COMPUTER SERVICES MARKETS
IN THE PETROLEUM INDUSTRY

INPUT

INDUSTRY REPORT

#1

COMPUTER SERVICES MARKETS IN THE PETROLEUM INDUSTRY

MAY 18, 1976

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INPUT

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LIST OF EXHIBITS

INTRODUCTION

- This report is produced by INPUT as part of the Market Analysis Program.

- It is based on interviews with:
  - Petroleum industry users of computer services.
  - Data processing managers in petroleum companies.
  - Suppliers of computer services to the petroleum industry.
  - Suppliers of other services to the petroleum industry.
  - Consultants, associations and other third parties.

- Research was carried out on-site in Houston, as well as by telephone.

- Prior to the research activity each client was asked to suggest particular areas of interest for the study.

- Considerable effort has been made to describe the industry and application characteristics so that this report may provide a base structure for planning the provision of computer services to the petroleum industry.

- Individual client inquiries about the report are welcomed.

I. MANAGEMENT SUMMARY

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INDUSTRY STRUCTURE

- Nineteen U.S. integrated oil companies, each with gross revenues exceeding $2 billion, are responsible for more than 75% of domestic crude oil production, U.S. refinery capacity, and gasoline sold. In 1974, EXXON Corporation accounted for over 25% of these revenues, reported earnings of $3.1 billion, and was first in the Fortune 500.

- In addition to the majors, there are over 10,000 independent petroleum companies in the United States.

- Oil remains the only price-controlled industry in the U.S. Prices are controlled at the well and at the gasoline pump.

- Price control aids the growth of EDP expenditures because of:
  - Extensive record keeping for government reporting
  - Higher demands on inventory management
  - Increased sophistication in locating and extracting oil as a result of fixed selling prices.

EDP AND COMPUTER SERVICES EXPENDITURES

- Total EDP expenditures by oil companies in 1976 will amount to $1.8 billion, increasing to $2.9 billion in 1981, assuming,
  - No divestiture legislation requiring the break-up of major oil companies.

- Continuation of price controls
- A U.S. economic slowdown in 1978.

- Computer services expenditures by oil companies in 1976 will amount to $96 million, and will grow at an average annual growth rate (AAGR) of 15%, to a level of $194 million in 1981.

- Remote computing, the largest and fastest growing segment, will increase from $61 million in 1976 to $141 million in 1981, an AAGR of 18%.
  - The interactive component will grow at 22%, from $24 million to $64 million.
  - The remote batch component will grow at 15%, from $34 million to $68 million.

- In both cases, driving forces for growth will be increased use of special applications, both business and scientific, in all phases of the petroleum industry; these applications will include remote batch and interactive components.

- Revenues to the remote computing vendors related to the petroleum industry will be considerably larger than indicated above because of expenditures on behalf of the oil industry by software products, engineering, construction, and chemical firms.

- Software products, the second largest and second fastest growing segment, will increase from $15 million in 1976 to $26 million in 1981, an AAGR of 12%. This growth will primarily stem from applications products which will double in market size from $6 million in 1976 to $13 million in 1981.

- Software products vendors are large users of remote computing services. They buy time "wholesale" and "retail" it to their product customers; such user expenditures are counted as remote computing services expenditures.

- Batch processing, in this industry as in most others, will be the weakest performer growing at an AAGR of 5%, from $14 million in 1976 to $18 million in 1980. Significant large batch projects will be converted to remote computing, primarily in the scientific area.

SPECIALTY APPLICATIONS INCREASE MARKET SHARE AT THE EXPENSE OF UTILITY PROCESSING

- Specialty Applications, which are now represented in this industry largely by seismic data reduction, will increase their share slightly from 34% to 40% as exploration and development become more important and more complex.

- Business oriented applications account for 42% of processing services expenditures in 1976, and will slightly increase their share by 1981, primarily through increases in General Business and Specialty Applications on interactive systems, more than compensating for losses of 'Utility' processing to in-house systems.

- Scientific applications, currently 21% of expenditures, will maintain their proportion of the market, growing in response to technological pressures for relatively cheaper energy.

REASONS FOR USE OF COMPUTER SERVICES

- The major reasons that oil companies use computer services are:

- Turnaround time
- Specialization
- Convenient access

- Turnaround time is a particular problem in oil companies because of the erratic loading schedules (they may vary widely as projects start and stop), and because of the long time it takes to run some of the problems (a reservoir modeling problem may take as much as 24 hours to run).

- Specialization has to do with the intensive level of scientific knowledge required, and the constant change and improvement of expensive software. This is generally unreasonable for one oil company to undertake, when standard products are available from commercial remote computing and software vendors.

- Convenient access to remote oil operational sites, which may be temporary in nature, is often simpler and less expensive for a services company to achieve due to its network and communications capacity.

VENDOR SPECIALIZATION IS MANDATORY

- Vendors wishing to make major penetration in the oil industry require high technological skills and/or support from a high technology company.

- When significant scientific calculation is required, users will turn to Control Data Corporation (CDC), or to a services company with CDC equipment.

- When communications and network capabilities are required nationally or internationally, particularly for frequent input/output of data, General Electric Information Systems (GEIS) is first choice.

- While there is not much brand loyalty evident, users are not likely to change vendors unless they are grossly dissatisfied, or a competitor comes out with a new or greatly improved product. The user is likely then to use both vendors. Some oil companies use more than eight vendors concurrently.

- Users are satisfied with current vendor performance.

COMPETITION IS MAINLY IN-HOUSE

- The main competition to services is the in-house data processing resource, which is very large for most oil companies. Oil firms plan on taking more of their outside work in-house over the years. The most vulnerable applications are business and accounting. The least vulnerable are seismic and other Specialty Applications.

- Some oil companies do market their products and/or EDP capability to others in the industry (e.g., Sun Oil's new Information Services Division).

- Minicomputers are not a threat to services in this industry. They simply cannot handle the scope of most of the problems. They will, however, grow in process control applications, and for some small, special purpose, dedicated applications such as message switching and data code conversion.

RECOMMENDED STRATEGIES FOR VENDORS

- Remote computing services vendors should not make any significant investment in products and services in established applications areas unless they:

- Choose to enter into highly competitive markets
- Are prepared to acquire highly skilled staff
- Choose to enter into arenas with well entrenched competitors.

- While there is little avowed vendor loyalty, users will not change vendors unless dissatisfied - and there is very little evidence of dissatisfaction. In order to displace an entrenched vendor who is already forced to meet competitive pricing, a new contender would have to provide a better product at a cost reduction for replacement of up to 25% -- depending on the expenditure level, complexity of the coding, and conversion requirements.

- Sales can be increased by adding new products which are developed by others; support, maintenance, and upgrades may be supplied by either party. Financial, oil and gas accounting, engineering and construction program packages have been developed at great expense by oil companies, consultants, and software houses, and should be offered in "piggy back" mode until their value is proven.

- An exclusive license is a double edged sword. If the package is the best of its kind, and is supported, there is a marketing advantage. If the package becomes obsolete because of changes in regulations or technology, and the software developer does not support the necessary changes and improvements, the exclusive works against the vendor.

- It appears unlikely that a standardized accounting package is worthwhile developing. Offering a user the necessary tools and software support to permit it to develop and/or modify its own package will be more successful.

- Mergers and joint ventures are the chief method for rapidly establishing a sound position in the industry. The cooperative venture of CDC and Core Labs is an excellent example. There are many small, specialized companies servicing the petroleum industry whose expertise may be shared.

- There is generally no centralized user contact to which to sell computer services. The various departments, as well as the various levels of management, tend to be unaware, and in many cases unconcerned about, the computer services purchases of others. Thus, it is necessary to ferret out potential users of products and services both horizontally and vertically throughout any given oil company organizational unit. A $1,000 per month expenditure is invisible in most oil company departmental budgets.

- Computer services offered to petroleum companies are fragmented. Specialized services will always be in demand by these companies and so consolidation of services into an industry "package" is recommended for major computer services vendors. More appropriately, a set of "packages" one for each of the major segments of the industry, should be established. This will additionally prepare the vendor for any forced break-up of the oil companies.

II. INDUSTRY STRUCTURE OF U.S. FIRMS

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INTRODUCTION

The petroleum industry begins with the search for oil, and ends with the sale of petroleum components and products all the way to the consumer's automobile gas tank. It is nominally broken down into five major activities:

- Exploration
- Production
- Transportation (of crude oil and of products)
- Refining
- Marketing

Oil companies are also active in other industries, including coal and chemicals, which are not specifically addressed in this report.

Many firms in other major industry sectors, such as construction, engineering, measurement and control, and data processing derive substantial revenues from the oil industry, and they are included in this discussion. Computer services expenditures by petroleum companies to these organizations are included when specifically contracted for: when these expenditures are part of a total construction, engineering, or exploration project and not specifically identified, then the computer component is not counted here as a computer service expenditure but is included as an

EDP or computer service expenditure in that industry to which the contractor belongs.

Exhibit II-1 is a graphic representation of the petroleum industry and its satellite industry contributors. Exhibit II-2 details the definitions of the Standard Industrial Classification (SIC) codes (1972 revision) which apply. Computer services expenditures by companies included in the 'Basic Petroleum Industry' category are covered by this report.

At every step in the process, integrated oil companies compete with independents for a share of this gigantic industry.

INTEGRATED PETROLEUM COMPANIES

Vertically integrated oil companies are active in all phases of the petroleum industry, from exploration to gas station delivery. In addition, many are active in related industries, such as coal and chemicals.

In 1974, there were 19 integrated U.S. oil companies with gross revenues over $2 billion. The largest of these, Exxon Corporation, was first in the Fortune 500, with gross sales of $42 billion, and net income of $3.1 billion. Standard Oil Company of Ohio, the smallest of these 19, with revenues of $2.2 billion, was number 86 in the Fortune 500.

These 19 companies are responsible for more than 75% of domestic crude oil production, U.S. refinery capacity, and gasoline sold.

Table II-3 shows the ranking of these 19 integrated oil companies in various aspects of industry activity.

