 East 42nd Street New York, New York 10017 (212) 986-2700	1,000	x	x		x			
HARZA ENGINEERING COMPANY 150 South Wacker Drive Chicago, Illinois 60606 (312) 855-7000	440	x	x		x			
THE HINCHMAN COMPANY 304 Francis Palms Building Detroit, Michigan 48201 (313) 962-5272		x	x					
HOWARD, NEEDLES, TAMMEN & BERGENDOFF Suite 3050, Prudential Center Boston, Massachusetts 02199 (617) 267-6710	1,100	x	x		x			
HUDGINS, THOMPSON, BALL AND ASSOCIATES P. O. Box 1845 Oklahoma City, Oklahoma 73101 (405) 525-7451	300	x	x					
INTERNATIONAL ENGINEERING COMPANY 220 Montgomery Street San Francisco, California 94104 (415) 397-4071		x	x					

SELECTED A&E FIRMS AND THEIR

AREA OF SPECIALTY

Name and Address	No. of Employees	International	Area of Specialty: Structural	Geology	Water and Pollution	Urban Planning	Material Testing	Comments
I R G (INTERNATIONAL RESOURCES AND GEOTECHNICS, INC.) Westchester County Airport White Plains, New York 10604 (914) 946-1300		x		x	x	x		
JOHNSON & ANDERSON, INC. 2300 Dixie Highway P. O. Box 1066 Pontiac, Michigan 48056 (313) 334-9901	170	x			x			
BERNARD JOHNSON INCORPORATED 5050 Westheimer Houston, Texas 77027 (713) 622-1400	150	x	x					
JUSTIN & COURTNEY 226 W. Rittenhouse Square Philadelphia, Pennsylvania 19103 (215) 546-5504		x			x			
KENNEDY ENGINEERS 657 Howard Street San Francisco, California 94105 (415) 362-6065	40	x			x			
L. ROBERT KIMBALL CONSULTING ENGINEERS 615 West Highland Avenue Ebensburg, Pennsylvania 15931 (814) 472-7700	400	x	x	x				

SELECTED A&E FIRMS AND THEIR

AREA OF SPECIALTY

Name and Address	No. of Employees	International	Area of Specialty: Structural	Geology	Water and Pollution	Urban Planning	Material Testing	Comments
KRAMER, CHIN & MAYO 1917 First Avenue Seattle, Washington 98101 (206) 682-2939		x			x			
LAW ENGINEERING TESTING COMPANY 396 Plasters Avenue, N.E. P. O. Box 13508 Atlanta, Georgia 30324 (404) 873-2811	360	x	x			x	x	
LEEDS, HILL AND JEWETT, INC. 120 Montgomery Street San Francisco, California 94104 (415) 781-6100		x			x			
DAVID V. LEWIN CORPORATION The Arcade Cleveland, Ohio 44114 (216) 696-8151		x	x					
LOCKWOOD, KESSLER & BARTLESS, INC. One Aerial Way Syosset, New York 11791 (516) 938-0600	600	x	x		x	x		
PETER F. LOFTUS CORPORATION Chamber of Commerce Building Pittsburgh, Pennsylvania 15219 (412) 391-2280	160	x	x					

SELECTED A&E FIRMS AND THEIR

AREA OF SPECIALTY

Name and Address	No. of Employees	International	Area of Specialty: Structural	Geology	Water and Pollution	Urban Planning	Material Testing	Comments
MADIGAN-HYLAND, INC.- PRAEGER-KAVANAGH-WATERBURY 200 Park Avenue New York, New York 10017 (212) 661-1800	300	x	x					
LYON ASSOCIATES, INC. 6707 Whitestone Road Baltimore, Maryland 21207 (301) 944-9112		x	x					
CHAS. T. MAIN INTERNATIONAL, INC. Southeast Tower, Prudential Ctr. Boston, Massachusetts 02199 (617) 262-3200	1,000	x	x		x			
MODJESKI AND MASTERS P. O. Box 2345 Harrisburg, Pennsylvania 17105 (717) 234-4135	100	x	x					
JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC. 555 East Walnut Street Pasadena, California 91101 (213) 796-9141	160	x	x		x			
O'BRIEN & GERE ENGINEERS, INC. 1050 West Genesee Street Syracuse, New York 13201 (315) 472-6251	240	x	x		x			