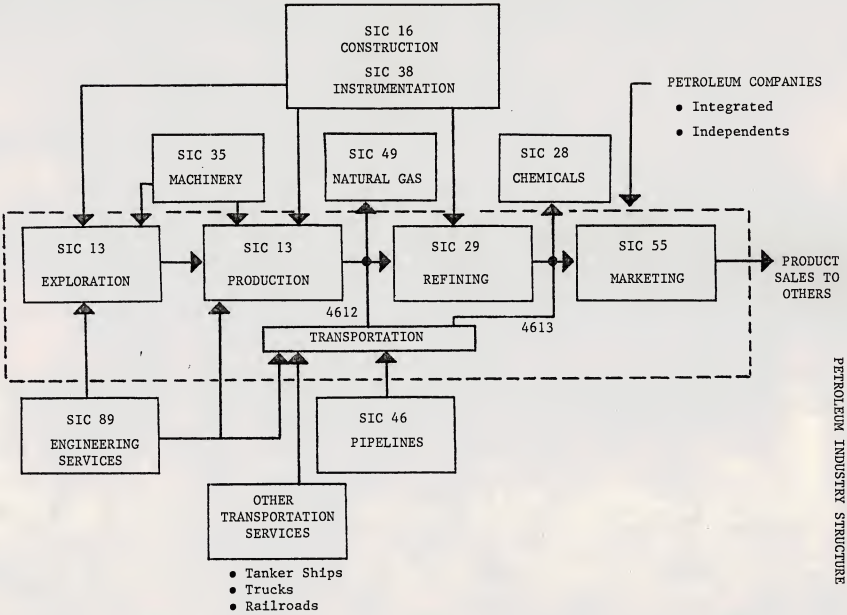


EXHIBIT II-1

PETROLEUM INDUSTRY STRUCTURE

EXHIBIT II-2

SIC CODES

BASIC PETROLEUM INDUSTRY

Major Group	Group No.	Industry No.	Description	Number of Establishments
13			OIL AND GAS EXTRACTION	
	131		CRUDE PETROLEUM & NATURAL GAS	
		1311	Crude Petroleum and Natural Gas - Exploration for crude petroleum and natural gas - Drilling, completing, and equipping wells - All other activities in the preparation of oil and gas up to the point of shipment from the producing property	7,298
	138		OIL AND GAS FIELD SERVICES	
		1381	Drilling Oil and Gas Wells - Drilling wells for oil or gas field operations for others, on a contract or fee basis	3,194
		1382	Oil and Gas Field Exploration Services - Performing geophysical, geological, and other exploration services for oil and gas on a contract or fee basis	1,401
		1389	Other Oil and Gas Field Services	5,051
29			PETROLEUM REFINING AND RELATED INDUSTRIES	
	291		PETROLEUM REFINING	
		2911	Petroleum Refining - Production of Gasoline, kerosene, distillate fuel oils and other products from crude oil, redistillation of unfinished petroleum derivatives, cracking or other processes.	934

BASIC PETROLEUM INDUSTRY (Continued)

Major Group	Group No.	Industry No.	Description	Number of Establishments
(46)*	(461)	4612	Crude Petroleum Pipe Lines - Pipeline transportation of crude petroleum. (Field gathering lines are classified in Major Group 13)	280
		4613	Refined Petroleum Pipe Lines - Pipeline transportation of refined products of petroleum, such as gasoline and fuel oil.	187
55	554	5541	Gasoline Service Stations	226,459

PETROLEUM SATELLITE INDUSTRIES

Major Group	Group No.	Industry No.	Description	Number of Establishments
16			CONSTRUCTION OTHER THAN BUILDING CONSTRUCTION	
	162		HEAVY CONSTRUCTION, EXCEPT HIGHWAY AND STREET	
		1623	Water, Sewer, Pipeline, Communication and Power Line Construction - Distribution Lines (oil and gas field) - Pipe laying - Pipeline construction - Pumping station construction	7,853
		1629	Heavy Construction, Not Elsewhere Classified - Petroleum refinery construction	6,562

*Some major group 46 are listed in Satellite Industries

PETROLEUM SATELLITE INDUSTRIES (Continued)

Major Group	Group No.	Industry No.	Description	Number of Establishments
35	353		CONSTRUCTION MACHINERY & EQUIPMENT	
		3533	Oil Field Machinery & Equipment - Manufacture of Machinery and equipment for use in oil and gas fields, or for drilling water wells (included are oil field tools, derricks, drill rigs, and field and well machinery).	723
	355	3559	Special Industry Machinery - Not Elsewhere Classified - Petroleum refinery machinery	2,463
38	381	3811	ENGINEERING, LABORATORY, SCIENTIFIC & RESEARCH INSTRUMENTS & ASSOCIATED EQUIPMENT - Manufacture of such items as petroleum product analyzing apparatus, seismographs, seismometers, laboratory standards and calibrating equipment	1,456
	382	3823	MEASURING AND CONTROLLING INSTRUMENTS - Manufacture of industrial instruments and related products for measuring, displaying, transmitting, and controlling process variables in manufacturing, energy conversion, and public service utilities.	562
46	461		PIPELINES, EXCEPT NATURAL GAS	

PETROLEUM SATELLITE INDUSTRIES (Continued)

Major Group	Group No.	Industry No.	Description	Number of Establishments
49	492		GAS PRODUCTION AND DISTRIBUTION	
		4922	Transmission and/or storage of natural gas for sale	416
		4923	Both transmission and distribution of natural gas for sale.	422
		4924	Distribution of natural gas for sale	882
89	891	8911	ENGINEERING, ARCHITECTURAL, AND SURVEYING SERVICES - Petroleum engineering	19,053

EXHIBIT II-3

ANNUAL RANKING OF INTEGRATED OIL COMPANIES

OIL COMPANY	SALES	WELLS DRILLED	PRODUCTION OF CRUDE OIL	REFINED PRODUCT SALES	SHARE OF U.S. 1974 GASOLINE MARKET (Rank-%)
AMERADA HESS	14				
ASHLAND OIL	15				
ATLANTIC RICHFIELD	9	9	8	8	8-4.0%
CITIES SERVICE OIL CO.	17				
CONTINENTAL	8	8	9		
EXXON	1	3	3	2	3-7.4%
GETTY OIL CORP.	18	6	10		
GULF OIL CORP.	5	5	5	6	5-6.6%
MARATHON OIL CO.	16				
MOBIL OIL CORP.	3	4	6	4	6-6.5%
PHILLIPS PETROLEUM CO.	10			10	9-3.8%
SHELL OIL COMPANY	7	7	1*	1*	2-7.4%
STANDARD OIL CO. OF CALIFORNIA	4		4	5	7-4.9%
STANDARD OIL CO. (INDIANA)	6	2	7	7	
STANDARD OIL CO. (OHIO)	19				
SUN OIL COMPANY	13			9	10-3.7%
TENNECO CORP.	11				
TEXACO INC.	2	1	2	3	1-8.1%
UNION OIL OF CALIFORNIA	12	10			
AMOCO (Division of Standard Oil - Indiana)					4-7.0%

* ROYAL DUTCH/ SHELL GROUP

INDEPENDENT PETROLEUM COMPANIES

There are about 10,000 independent petroleum companies in the U.S. Since 1969, the independent segment has drilled about 9 out of every 10 new field wildcat (initial exploration) wells in the U.S., with a success rate of about 2%, accounting for 75% of the new field wildcat discoveries. They discovered about half of the oil and gas reserves in the U.S. during the past five years. Most of the majors, conversely, exploring in higher-risk, higher-cost environments of off-shore, Arctic, and ultra-deep inland drilling, have found larger reservoirs, contributing their half of the supply with only 25% of the wildcat successes.

Independents are also active in other segments of the industry. Twenty independents have built refineries since 1950, and 30% of all gasoline is marketed by independents. Thus, both segments of the industry are very important to the economy, and to the consumer.

INDUSTRIES SUPPLYING GOODS AND SERVICES TO THE PETROLEUM INDUSTRY

Goods and services provided by firms other than petroleum companies include construction services, engineering services, transportation services, instrumentation and machinery (including tools). Oil companies will, in addition to contracting for the above services, have varying degrees of in-house capability. The large integrated firms will have their own engineers, physicists, geophysicists, architects, construction crews, pipelines, tankers, etc. They do not manufacture their own tools, machinery, or basic instruments, although they may design and build their own instrumentation systems with commercially available measuring, controlling, and data processing and communication equipment.

Firms supplying goods and services to the petroleum industry may also

be integrated vertically as well as horizontally, and diversified into many industries. For example, the Halliburton Company is the world's largest and most diversified oil and gas service and construction company. One of its subsidiaries, Brown and Root has annual revenues in excess of $5 billion, and is the largest U.S. contractor. Brown and Root has an Engineering Division which is involved in architecture, instrumentation, marine industries and pipelines, mechanical engineering, and petroleum and chemical engineering, to name of few fields. Their Industrial Facilities Construction Division is active in power plants, petroleum, chemical and paper mill facilities construction. Their Marine Division has pipeline, marine and oil field projects around the world. In addition to numerous subsidiaries in construction and engineering, Brown and Root has a 100 employee Data Processing Department with RJE sites around the world, offering the full range of financial, engineering and scheduling services inside the company and to outside clients.

INDUSTRIES BEING SUPPLIED BY PETROLEUM COMPANIES

Industries which are directly dependent upon petroleum companies for their raw materials include natural gas and chemical industries. Numerous other industries - perhaps all - are secondarily dependent on the petroleum industry as a consequence of their need for organic chemicals produced by the chemical industry from petroleum products.

Natural gas is always found where oil is found. If the oil production company does not sell or process natural gas, the gas may be sold off directly at the well-head, and pipelined to a natural gas company client, and further processed to gas utilities, bottled gas manufacturers, etc.

The chemical industry is comprised of independents and large oil companies. About $11 billion, representing 7% of oil company fixed assets are in their chemical operations.

Independents are varyingly dependent upon the oil industry, as a function of their product line. Ethyl Corporation, for example, widely known for its no-knock additive to gasoline, has a widely diversified, non-organic product line, and only buys one chemical output of petroleum - ethylene. Other of their products are based on chlorine and salt, which are not petroleum related.

GEOGRAPHIC DISTRIBUTION

Exploration and Drilling

Within the U.S., nearly 39,000 wells were drilled in 1975 by 1,811 rotary drill rigs. Estimates for 1976 are about the same. Thirteen states recorded over 1,000 wells drilled, with only 5 having over 2,000 as shown in Exhibit II-4.

Although still quite low in number of wells drilled, Alaska is a prime hope for new oil. There were 69 wells drilled in Alaska in 1975, with 138 due in 1976 (38 wildcats, and 100 field wells).

Production of Crude Oil

There are 5 production districts in the U.S., producing a total of 8.3 million barrels per day. Of that amount, 5.6 million (67.5%) is produced in District 3, and 1.1 million (13.3%) is produced in District 5.

District 3 includes Alabama, Arkansas, Louisana, Missippi, New Mexico, and Texas. District 5 includes Alaska, Arizona, California, and Nevada.

EXHIBIT II-4

LEADING STATES IN DRILLING AND PRODUCTION IN 1975

(For States drilling at least 2000 wells)

State	Number of Wells Drilled	Production (Millions of Barrels/Day)
TEXAS	12,306	3.3
OKLAHOMA	3,843	-
KANSAS	3,467	-
LOUISIANA	3,099	1.8
CALIFORNIA	2,416	0.9

The largest supplying states are also shown in Exhibit II-4.

Refining

There are 256 refineries operating in the U.S., with a processing capacity of 15 million barrels of crude oil per day. With U.S. crude production of 8.3 million barrels per day (see above), the use of imported crude oil is highlighted.

Only 7 states have more than 10 refineries, comprising 57% of all U.S. refineries, as shown in Exhibit II-5. All states have at least one.

Marketing, Distribution, Retailing

Oil companies will spend most of their marketing capital budget (53%, or about $460 million) on gas station upgrading. There are over 200,000 gas service stations in the U.S., whose 1974 sales of $40 billion is rougly equal to sales of eating and drinking places, one third that of the entire U.S. food group, and 4% of total personal consumption expenditures.

Except for Texaco, individual oil companies do not market in all 50 states. Amoco and Mobil market in 49. Consumption of gasoline in the U.S. in 1974 was 110 billion gallons, up less than 4% from 1973. In order of rank, the 5 largest consumers of gasoline were California, Texas New York, Ohio and Illinois. The total number of gasoline service stations per state ranks exactly the same way.

Retail market shares are divided among the five leading oil companies (all integrated), as shown in Exhibit II-6.

EXHIBIT II-5

LOCATION OF OPERATING REFINERIES IN THE U.S. (1976)

State	Number of Refineries Operating
Texas	46
California	35
Louisiana	19
Oklahoma	12
Illinois	11
Kansas	11
Pennsylvania	11
Sub-Total	145
Other States	111
TOTAL	256

EXHIBIT II-6

RETAIL MARKET SHARES OF LEADING OIL COMPANIES

Company	% of National Market
TEXACO	8.1
SHELL	7.4
EXXON	7.4
AMOCO	7.0
GULF	6.6

Administration

Overall, Houston, known as "the oiliest city in the U.S." has the highest concentration of oil company offices in the U.S. A large number of computer services firms dedicated to the oil industry, and special district offices of national services firms abound. The Houston Yellow Pages list nearly 200 Data Processing Services Companies, to service this high density industry concentration. All of the major services companies are represented.

GROWTH CHARACTERISTICS

1975 Sales Up 10%

One major characteristic of the oil industry is its size, with 12 out of the top 25 Fortune 500 Industrials in 1974 being oil companies. Oil company revenues in 1975 increased by 10% over 1974, to a total exceeding $250 billion, which was an 83% increase over 1973. The huge '74-'73 increase results from the international oil shortage and consequent price increases. Sales of crude oil and refined products account for more than 85% of the operating revenue of the larger oil companies. Growth in 1976 should continue at the same 10% rate, although there are signs of excess oil build-ups in the OPEC nations, which could cause price reductions as buyer bargaining power improves.

1975 Earnings Slump

The net income picture is not as bright. In 1975, only 1 oil firm, Exxon, had earnings exceeding $1 billion (actual earnings of $2.5 billion, down 18% from 1974). In the prior year, four oil firms, Exxon, Texaco,

Gulf, and Mobil earned over $1 billion each. Contributing to lower earnings was a 10% decline in product sales volume resulting from lower industrial activity, increased conservation by consumers, and continued highly competitive market conditions. Texaco, sustained the greatest loss, amounting to -46% in earnings. The prospects for 1976 look better than last year, as evidenced by fourth quarter 1975 earnings reported better than prior quarters of the year.

Oil Fixed Assets Exceed $160 Billion

In 1974, total fixed assets owned by the oil industry amounted to $161 billion, as shown in Exhibit II-7. Each of the segments is in itself large enough to be a separate industry. Indeed, of great concern to the industry today is the potential for the passage of divestiture legislation.

IMPACT OF LEGISLATION

For the first time since the 1911 breakup of Standard Oil, there may be enough momentum of political backlash against the oil companies to permit divestiture legislation to be passed in Washington. With 1976 being an election year, and some uncertainty about the wisdom of such a move, the legislation may or may not be carried forward. A recent proposal (October, 1975) would limit any major firm to only one phase of the total business, i.e., production, transportation, refining, or marketing -- vertical integration being no longer legal. The impact of such legislation is sheer speculation, yet, of great concern to the industry.

Sun Oil, has recently undergone a major restructuring including setting up a separate marketing company, and a computer services company. Sun

EXHIBIT II-7

FIXED ASSET DISTRIBUTIONS

Segment	$Billion	%
Exploration & Production	71	44
Refining	32	20
Marketing	26	16
Transportation	16	10
Chemicals and Other	16	10
TOTAL	161	100

management vehemently denies any correlation between their reorganization and the threat of divestiture legislation.

Similarly, Gulf Oil has combined its U.S. and foreign organizations, and restructured the combination into three companies, Gulf Energy and Minerals Company, Gulf Trading and Transport Company, and Gulf Refining and Marketing Company, with assets of $4.5, $1.7, and $3.0 billion respectively.

On the other hand, some fairly large firms, such as Louisiana Land and Superior Oil are pure production companies, and thus not threatened by divestiture legislation.

Additionally, oil is the only remaining price controlled U.S. industry, which significantly impacts capital investment. While total investment in petroleum is expected to increase 11% over 1975, allocation of funds for exploration and discovery of new oil is being hampered by the cost equation. Oil companies claim that there is not enough return at current crude prices to take as much risk in exploration and recovery. On the other hand, the tight economics and the immense reporting requirements are causing increased use of data processing.

III. USE OF EDP

III USE OF EDP

INTRODUCTION

The size, geographic distribution, and diversity of activities within the industry make it a fertile field for all kinds and all variations of EDP processing and compute power distribution. There is not a common organizational structure -- or even a typical one. Usually there is less centralized budget control with increasing size and diversity, as well as less centralized information regarding actual EDP expenditures. A geophysicist in an exploration department of a giant oil company can get a terminal in his office for $1000 per month without that expense showing up beside the decimal point in the expense budget. This is an industry where $1 billion is relatively small.

DATA CENTER ORGANIZATION VARIES

Nevertheless, there are organizations, policies, and guidelines for the use of EDP -- particularly services. And each major oil company has one or more elaborate data centers to handle its own needs. As in other industries, penetration of in-house computers and services is a function of size. Small companies still do a great deal manually, and are targets for services and entry level

business computer systems; firms spending up to $10,000 per month are most dependent upon computer services; and firms spending over $10,000 per month usually have their own in-house installations. These larger firms also use outside services for long scientific problems, fast turn-around situations, and for access to some of the geographically more remote areas of the industry's business, where access is a problem. They will acquire software packages for sophisticated or complex problem solving, where the payoff for in-house development does not exist.

Exhibit III-1 gives descriptive information about some of the oil company data centers.

PROCESS CONTROL IS ALSO A MAJOR EDP APPLICATION

In addition to data center type of EDP, process control is a major computer application. On a world wide basis in 1975, 375 digital-control computer projects were initiated in the petroleum and petro-chemical industries, bringing the total to 2454, as shown in Exhibit III-2. 1975 showed the second highest gain installations since 1958, with the highest year having been 1974. These installations are generally not available for computer services vendors because of the high performance risk and great security problems associated with the projects. A partial list of users, vendors, and applications for digital computer control as applied to U.S. petroleum activity is shown in Exhibit III-3. It is in this area that minicomputers and microcomputers will find increasing use, in dedicated applications. Distributed processing with hierarchical supervisory control is

EXHIBIT III-1

SELECTED OIL COMPANY DATA CENTERS

Company	Data Center Characteristics
EXXON (USA)	Company revenues $42 billion - 10 data centers using IBM and Univac equipment. Univac is used for credit card processing.
SUN OIL CO.	Company revenues $4 billion - Recent reorganization formed Information Services Division of Suntech, Inc. Central computing facility in Dallas has 2 IBM 370/168s. Corporate computing is done via terminals and lines into the one center.
ASHLAND OIL	Company revenues $4 billion - One regional center in Houston (370/115) tied to corporate data center in Ashland, Kentucky, which has 1 IBM 370/158, and 1 IBM 370/168.
AMOCO	(Production Subsidiary of Standard Oil of Indiana)-Two data centers, one with 3 IBM 370/168s, the other with 4 IBM 370/168's, with terminals extended to all Amoco offices.
AMERICAN PETROLEUM	Company revenues - $950 million - One data center, with IBM 370/155.
MK OIL & GAS	Company revenues $360 million - no computer.