SELECTED A&E FIRMS AND THEIR

AREA OF SPECIALTY

Name and Address	No. of Employees	International	Area of Specialty: Structural	Geology	Water and Pollution	Urban Planning	Material Testing	Comments
PARSONS, BRINCHERHOFF, QUADE & DOUGLAS 111 John Street New York, New York 10038 (212) 233-6300	600	x	x					
PORTER AND RIPA ASSOCIATES, INC. 200 Madison Avenue Morristown, New Jersey 07960 (201) 267-8800		x	x		x			
QUINTON-BUDLONG 912 West 8th Street Los Angeles, California 90017 (213) 624-7651	300	x	x			x		
RADER AND ASSOCIATES The First National Bank Bldg. Miami, Florida 33131 (305) 371-3551	300	x	x		x	x		
JOHN G. REUTTER ASSOCIATES Ninth & Cooper Streets Camden, New Jersey 08101 (609) 541-7700	100	x	x		x			
SHANNON & WILSON, INC. 1105 North 38th Street Seattle, Washington 98103 (206) 632-8020	100	x	x	x	x			

SELECTED A&E FIRMS AND THEIR AREA OF SPECIALTY

Name and Address	No. of Employees	International	Area of Specialty: Structural	Geology	Water and Pollution	Urban Planning	Material Testing	Comments
J. E. SIRRINE COMPANY 216 S. Pleasantburg Drive Greenville, South Carolina 29606 (803) 233-2531	500	x	x		x			
SLOCUM AND FULLER 440 Park Avenue South New York, New York 10016 (212) 686-6081		x	x		x			
THE SMITH, HORACH, HAYET, HAYNIE PARTNERSHIP 721 N.W. 21St. Court Miami, Florida 33125 (305) 642-6661		x	x		x	x		
SOROS ASSOCIATES 575 Lexington Avenue New York, New York 10022 (212) 412-0400		x	x			x		
STANLEY CONSULTANTS, INC. Stanley Building Muscatine, Iowa 52761 (319) 263-9494	400	x	x					
THE T. E. STIVERS ORGANIZATION 1452 Church Street Decatur, Georgia 30031 (404) 378-1392		x						

SELECTED A&E FIRMS AND THEIR

AREA OF SPECIALTY

Name and Address	No. of Employees	International	Structural	Geology	Water and Pollution	Urban Planning	Material Testing	Comments
			Area of Specialty					
SYSKA & HENNESSY 110 West 50 Street New York, New York 10020 (212) 489-9200	350	x	x		x			
JOHN A. TALBOTT, INC., CONSULTING ENGINEERS 2014 N. E. Sandy Boulevard Portland, Oregon 97232 (503) 233-6587		x	x				x	
TAMS (TIPPETTS-ABBETT-McCARTHY-STRATTON) 345 Park Avenue New York, New York 10022 (212) PL5-2000	582	x	x		x	x		
TECHNICAL SERVICE COMPANY 6630 East Hampden Avenue Denver, Colorado 80222 (303) 756-9463		x	x					
TUDOR ENGINEERING COMPANY 149 New Montgomery Street San Francisco, California 94105 (415) 982-8338		x	x			x		
URS SYSTEMS CORPORATION 155 Bovet Road San Mateo, California 94402 (415) 574-5000 (See next 5 companies listed)			x	x	x	x		

SELECTED A&E FIRMS AND THEIR

AREA OF SPECIALTY

Name and Address	No. of Employees	International	Area of Specialty: Structural	Geology	Water and Pollution	Urban Planning	Material Testing	Comments
JOHN A. BLUME & ASSOCIATES, ENGINEERS (URS SYSTEMS CORP. Affiliate) 100 Jessie Street San Francisco, California 94105			x	x				
CLOVERDALE & COLPITTS, INC. (URS SYSTEMS CORP. Affiliate) 140 Broadway New York, New York 10005			x			x		
HILL, INGMAN, CHASE & COMPANY (URS SYSTEMS CORP. Affiliate) 2909 Third Avenue Seattle, Washington, 98121			x		x			
MADIGAN-PRAEGER, INC. (URS SYSTEMS CORP. Affiliate) 200 Park Avenue New York, New York 10017			x					
THE KEN R. WHITE COMPANY (URS SYSTEMS CORP. Affiliate) P. O. Box 6218 Denver, Colorado 80206			x					
VAN HOUTEN ASSOCIATES, INC. 420 Lexington Avenue New York, New York 10017 (212) 889-7350	150	x	x					