EXHIBIT III-3

DIGITAL COMPUTER CONTROL APPLICATIONS IN PETROLEUM

Company/Location	Application	Type	Start-Up Year
PRODUCTION			
AMOCO PRODUCTION CO. (Levelland, TX)	Supervisory	Interdata 70 IBM 1800	1973 1968
ATLANTIC RICHFIELD (Recluse, WY)	Production Monitoring & Control	NOVA 1200	1971
CHEVRON OIL CO. - CALCO (Gulf Coast, Offshore)	Drilling data acquisition	HP-2100 A	1972
CONTINENTAL OIL CO. (Casper, WY)	Production operations	CDC 636	1965
MARATHON OIL CO. (Iran, TX)	Oil Well Control	TI 960-A	1974
STANDARD OIL OF CALIFORNIA (Carpenteria, CA)	Field Operations	2 PDP 11/05	1973
PIPELINING			
AMOCO PIPELINE CO. (Casper, WY)	Supervisory Control	2 Xerox 530s	1977
COLUMBIA GULF TRANSMISSION CO. (Houston, TX)	Gas Dispatching	GE PAC 4010	1971
GETTY OIL (Coalinga, CA)	Pipeline Control	Varian 6202	1968
REFINING			
AMOCO OIL CO. (Texas City, TX)	Ultraforming (DDC)	Foxboro PCP-88	1971
ATLANTIC RICHFIELD (Houston, TX)	Process chromatographs	PDP-8	-
MOBIL OIL CORP. (Beaumont, TX)	Chromotograph	EAI 640	1971
SHELL OIL CO. (Deer Park, TX)	Gasoline Blending	Foxboro Fox 2/30	1975
STANDARD OIL OF OHIO (Linja, OH)	Process Monitoring	IBM 1800 IBM 1130	1969 1969

EXHIBIT III-2

DIGITAL CONTROL COMPUTER USAGE WORLDWIDE

Industry Segment	Number of Projects Added in 1975	Total Number of Projects (cumulative)	U.S.	Foreign
PETROCHEMICAL	211	1,240	897	343
PETROLEUM PRODUCTION	2	218	N/A	N/A
PIPELINE	122	475	N/A	N/A
PETROLEUM REFINING	40	521	260	261
TOTAL	375	2,454	1,157	604

well accepted in process control.

The oil industry has demonstrated its need and willingness to acquire total control systems. One major vendor, Fisher Control Company, is developing standardized control packages, combining analog and digital hardware with pre-written software modules that can be customized and combined easily.

In addition, micro-computers are ideal for use as code converters, to standardize the output of analytical and process instruments.

EXPENDITURES ON EDP

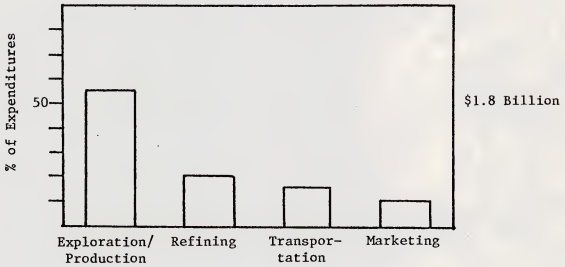
1976 expenditures for EDP by oil companies will amount to $1.8 billion, increasing to $2.9 billion by 1981, assuming no divestiture legislation, and continuation of federal price controls on sales of crude oil and some refined products. Divestiture legislation would lead to a chaotic redistribution of computing resources, increases in computer and communications hardware and software for distributed, decentralized processing, and greater opportunities for computer services' participation in what is now captive in-house EDP activity. In as much as 87% of oil company revenues come from the sales of crude oil and refined products, lifting of price controls would provide the increased profits which would stimulate greater exploration and production expenditures. The increased activity and revenue would reflect in greater expenditure for EDP. During the 1973-74 period, when the industry's revenues achieved an all time high growth of 83%, internal EDP staffs received salary increases considerably higher than normal.

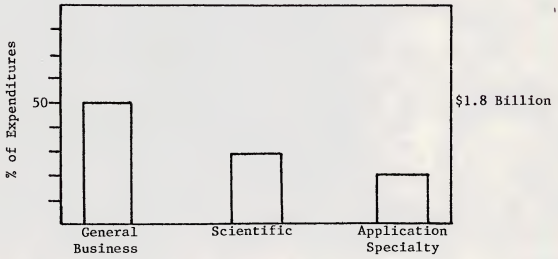
On the other hand, continuation of the financial and crude oil resource pressures, along with severe accounting and reporting requirements imposed by state and federal agencies, is causing increases in data processing for record keeping and inventory management and control.

As shown in Exhibit III-4, these expenditures are mostly (55%) for exploration and production functions. From the applications point of view, 50% overall is for general business, while 30% is for scientific computation, and 20% is for applications specialties unique to this industry -- in this case, mostly seismic data reduction.

EXHIBIT III-4

DISTRIBUTION OF TOTAL EDP EXPENDITURES IN 1976
BY FUNCTIONAL AREA AND APPLICATION





IV. APPLICATIONS ANALYSES

IV APPLICATIONS ANALYSES

FUNCTIONAL DESCRIPTION OF THE INDUSTRY

The industry has 5 major segments, each of which has special problems which lend themselves to EDP solutions. These 5 major segments are described below:

- Exploration includes all activities involved in the location of probable oil sites, and the drilling of the wildcat wells. In 1975, 76.7% of the wildcat wells drilled were dry. This operation has a very high risk of failure and financial loss, hence a considerable amount of EDP activity is associated with it, in the form of seismic data reduction; reservoir modeling, and production forecasting. Exploration may be done on land, or off shore. The cost of a single wildcat may range from $100,000 to about $3 million. Amoco, the production subsidiary of Standard Oil of Indiana, is the nation's number one wildcatter. Most Amoco wells are actually drilled under contract to outside firms.

- Production. After the first producing well is completed, a production company may take over the well; it will begin to develop the field, get the oil out of the ground and up to the well head,

and drill development wells into the new found reservoir. Costs and risks are less, with developmental wells ranging around $1 million. Working around the clock, seven days a week, crews may drill a well in a few days, or may take as long as a year, depending on the location and depth of the well.

- Refining is that segment of the industry which converts crude oil into other petrochemicals for intermediate or final use. This element of the process feeds the large worldwide petrochemical industry, as well as producing consumer end products such as gasoline. The economic decisions about what products to make, and the planning and control of the refinery to produce those products are the major EDP applications in the refinery.

- Transportation actually occurs in two phases of the operations; first, the crude oil and/or natural gas are moved by pipeline from the field. It may continue by pipeline to a refinery, natural gas customer, or other destination for further processing or for transportation by tanker. The second phase of transportation activity is for refined products, transported by pipeline, truck, tanker, or other means, to chemical processing plants, wholesalers, or retailers such as gasoline service stations. Some portion of transportation costs in this phase may be included under Marketing.

- Marketing. Aside from the administrative and financial record keeping related to the sale of crude and refined product, a major EDP expenditure relates to credit card purchases. Credit verification is mostly an outside activity, while credit card purchases processing

may be done either in-house or outside company. Costs related to the design of product pipeline to transport the products to the customers will often come out of marketing budgets.

APPLICATIONS DESCRIPTION BY INDUSTRY FUNCTION

Within each of the five major industry functions, there are specific EDP applications. Many are restricted to in-company data processing, because of the security imposed, or the performance risk involved, as with process control. Others are available as portions of sub-contract work (as with seismic data reduction, pipeline design and construction, off-shore platform design and construction, etc.), or to outside services companies. This section will describe the applications areas, and the next chapter will detail the role of computer services.

EXPLORATION AND PRODUCTION

- Seismic Data Reduction is the primary concern of petroleum geologists in order to obtain more reliable information on likely accumulations of oil and gas. The technologies used involve measurement of gravity and magnetism, and the propagation and recording of elastic and electromagnetic waves in the earth. The geophysicist's best-known tool is the seismograph, which provides the only direct way of acquiring subsurface structual information without drilling wells. Dynamite and mechanical sources of wave energy create seismic waves in the earth. Geophones are strung in long lines connected by cables over the survey area, each one sensitive enough to detect a person walking a quarter of

a mile away. Each geophone produces its own magnetic tape and visual trace. The tapes are played back, enhanced, interpreted and displayed by digital computer techniques.

- Reservoir Simulation and Forecasting is the EDP tool to support the main object of petroleum production today - to recover as much oil and gas as possible from the reservoir within the cost limitations imposed by the price of crude oil. By using known history of the field, models are generated to forecast future potential output. Through the application of various conservation and recovery techniques, producers usually can recover 35 to 60 percent of the underground oil - and in some cases, as high as 80 or 90 percent.

- Offshore Construction involves the usual structural design automation plus those special problems of the platform being in the water, e.g., wave motion loading and stress analysis.

- Drilling is optimized by computer. At Amoco, computer-analyzed data taken from nearby wells already drilled is used by the computer to compare to data on the new well. The computer prescribes the drilling variables, such as weight on the bit, rotary speed, rate of cooling mud circulation, type of drill bit, etc. For a 20,000 ft. well, the drilling apparatus is over 3 1/2 miles long!

- Oil field automation enables computers to produce, measure, sell, and carry off oil and gas by pipeline for processing or refining without their ever being seen. 65% of Amoco's production is thus automated.

- Oil well logging, sometimes called electric logging, provides

recorded measurements of various formation characteristics needed to determine the optimum procedure for completing the well. This would include water injection or gas injection procedures for secondary recovery of oil from formations which became depleted to the point of being uneconomical for processing by primary - or natural - recovery methods.

- Land leases are negotiated for the right to drill and produce hydrocarbons on a landowner's property. He continues to use the surface for his own purposes, and receives an immediate bonus payment, plus an annual rental fee. Should the property ever produce oil or gas, the landowner receives a royalty of 12.5% of the value of the oil and/or gas produced on his lease. This royalty payment must be made very promptly every month. In cases where a lease is owned by many individuals, it is not uncommon to make payments on 1/22 of an acre every month.

- Oil pricing is done at the <u>end</u> of each month. According to FEA (Federal Energy Administration), the price of oil shipped from the well head cannot be determined until the monthly output of each well is compared to its output during the same month in 1972. Each of four classifications, old oil, new oil, freed oil, and stripped is separately determined from pipeline run tickets and check stubs from outside purchasers. The volume is accumulated through the month, and the total price is determined at the end of the month.

TRANSPORTATION

Responsibility for the oil and gas passes from production to transportation departments (or divisons, or companies) at the entry to the pipeline. At this point, oil/gas may be sold to others, or routed into the pipeline. Pipelines are shared. If a Mobil oil field is near an Exxon refinery and vice versa, they swap crude. Ten major oil firms share the Texas to New England Colonial Pipeline. Thus, a petroleum product buyer may have no idea whose product he is buying when it comes out of the pipe at the terminal. In the case of an independent pipeline company, such as Williams Pipe Line (Tulsa, OK), oil, gas, fertilizer and other products are taken-in from various companies, and transported to their destination. Williams does volume accounting at its own data center, and bills all parties accordingly, using their own software product Petroex.

- Thus, a primary EDP activity in the transportation phase is keeping track of the quantity of input and output of each product by buyer and seller, and debiting and crediting each party accordingly.

- Tankers are also used to transport petroleum product, and they are loaded at pipeline terminals. EDP is used in loading of the tankers to insure proper weight and stress distributions in the vessel. Bath Iron Works Corporation predicts how the distribution of cargo tonnage will affect a cargo vessels's performance. Via CRT terminal connected to a Raytheon Loadmax 200, they simulate and print out the tonnages in more than 200 cargo spaces and fuel or ballast tanks, and the resulting physical stresses.

- Supervisory control and data acquisition of pipeline operations (pumps, valves, etc.) are computer controlled. Capline, the nation's largest crude oil pipeline is controlled by two Xerox 530 computers. Explorer Pipeline, built by 8 participating oil companies, is controlled by a Xerox Sigma 3, using a Supervisory Control and Data Acquisition System (SCADA) designed by F & M Systems of Dallas, TX.

REFINING

Crude oil is delivered to the 256 U.S. refineries for conversion into petroleum products. Extensive use is made of process control electronics - instruments, data loggers, and computers, which sample and control the quality, quantity, and variety of products produced.

- Linear programming techniques are used to simulate and optimize refinery performance and production in accordance with demand and pricing restrictions, to minimize energy consumption, and to control waste and pollution. The refinery must respond to a constantly changing input/output environment. The process must be changed according to the source and quality of the feedstock (crude oil and other inputs). Weather conditions set up a varying demand for heating oil and gasoline. Federal regulations affecting automobiles constantly change the demand for ethyl gasoline versus regular or no-lead. All these data are input to the refinery model to optimize economic efficiency. Profimatics, an engineering services firm in Woodland Hills, CA, offers a Generalized Refining - Transportation - Marketing Planning System (GRTMPS) which generates LP models for refining, reports on purchases and sales, deliveries and stock movements, inventories at multiple locations in the process

stream, and motor gas blending, in addition to controlling the Data Library for input to the program.

- Research and development activities related to EDP in refineries include process improvement, new product development and product files. Because of the highly proprietary nature of such information, the EDP is usually done in-house.

- There is so much information to handle and process, that data management in software is needed, such as the use of Mark IV from Informatics by the 400 employee Chevron Oil Field Research facility at Le Habra, California.

MARKETING, DISTRIBUTION, RETAIL

The main EDP applications in this segment are the routine accounting functions of any wholesale or retail business - accounts receivable and payable, general ledger, inventory control, cash management, billing, etc.

- Credit operations, which include authorization for new accounts and large purchases, as well as the processing of credit card transactions is a large part of the billing function. While the trend is toward in-house credit authorization and processing, at least one large company, National Data Corporation, (Atlanta, GA) derives a majority of its revenue from oil company credit activities. NDC at one time had 22 oil company clients for credit authorization, and that number is now down to about 13, as oil credit moves in-house. In providing credit authorization NDC primarily relies on voice-response from telephone/terminal operators.

of each well, to set crude prices and pump prices.

- One example is FEO-96, the monthly allocation report, which is the means by which regulated companies, "compute, report, and adjust May 15, 1973 selling prices for covered products....Form FEO-96 is designed to provide the data necessary for the Federal Energy Office (FEO) and the Internal Revenue Service (IRS) to execute their role in monitoring certain cost and price movements within the U.S. Petroleum Industry."

  - At the pump, retailers may more easily compute Federal Energy Administration (FEA) maximum gasoline prices allowed by, "determining your May 15, 1973 selling price for each grade of gasoline you sold; you then add to that price the difference between the cost of that grade of gasoline in your inventory on May 15, 1973, and the current cost for that grade in your inventory. To this amount, you may add up to 3 cents per gallon for non-product cost increases incurred." Records are in the form of purchase invoices and daily sales records. Calculations are manual.

- State government reporting is more complex, because each state makes its own requirements. In the state of Texas, the Texas Railroad Commission (Austin, TX) oversees the regulatory requirements of that state, at a data center in Austin equipped with a B3500 system. The Texas Oil and Gas Handbook, published by R.W. Byram and Company (Austin, TX) is a 215 page manual containing 74 required forms and information on how and why they are to be completed. R.W. Byram also

- Retailing of gasoline is changing from full service to self service and automation. Atlantic Richfield and Amoco have installed automated gas pumps which are operated by the company's credit card, and billing data is automatically transmitted on-line to National Data Corporation. Other oil companies are also using automated pumps into their own data centers. Credit in these cases will also be handled in on-line mode.

- Most gas station accounting is done manually except for credit card accounting. Automotive supplies and services provided by gas stations are generally too small a percentage of revenues to warrant automation at this time.

- Retail delivery of home heating oil is made more profitable via a computer based system for delivery, accounting, and burner service offered by Petroleum Data Corporation (Princeton, NJ), via its PETRODATA system. PETRODATA processes over 600,000 retail accounts in several states, for both major and independent oil companies. Over 200 programs are available for delivery, real time accounting, and service scheduling.

GOVERNMENT REPORTING

The petroleum industry is price controlled at the well and at the gasoline pump. Both federal and state governments impose reporting requirements which make heavy demands upon oil companies' EDP capabilities.

- Federal government reporting is intended to develop an energy resource data base, to monitor and control the amount of oil taken out

acts as a vendor of computer services and data reports.

DATA BASES

Data base use cuts across the various phases of the petroleum industry. Specific vendors and products will be further described in section VII of this report. Examples include:

- R.W. Byram, Petroleum Information Corporation and the University of Oklahoma provide data on oil - quantity, location, prices, etc.

- The Office of Pipeline Safety (OPS) - U.S. Government - offers Automated Leak and Test Failure Reporting System which itemizes and analyses pipeline failures, their consequences, and the vendors involved. This report is generally available, and takes its information from the industry.

- EPA and the Coast Guard Maintain a Technical Assistance Data System to enable them to combat chemical spills.

- Lockheed, System Development Corporation, and others maintain literature search data bases for libraries and individual researchers.

- Econometric data bases, such as available from Chase Econometrics are used in corporate planning.

Despite the size and relative homogeneity of the oil industry there is a lack of information available on it; this is partially due to the secrecy which has surrounded many corporate operations. There will be an increasing use of data bases in each phase of the industry, as more information is accumulated.

V. COMPUTER SERVICES MARKET ANALYSIS AND FORECAST

V COMPUTER SERVICES MARKET ANALYSIS AND FORECAST

COMPUTER SERVICES EXPENDITURES TO GROW AT AN AVERAGE RATE OF 15%

Expenditures by petroleum companies for computer services will grow from $95.5 million in 1976 to $194 million in 1981, at an average annual growth rate (AAGR) of 15%. The distribution of these expenditures is shown in Exhibit V-1 by major service category. The largest expenditures are, and will continue to be for remote computing, with software products in second place. These data are based on the assumption that there will be no divestiture legislation, no major energy crisis during the forecast period, and an economic slowdown in 1978.

These figures represent expenditures by firms whose primary business is petroleum (as opposed to revenues by services vendors) for the specific service purchased. Thus, if an oil company contracts with a software vendor for the use of a software product, and the oil company pays the software vendor, who then arranges to have its product available over a timesharing service, the expenditure shows up here for remote computing services.

Similarly, if an oil company contracts with a construction company to build an offshore platform, and that construction company rents computer time to run stress analysis program, no expenditure for computer services shows up here. It will be reflected as an expenditure for computer services by the construction industry. If the oil company does its own construction and rents computer time, the expenditure does show up here.

EXHIBIT V-1

COMPUTER SERVICES EXPENDITURES

1976 - 1981

BY MAJOR SERVICE MODE

COMPUTER SERVICE CATEGORY	EXPENDITURES ($ Millions)		AVERAGE ANNUAL GROWTH RATE
	1976	1981	
REMOTE COMPUTING SERVICES			
• Interactive	24	64	22%
• Remote Batch	34	68	15%
• Data Base	3	9	25%
Sub-Total	61	141	18%
BATCH PROCESSING SERVICES	14	18	5%
FACILITIES MANAGEMENT	1	2	10%
PROFESSIONAL SERVICES	5	7	8%
SOFTWARE PRODUCTS			
• Systems Packages	9	13	8%
• Applications Packages	6	13	18%
Sub-Total	15	26	12%
TOTAL	96	194	15%

All expenditures are 'available'; i.e., expenditures of a parent with a subsidiary are not included.

REMOTE COMPUTING SERVICES ARE LARGEST SEGMENT

The largest expenditure, and the fastest growth rate occur with remote computing services (increasing at 18% per year, from $61 million in 1976 to $141 million in 1981). The combination of specialized software products and a timesharing network is the most important application of interactive remote computing services in this industry, accounting for 50% of the interactive revenues of remote computing services vendors. The remaining 50% is for raw time, with the remote computing services vendor serving as a computer utility for the development and processing of interactive applications of the user's choice. A significant portion of these expenditures are for the development of programs which will later be run in remote batch or combined interactive/remote batch mode.

Over 70% of remote batch expenditures are for scientific-oriented processing with the bulk coming from Specialty Applications such as seismic processing and structures analysis systems.

SOFTWARE PRODUCTS AVAILABLE THREE WAYS

Vendors of software products use three methods of marketing their software:

- Selling or leasing directly to the user for in-house use;
- Making a sale, lease or royalty arrangement with one or more timesharing vendors, who market the product;

- Buying "time" on a wholesale basis from one or more vendors, and marketing their products over the most convenient network, at a "retail."