SELECTED A&E FIRMS AND THEIR

AREA OF SPECIALTY

			Area of Specialty					
Name and Address	No. of Employees	International	Structural	Geology	Water and Pollution	Urban Planning	Material Testing	Comments
CHARLES R. VELZY ASSOCIATES, INC. 350 Executive Boulevard Elmsford, New York 10523 (914) 592-4750	150	x	x		x			
W. A. WAHLER & ASSOCIATES 1023 Corporation Way Palo Alto, California 94303 (415) 968-6250		x	x	x	x			
WALK, HAYDEL & ASSOCIATES, INC. 762 Baronne Street New Orleans, Louisiana 70113 (504) 529-2133	270+	x	x		x			
JOSEPH S. WARD INTERNATIONAL 91 Roseland Avenue P. O. Box 91 Caldwell, New Jersey 07006 (201) 226-9191		x		x	x	x		
PAUL WEIR COMPANY 20 North Wacker Drive Chicago, Illinois 60606 (312) 346-0275		x	x	x		x		
WESTENHOFF AND NOVICK, INC. 222 W. Adams Street Chicago, Illinois 60606 (312) 263-0114	100	x	x	x		x		

SELECTED A&E FIRMS AND THEIR

AREA OF SPECIALTY

Name and Address	No. of Employees	International	Area of Specialty: Structural	Geology	Water and Pollution	Urban Planning	Material Testing	Comments
ROY F. WESTON, INCORPORATED Lewis Lane West Chester, Pennsylvania 19380 (215) 692-3030		x			x	x		
ADRIAN WILSON ASSOCIATES 621 S. Westmoreland Avenue Los Angeles, California 90005 (213) 386-7070		x	x			x		
WOODWARD-CLYDE CONSULTANTS (A non-operating holding company based in San Francisco. See following list of affiliate offices):			x	x	x			
WOODWARD-CLEVENGER & ASSOCIATES 2909 West 7th Avenue Denver, Colorado 80204 (303) 322-9434			x					
WOODWARD-GARDNER & ASSOCIATES 2100 Locust Street Philadelphia, PA 19103 (215) 732-1333 12150 Parklawn Drive Rockville, Maryland 20852 (301) 881-3940			x					

APPENDIX E. QUESTIONNAIRE

CONFIDENTIAL

INPUT QUESTIONNAIRE

MARKET ANALYSIS PROGRAM/SERVICES INDUSTRY

VENDOR QUESTIONNAIRE

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1. Do you provide services to any of the following users?

_____a. CPAs
_____b. LAWYERS
_____c. CONSULTANTS
_____d. ARCHITECTS
_____e. ENGINEERS
_____f. R&D ORGANIZATIONS
_____G. OTHER SERVICE INDUSTRY

2. What services do you provide for them?

3.

Type	Geog. Dist.	Size of Av. User	# of Clients	$ by Av User	Expected User Growth	Share of Your Rev.

4. Does your product/service have any unique capabilities which would make it more attractive to clients than your competitors'?

5. Do your marketing, sales, or support organizations have any unique capabilities or characteristics which would make your company more attractive to potential clients than your competitors?

6. Who are your major competitors? In what order would you rank yourself and your major competitors in terms of market share?

COMPETITOR	RANK

7. HOW DO YOU PRICE YOUR SERVICE/PRODUCT TO YOUR CLIENTS? (Transaction pricing, Connect, memory, CPU, etc)

8. What level of person in an organization needs to be convinced before the company will buy your service?

9. What is your opinion of the potential threat of mini-computers to your business in these areas?

10. What do you think is the total dollar market for your service,

a. Now (1976) $____________

b. 1981 $____________

11. What percentage of all those who could use a product/service such as you provide do you believe are actually using it,