While the first two methods are most popular, the third contributes significant revnues to the remote computing services vendor as well as increasing the revenue base for the software product vendor. In addition, the software product vendor may also use its "wholesale" purchase of time to do its own in-house software development work at reduced cost. Chemshare Corporation (Houston, TX), and Garrett Computing Systems (Dallas, TX) are examples of such user/vendors, whose combined purchases of remote computing time approach $1 million per year.

FACILITIES MANAGEMENT NOT EVIDENT

There appears to be virtually no FM contracting done by oil companies, although firms such as Boeing Computer Services (BCS) and Optimum Systems, Inc. (OSI) are active in petroleum industry related contracts with the U.S. Government. OSI has a $15 million, one year FM contract with Environmental Protection Agency (EPA), and a $7.5 million one year FM contract with Federal Energy Administration (FEA): BCS has a three year, $35 million FM contract with Energy Research and Development Administration (ERDA). Oil companies are very much concerned about the security of their information, as well as having enormous in-house EDP capabilities, both of which tend to mitigate against the use of FM contracting.

BATCH PROCESSING SHOWS SLOWEST GROWTH

In this industry, as in many others, batch processing is mainly a computer services entry level activity, which ultimately generates

remote computing or small business computer clients. However there is a significant amount of large-scale batch processing for LP Models and such applications; this is moving to remote batch and/or in-house systems. Because of this batch processing will grow, at less than inflation levels, from $14 million in 1976 to $18 million in 1981 - an AAGR of only 5%. Applications in this mode, by the small users, are for general business and for large users scientific.

Some oil company sub-divisions, such as Ashland Exploration Company (Houston, TX), whose main corporate data processing is elsewhere (Ashland, KY), go outside for general business batch processing at a $1000 per month level, due to loading priorities on their local in-house computer.

An example of a non-business batch application is American Petrofina's occasional use of batch services to run a large refinery model, which they do either at LTV or UCC in Dallas. American Petrofina is a $950 million subsidiary of Petrofina, S.A., Belgium, and does all their other data processing - including credit cards - in-house, on an IBM 360/30.

Some outlying sub-divisions have all their batch processing done by the parent's data center, as is the case with Newhall Refining Company, Inc. (CA), whose parent, Pauley Petroleum (Santa Monica, CA) batch processes all of its EDP requirements. Data is exchanged between the two organizations by courier - this type of competition for batch processing services is very unusual, as a terminal providing remote batch capability is usually considered worth the cost.

PROFESSIONAL SERVICES; SOFTWARE SERVICES AND EDP CONSULTING SMALL AND STEADY

Growing at an AAGR of 8% per year, the petroleum related market for these services will increase from $5 million in 1976 to just over $7 million in 1981. Even though petroleum is a highly specialized industry, where a considerable amount of EDP consulting is done, the great expense involved in the development of software usually results in existing software products being used where possible. Larger oil companies who use specialized software are usually also in a position to develop it in-house; they may buy time to develop it from a services vendor, in order not to conflict with priority applications on their in-house processors.

Consulting which relates to process control or construction often has an EDP content which is a necessary part of the job, but which is not contracted for specifically by the user and is therefore not included in expenditures for professional services. It will often be run on the consulting firm's in-house EDP equipment.

A good example of such a consulting company is Bonner and Moore (Houston, TX). An 80 man company owned by Fluor Corporation, their thrust is consulting to the petrochemical refining industry. B & M has a separate computing company which accounts for 20 of the 80 employees, and a separate software systems company. Being experts in linear programming, the company sells software packages of their own design, and has royalty arrangements with others. They also sell raw time, and do custom programming. Only the last item, custom programming, is accounted for in this category.

COMPUTER SERVICES EXPENDITURES BY APPLICATIONS CATEGORY

General Business Applications Account for 16% of Expenditures

General business applications account for 16% of processing services expenditures in 1976, as shown in Exhibit V-2. This category includes the normal business accounting activities of accounts payable, receivables, general ledger, payroll, and other general applications such as credit authorization, credit card processing, financial planning, budgeting, personnel, and inventory control.

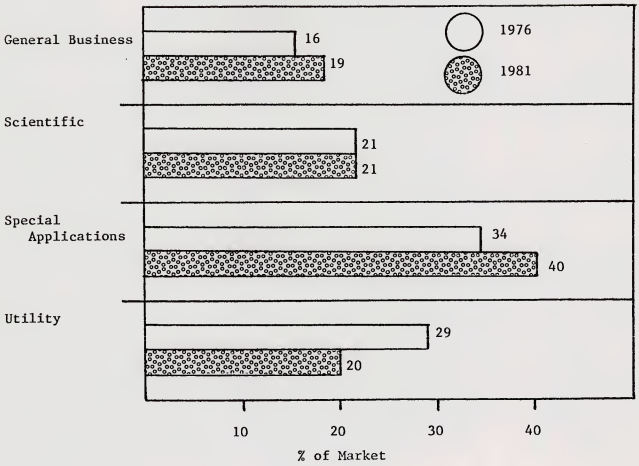
Computer Sciences Corporation (CSC) in Houston and Dallas emphasizes this aspect of the business. In spite of the extensive regulation by state and federal governments, each oil company continues to have unique needs and preferences for format, content, timing and distribution of its financial record keeping and reporting. CSC works closely with those firms who wish to develop their own accounting and management information systems, and put them into effect using CSC's INFONET.

Service Bureau Company (SBC) in Houston is divided into two distinct applications groups, one of which administers the short term business applications such as payroll and general ledger, while the other is concerned with longer range applications such as management information systems (MIS), long range planning models, and market forecasting.

Most of the small, local vendors, have no industry specialization and are exclusively oriented toward simple accounting. This is generally the entry level application for new remote computing uses, as well as the stable application for smaller users. M&K Oil and Gas is a small ($4 million gross annual revenues) oil and gas exploration and production company, with 11 full time employees, using contract field labor. They spend $2,000 per month with a local service bureau - Management Research Consul-

EXHIBIT V-2

PROCESSING SERVICES EXPENDITURES BY
TYPE OF SERVICE



tants - and have all of their business data processing done there.

Over the next five years, oil companies are planning to bring some of this work in-house, which will result in a slower growth of the total expenditures for services going into General Business applications than results from increasing penetration of existing and new services into the business function of the industry.

SCIENTIFIC APPLICATIONS CAPTURE 32% - GROW TO 40%

Almost 60% of the processing expenditures by petroleum companies are scientific and engineering related. Of this 60% ($44 million) over a third ($16 million) is for general scientific and engineering processing counted under the heading of Scientific Processing. This category includes all generalized problem solving for engineering, R&D, construction, process control modeling, and other "number crunching" problems which are not unique applications in the petroleum industry (Seismic data reduction would be a unique application, and is classified under "Specialty Applications"). The software products sold to meet these requirements generally work across industry lines, and would include stress and structural analysis (TRIFLEX, ANSYS, DAGS, SAGS, SPIN), fluid flow and piping analysis (FAAST, PLDES, PIPEFLEX, ALDPIPE), engineering drawing (COMPAID), graphics (DISPLAY), and project management (PERT, PROPLAN).

Garrett Computing Systems specializes in petroleum engineering and economics. The "Garrett Package", containing 17 major programs or series of programs for Scientific and Specialty Applications, is available on GEIS and United Computing Systems (UCS) networks.

Engineering Numerics Corporation (Dallas, Texas) is a joint partnership of Core Labs (52%) and CDC (48%), and offers a program library of sci-

entific applications, including reservoir engineering, field development, economics of oil and gas, and reservoir simulation. While they have their own computer, most of their processing is done via remote batch terminals to CDC 6600 sites. Core Labs does its own general business processing on its own in-house computer.

Intercomp (Houston), if not the largest, is one of the most prestigious suppliers of scientific software, leases software models for reservoirs, pipelines and the atmosphere to end users only.

CDC is a major vendor in this area, because of the scientific calculating speed of CDC computers compared to others. One oil company would not consider using any service vendor which did not have a CDC 6600 to run its reservoir simulation, which runs 3 hours for every year of reservoir history being simulated. Sun Oil has a CDC 6400 which is used almost exclusively for reservoir modeling.

BCS, CSC, UCC have major interests in engineering and scientific applications, and make available a wide range of software products developed by others.

Expenditures for scientific applications will grow at the same rate as the processing services market (16%) through increased economic pressure to find and recover more oil, to examine new technological processes, such as recovery of oil from shale, and environmental control pressures for new products and processes to reduce air and water pollution.

SPECIALTY APPLICATIONS EXPENDITURES INCREASE FROM 20% to 25%

Specialty applications expenditures will increase from $26 million in 1976 to $65 million in 1981, a market share increase from 34% to 40%.

The main activity in this category is seismic data processing. This is such a highly technical area and such a large and active application, that there are many service companies that specialize in the data reduction and software package generation; in addition, extensive data reduction is done by seismic exploration companies with in-house EDP capabilities, and the exploration divisions of the major oil companies themselves. Portable minicomputer systems are being increasingly used.

Frequently, a portion of the exploration job will be subcontracted, in which case the subcontractor may have its own EDP capability. An exploration project costing $350 million total might include an outside subcontract of $4 million which could include $450,000 for EDP work.

Seiscom Delta is the largest independent data acquisition and processing company. Using proprietary software, they generate multicolor printed displays which can be visually interpreted by trained geophysicists to suggest possible oil locations. Worldwide EDP revenues of $10 million were accumulated in 1974 via data centers in Houston, London, Calgary and Singapore, with major areas of activity in the North Sea and Indonesia. Other specialized seismic vendors include Geoquest and Digicon, in Houston.

Exxon, USA, spends 75% of its services expenditures for remote batch seismic data processing at peak periods. The balance of their seismic work is done in-house. Their main seismic services vendor is Western Geophysical.

Raytheon Corporation, via its Seismograph Service Corporation, offers a minicomputer (Raytheon 704) based portable hardware/software system for on-site seismic data reduction. Sun Oil's offshore exploration group recently took one near the North Pole to use on a seismic exploration. Sun has five such systems. In addition, they purchased a seismic package from Bell and Murphy, for $8,000.

Amoco does one tenth of all the seismic exploration in North America. They are supported by 4-370/168s in Tulsa, and 3-370/168s in Chicago, each of which has 1 or 2 IBM 2938 array processors which are primarily (75%) for seismic data reduction.

There are also a number of industry specialized business applications such as well-head accounting, lease accounting, government price and volume reporting, and the use of industry data bases of business related data. The proportion of Specialty Applications for business activities will increase slightly by 1981.

WHO USES COMPUTER SERVICES

The use of computer services in this industry, as in all others, varies according to size of the company. Oil company size categories are shown in Exhibit V-3.

The small number of firms in the medium, large, and very large categories does not relate to the potential number of clients. These firms are usually broken down into functional sub-divisions (exploration, production, refining, transportation, marketing), and each sub-division may have multiple geographic locations, each of which has numerous individuals capable of purchasing some computer service - particularly a terminal for less than $1,000 per month. Thus, in addition to the data center manager, the corporate EDP staff member, and the controller, an oil company includes a host of small businesses.

Frequently, there is no one person responsible for outside services purchases, except perhaps for software which originates at one data center and may be made available throughout the company. Specialized software, which may be run at a local data center, on an in-house special purpose

EXHIBIT V-3

COMPANY SIZE CATEGORIES

Size	Annual Sales	Number of Firms
VERY LARGE	Over $1 billion	21
LARGE	$300 million to $1 billion	11
MEDIUM	$30 million to $300 million	25
SMALL	less than $30 million	15,000

minicomputer, or via a terminal to a service bureau, may be the private domain of a small group at a remote site. In fact, even where there are individuals responsible for company wide EDP purchases, they find it impossible to discover all the services expenditures because of the relatively small amounts of money involved, and the variety of ways in which products and services are bundled into engineering and scientific contracts.

WHY COMPUTER SERVICES ARE USED

There are three major reasons that oil companies use computer services in spite of the huge data processing resource at their disposal:

- Turnaround Time
- Specialization
- Convenient Access

- Turnaround Time

Loading on an oil company data center varies considerably as a function of accounting cycles, new exploration commitments, changing of a refinery schedule, or other significant EDP undertaking. At such times as the centers are fully scheduled, overload work may be done outside at the discretion of the data center manager, or the project manager. In some cases, certain large and time consuming problems, such as seismic data reduction, or reservoir modeling, will automatically be processed outside because of the center's inability to deal with the work without major rescheduling.

Turnaround time requirements for a situation may come up where there is not a computer loading problem, but where the normal queuing process does not permit rapid enough response. For example, a program may have to be reworked, or a new one developed "right now" in order to not impede the pro-

gress of a construction job. Outside timesharing or remote batch processing may be just the trick.

- Specialization

Many programs regarding the scientific problem solving, modeling, and process control are not worthwhile developing anew. They are very expensive to develop, and not likely to be an improvement over software products already available. Most products are easily available for lease for purchase, to run on in-house systems, or are available on one or more timesharing company's terminals. In highly competitive satellite industries there are continuing efforts by specialized firms to gain a competitive edge by developing and offering improved software products, enabling the oil firms to choose from many products which do essentially the same job, where one may be more suitable to the firms' operating philosophy than another - at no risk. Similar advice applies to the computer services industry. It is much safer and more profitable for a company to provide the high technology software developed by others, over its network, than to invest in developing a "better one" of its own. Numerous "piggyback" arrangements are possible, as discussed earlier.

- Convenient Access

Some oil companies have data networks, others, even very large ones, do not. In many applications, where data is to be input or output on a worldwide basis, a vendor's network may be the reason for getting work. In particular, GEIS' communications network is so highly regarded, that it is difficult to compete with when wide-spread accumulations and distribution of data is an important criterion for vendor selection.

On a local basis, one timesharing company is used to monitor crude oil loading onto tankers, because they are able to get a CRT at the loading ter-

minal dock, and run the load and stress analyses on the tanker, whereas the oil company could not conveniently install a terminal and support it on the schedule required.

At remote sites, a services firm can provide data access as a matter of course. BCS supports remote batch terminals on the Alaska Pipeline. The terminals are strung along the pipeline and used to collect remote batch data on payroll (timecards are input), job scheduling and other local site related data.

Thus, services firms can fill niches in the petroleum industry ranging from raw time service, to routine financial and forecasting data processing, to highly specialized technological support. As the level of technological products and services increases, the greater the requirement for highly skilled technology personnel becomes.

PETROLEUM SATELLITE INDUSTRIES' COMPUTER SERVICES MARKETS

INPUT estimates that construction, engineering, transportation, design, and other companies providing services to the petroleum industry will spend $74 million in 1976 on EDP for petroleum industry projects and services. Of this amount, approximately 50%, or about $35 million, may be spent for the purchase of computer services.

VI. TECHNICAL AND MARKETING REQUIREMENTS FOR VENDORS

VI TECHNICAL AND MARKETING REQUIREMENTS FOR VENDORS

TECHNICAL REQUIREMENTS FOR VENDORS

Industry Knowledge is Essential

To the extent any vendor wishes to be more than a computer utility in the oil industry, specialized knowledge is required by the user community.

One step up from the provision of raw time is financial services, packages, and software development support. For the most part, the user will need to write his own software, as each company has its now systems and procedures, and philosophy.

The next step would be to have software packages available for traditional scientific/engineering problem solving. Here it is necessary to understand the packages and the applications in moderate depth, with the software designer being available to the customer for further technical applications assistance. At this point, the hardware configuration and specific software package become important in terms of benchmarks and relative cost. Users will tend to go toward CDC equipped service companies for complex "number crunching" because it is most economical. Machine equivalence with the user is not especially important as long as data transfer is possible, and this will usually be accomplished via a vendor's terminal. Computer to computer transfers are virtually non-

existent, and user and vendor don't ordinarily hook into each others' networks. Some record keeping agencies, such as the Texas Railroad Commission may consider computer to computer transfer, but this would be unique.

Some software is more economical than others, to achieve similar ends. PROPLAN, a project management program, is claimed by its vendor, K & H Computer Systems, Inc. (London), to have been recently benchmark tested and found to be 14 times as fast in CPU time, and uses 1/3 the core required for CPM/PERT offerings by other vendors. PROPLAN only runs on a CDC-6600. Thus, the desire by a user to utilize PROPLAN would cause it to use CDC, a services company equipped by CDC, or perhaps, an in-house CDC computer.

As technical applications get more sophisticated, increasing technical support is required. Although reservoir modeling and lease performance programs are generally available on commercial networks, there is a tendency to have a technical company back the product, or to have the work done by a service company which specializes in the product or technique. An example of the former would be the Garrett Package, which is available through GEIS and UCS; an example of the latter would be linear programming applications to a refinery, as offered by Bonner and Moore in conjunction with their Software Systems Company, and their Computing Company.

The highest level of technical staff support is associated with such very specialized applications as seismic data reduction. Here, the individual commercial service company cannot participate, or, at best, can only act as a computer utility. This work is generally done by specialized services vendors, such as Seiscom Delta. A possible option for a general service company would be a technical joint venture, such as Engineering Numerics Corporation, the EDP joint partnership of Core Labs and CDC.

Networks and Communications May Be Required - Maybe Not

The only complaint offered by the users interviewed for this study regarding the use of computer services was the sometimes inadequate quality of the communications - generally the telephone company's responsibility. When communications is an important ingredient of the user's requirements, GEIS is easily the first choice.

Most often, the communications problems is not so stringent. Large and technical problems tend to be run at local data centers - which some of the smaller Houston based service companies capitalize upon. The degree of need for a network, and the importance of the quality of communication is a function of the individual requirement of the individual firm. As international input/output of data, and interactive timesharing needs increase, so does the importance of networks and communications. Commercial networks which extend to remote locations, where oil company networks do not, are also of marketable value during exploration and transportation phases.

MARKETING REQUIREMENTS FOR VENDORS

The authority to purchase outside computer services is diffuse, and decentralized organizationally as well as geographically. As oil companies get larger and more diversified, less control is exerted by, and less information available at, corporate levels regarding computer services expenditures. In addition, the larger oil companies have numerous data centers, and tend to deliberately move EDP responsibility down the line. However, some centralization is taking place, such as that at Sun Oil.

Some buyers can easily be identified and located by phone. The EDP manager(s) will be buying systems software, applications software for their more generalized applications, and remote computing services. Some EDP managers will only be responsible for one geographic area (Houston/Dallas), or only some of the applications ("all financial work is done at our corporate data center"), or a terminal location ("all our departments have COPE terminals which hook into the Tulsa data center"), and will gladly furnish names and phone numbers of responsible parties.

Controllers and VPs of Finance are targets for accounting, financial modeling, econometric data bases, and such specialized applications as lease management and well head accounting. For the latter, a vendor may be directed to the production subsidiary financial manager.

Buyers of highly esoteric products and services are fairly easy to locate, and usually have local purchasing authority. The chief geophysicist of the exploration division of a production company can deal with a vendor on a new seismic data reduction printout and display.

Users of generalized engineering and project management services are the most difficult to locate, as is a centralized buyer of such applications. Most engineering software products and associated timesharing usage is not petroleum industry specialized. Stress analysis, isometric drawing, display, and project control packages, for example, are sufficiently generalized to be used in many industries, with little or no modification. Vendors such as BCS and McAuto provide these generalized services to petroleum, chemical, construction, and other industries, wherever engineers and their managers can be found. Frequently, the oil industry is served second hand by these services which are first provided to construction firms who service petroleum as well as other industries, all in much the same technical fashion.

WHY DO THEY BUY SERVICES

Turnaround time and technical specialization are the two major reasons oil companies buy outside EDP products and services, in spite of their vast in-house capabilities. All users interviewed indicated their intention to bring more work in-house in future years, although they do not foresee any significant reduction in services expenditures. They also expect new and improved software products, communications capability and turn-key mini/micro systems to be available to enhance their present in-house or service applications. Thus, the same people will continue to buy solutions to the same kinds of problems because of internal loading and queuing problems, and the high cost and complexity of developing in-house custom solutions to compete with packaged product solutions.

HOW DO THEY CHOOSE A VENDOR

Vendors are chosen for different reasons, according to the application. Indeed, one oil company uses as many as 8 vendors simultaneously.