a. Now ________%

b. 1981 ________%

12. Where will the new users come from?

13. Do you buy computer services yourself (time, software, etc)?

14. Please send product literature.

15. Please provide data for CAMP.

CONFIDENTIAL

INPUT QUESTIONNAIRE

MARKET ANALYSIS PROGRAM - SERVICES INDUSTRY

USER'S QUESTIONNAIRE

---

1. How do you see your company growth 1975 - 1976 - 1977 - 1981?

2. Is this the same for your industry overall?

3. Compared to your expected revenue growth, will your expenditures for EDP (check one):

    _____a. Increase faster   What rate? __________

    _____b. Increase at the same rate

    _____c. Increase at a slower rate   What rate? __________

4. What concerns do you have about EDP use?

5. What EDP changes have you made in the past year?

6. What EDP changes do you expect to make in this year and next?

7. What EDP changes do you expect to make by 1980?

8. Is your EDP activity centralized, or decentralized?

9. What are your computer systems?

	MAINFRAME	OP. SYS.	DB LANG	ON-LINE SYST
NOW				
FUTURE				

10. a. How much is your internal EDP Budget, and how will that change in 1977, and by 1981 (if respondent declines to give dollars, ask for % of annual revenues).

	1976	1977	1981	REASONS FOR CHANGE
BUDGET ($ or %)				

b. How is that budget to be allocated among people, hardware, and other data center costs?

	1976	1977	1981	REASONS FOR CHANGE
PEOPLE (# or %)				
HARDWARE				
OTHER CENTER COSTS				

11. How much is being spent monthly (on the average) by your entire company for outside computer services?

Total $____________per month

or

________% of total EDP budget

12. How is that expenditure distributed, and how does this year compare with last year (1975), and your expectations for next year (1977)?

	1976	76/75	77/76	'76 $ BY APPLICATION
REMOTE COMPUTING				
Timesharing				
Remote Batch				
Data Base				
BATCH PROCESSING				
FACILITIES MGMT				
SOFTWARE PRODUCTS				
Systems				
Applications				
SOFTWARE SERVICES				
Consulting				
Programming				
EDUCATION				

13. Of those applications which are processed outside your company,

a. Which are considered primary, and which secondary?
b. What mode of processing is used?
c. What vendor is used?
d. Are you satisfied with the vendor's service?

FUNCTIONAL AREA	APPLICATION		MODE & VENDOR			SATIS-FIED?
	PRIMARY	SECONDARY	Batch	RB	Inter.	

14. Why do you use (RCS/FM/BATCH/, etc....whichever is appropriate)??

15. In order of priority, what will be the new applications you will develop, or require?

1.

2.

3.

4.

5.

16. Do you have the resources to do all these?

17. Which ones could be done outside (development or processing)?

18. What services might you consider using, if whatever you wanted were available?

19. What services would you like to have offered to you <u>now</u>?

20. Are there any applications which you would <u>not</u> consider doing outside? If so, which, and why not?

21. Have you considered/would you consider facilities management?

22. What is your opinion of doing EDP work in-house, versus using outside services?

23. What developments might increase/decrease your use of computer services?

24. When you do use an outside service, who usually chooses the vendor?

25. Please rank these characteristics in choosing a vendor (1 = unimportant; 5 = very important):

    a. Geographic location of vendor _______

    b. Vendor's technical expertise in your field _______

    c. Vendor's hardware/software (explain) _______

    d. Availability of a network, natl. or intl. _______

    e. Price _______

    f. Other______________________________ _______

26. Under what conditions might you change vendors?

27. All other things being equal, how much of a price reduction would you require to change vendors?

28. How do your vendors presently establish their billings to you (Transaction pricing? Fixed minimum plus monthly variable? CPU, connect, storage costs?)

29. How much support (sales, installation, conversion) did you require from your vendor(s) at the time of installation?

30. How much do you require now?

31. Do you have any technical requirements upon your vendors?

a. Computer hardware?

b. Software?

c. Network?

d. Languages used?

e. Terminals offered?

f. Communications speeds?

32. Have you considered, or will you consider using minicomputers instead of computer services?

33. Would you rate on a scale of 1 to 10 (1 = unsatisfactory, 5 = average, and 10 = outstanding), the computer services vendors you now use, <u>plus</u> any others with which you are familiar?

VENDOR	RATING	COMMENTS

34. Why did you choose the vendors you are now using?

35. Do you have any advice or suggestions you would like to offer to vendors of computer services?

Interviewer notes