For heavy duty input/output on-line applications, the decision is based on network and communications capability.

For complex, long running scientific projects, usually a CDC installation is chosen.

Other services are chosen based on availability of a particular product or solution at a competitive price. The lower the monthly cost, and the more generally available the product, the more likely a user will change vendors at comparable prices if his current vendor is not adequate. As the cost and complexity of the service increases, users would require 15-25 percent price reductions to switch vendors - all other things being equal - in order to offset conversion costs. However, no user who was

VII. COMPETITIVE ENVIRONMENT

interviewed expressed dissatisfaction with the services vendors being used, and little evidence of switching could be found. In general, the industry is relatively price insensitive.

The original use of a services vendor is made based on an economic justification, if it is not a high-pressure or technical specialty requirement. If there is a tanker waiting to be filled, and the in-house system will be backed up when needed, the tanker will be filled with the use of a service company. If a drilling project is in process and the in-house system is too busy running state reports and preparing lease payment checks, the drilling schedule will demand the use of a services company.

Thus, geographic location, opportunism, reliability, credibility, good service, and technical support all contribute to being selected as a vendor to the oil industry.

VII COMPETITIVE ENVIRONMENT

The competitive environment varies according to the application area. In all cases, the enormous in-house EDP resources of the petroleum companies themselves are the main source of competition to all services vendors. Within the commercial marketplace, competition exists among:

- Oil Companies
- Major remote computing services vendors
- Local services vendors and specialty firms
- Software products vendors and consultants
- Construction firms
- Data base vendors
- Mini/micro computers and turn-key systems

IN-HOUSE COMPETITION

EDP budgets in the petroleum industry have varied from about 0.5% of total revenues to just under 1% of revenues. As a result of the extraordinary 1973/1974 revenue increases due to oil price increases during the "oil crises", current EDP budgets related to total revenues run somewhat lower than they did two years ago. Of the total EDP budget, interviewees report between 2% and 6% going for outside services. Thus, the oil companies perform 94% to 98% of their own EDP needs, and uniformly report expectations of taking more work in-house during the next five years.

Nevertheless, expenditures for outside services will continue to grow because of increased EDP requirements, stability of the highly specialized technical servcies, and inflation.

OIL COMPANIES IN THE MARKETPLACE

The competition from oil companies in the commercial marketplace comes from two main sources:

- Processing Services offerings
- Software Product offerings

Processing services offerings are made by oil company data processing organizations which have a charter to compete commercially, as well as to support the in-house EDP requirements. One such example is the new Information Services Division of Sun Oil; another is the education and training services offerings of the Shell Oil data services group.

Software products are often made available to other oil companies, via commercial timesharing, in an effort to recoup some of the great expense incurred in developing the package. AMOCO and Shell have supplied numerous program items in the product catalogues of timesharing firms. It is this development cost which discourages internal software development and improves the market for specialized software product development companies.

MAJOR REMOTE COMPUTING SERVICES VENDORS

The major remote computing services vendors to the oil industry are:

- General Electric Information Services (GEIS)
- Control Data Corporation (CDC)

Other important vendors include:

- Boeing Computer Services (BCS)
- Computer Sciences Corporation (CSC)
- Comshare
- McDonnell Douglas Automation (McAuto)
- Tymshare, Inc.
- United Computing Systems (UCS)
- University Computing Company (UCC)

These companies provide time, applications support, software products and programming services. They are represented by more than 200 sales and sales support personnel in the Houston and Dallas areas alone.

General Electric Information Services (GEIS)

GEIS is the largest U.S. remote computing services vendor, perhaps exceeded in total sales only by the SBC and CDC computer services activities combined. GEIS' major strength is its communications capability. The majority of large oil companies use GEIS as a computer utility. Most of their software products are "authorship" programs - developed by others, and offered "piggyback" on the GE network, on a royalty basis to the author. GEIS pursues large clients who will spend $10,000 per month or more, and has as many clients as their next five competitors combined. GE clients include Sun Oil, AMOCO, and Atlantic Richfield.

The GEIS program catalog comprises 37 pages of nearly 200 programs and routines of both a general nature and specific petroleum industry applications. Among the latter are POGO (Profitability of Oil and Gas Opportunities), which is an oil and gas lease economic evaluation model,

and PETROEX (Product Exchange Data Clearinghouse) previously described as a complex product movement and inventory function of the Williams Pipeline Company.

The latest offering of GEIS, being introduced in May 1976, is the Petroleum Data System (PDS). The PDS file was constructed by the University of Oklahoma, through a contract with the U.S. Geological Survey and has recently been made available to the public. PDS is a searchable, computerized data base containing information for all oil and gas fields and pools in the U.S. and Canada.

Control Data Corporation (CDC)

CDC is committed to the petroleum industry to the extent of setting up a Petroleum Services Firm in Houston. The "firm" concept of CDC's is a way of organizing its hardware, software, and people for the support of a specific industry, in order to provide the most appropriate EDP solution to a given problem. SBC also operates as a separate entity in Houston and Dallas, offering remote computing and batch servcies which tend to be non-industry specific.

CDC services customers buy both time and applications. The software packages for data management and structural analysis tend to be "piggyback." CDC begins a "piggyback" project by merely advertising the product. If it is a good product, they will make all arrangements to market it via their network, provide program maintenance, etc. Other packages include financial modeling and PROPLAN, a previously described improvement over CPM/PERT, developed by K & H Computer Systems (Denville, NJ). In Houston, CDC has one model 6600 and one Cyber 74 in a multi-mainframe environment. Much of their work is performed in batch mode; the remainder is remote batch

on these systems. CDC's clients include Getty Oil, Tenneco, and Intercomp (simulation software products).

The SBC operation is divided among batch services - mostly general business applications - and remote computing, both of which operate across industry lines. Oil companies are not considered as industry specialties, although about 75% of the Houston timesharing is petroleum related. SBC has about 90 people in Houston, including keypunch operators.

Boeing Computer Services (BCS)

BCS does not specialize in data processing services to the petroleum industry, although there is a subsidiary, Energy Technology Applications (ETA) comprising about 100 engineering/scientific PhD's which provides consulting services on all aspects of energy. MAINSTREAM-TSO is BCS's nationwide remote data handling and RJE system, adapted from IBM's TSO. With this capability, BCS offers information management (MARK IV, TOTAL, RE-ACT), project management, simulation, modeling, math and statistics packages, and economic forecasting (SIMPLAN) to all industries. Of some specific interest to the Oil industry are ICES/STRUDL II, an engineering structural design package, and NASTRAN Structural Analysis System. The BIG (BCS Interactive Graphics) System also has applications in exploration, construction, and other display output oriented requirements.

BCS has a $35 million, 5 year FM contract with ERDA in Richmond, Washington, and is the prime EDP contractor on the Alaska Pipeline - a remote batch management system using Data 100 terminals. BCS has a few petroleum firm clients. Their activity is mostly at the Alaska North Slope, and is minimal in Houston.

Computer Sciences Corporation (CSC)

CSC does not specialize in the petroleum industry, but offers financial, structural, engineering, and project management services and products which are useful across many industries. They seek petroleum clients with sales over $100 million, and support their use of CSC data management packages to produce their own financial reports. CSC also markets TRIFLEX, a piping analysis program developed by AAA Technology and Specialties Company, PERT and SCIONICS (linear programming) over its network, INFONET.

CSC has offices both in Houston and Dallas, offering general business as well as engineering oriented packages to oil and other industries. They stress PRO/FILE, a detailed personnel package; a mechanical design library of about 20 packages developed by Structural Dynamics Research Corporation (SDRC - Cincinnati); proprietary data bases, and linear programming.

McDonnell Douglas Automation Company (McAuto)

McAuto provides engineering and project oriented services and support for petrochemical and nuclear industries, and is more involved with applications than the provision of raw time. Simulation programs, used prior to construction of a new petrochemical plant, were jointly developed by Phillips Petroleum and Simulation Sciences; piping analysis programs include TRIFLEX, PIPEFLEX (developed by U.S. Navy), and ADL-PIPE (by Arthur D. Little). COMPAID, developed in 1966 in England, by D-A Computer Services Ltd., and Davy Power Gas Ltd., automatically generates 21 standard reports for material control, management reporting, and isometric drawing. MCSS competes with PERT for project management, and ANSYS is available for large scale computer applications to engineering analysis

programs. Most of these programs are set up by the user on a time share basis, and actually run in a remote batch mode. McAuto's costs may sometimes be a little higher than competition, due to their dedication to customer support.

Tymshare, Inc.

Tymshare has a Petroleum District Office in Houston which offers generalized services and products to the petroleum industry, with particular emphasis on data management (System 2000, FOCUS, X22, MAGNUM) and data analysis (EXPRESS, TYMTAB). TYMNET, their remote computing network, is an asset in reaching remote sites, and also yields opportunities for training and support services at those sites. Tymshare does not now offer engineering/scientific packages for the technical aspects of the petroleum industry, although they do wholesale time to some technical specialty products firms who offer their software to users via the networks.

The Data Center Division, the batch processing arm of the company, offers COMPUTAFUEL to oil dealers, to determine fuel distribution routes.

Most of Tymshare's more than 4000 clients are concentrated in the manufacturing and utilities industries. Several large oil companies, including EXXON, are major timesharing users of Tymshare.

University Computing Company (UCC)

The Scientific and Engineering Division of UCC is fundamentally in business to provide computer service and support to construction firms serving hydrocarbon industries - petroleum and chemical. UCC's capability

extends from the conceptual modeling of say, a refinery, where the model is used as part of the bidding process by the construction firm, through the structural, piping and vessel analysis, heat exchanger design, etc. With about 50 users, UCC may well be the number one supplier of computer services in this area. They also provide access to the Garrett package which is financially oriented toward exploration and production. UCC was frequently commented upon by users as providing good support to its clients, regardless of their size.

United Computing Systems (UCS - Kansas City, MO)

UCS offers computing power and applications support to medium and large size oil companies. One of their major products is SACM (Surface Approximation and Contour Mapping Program) which analyzes three dimensional surfaces, does reservoir volumetric calculations, and produces contour maps. UCS uses CDC equipment and offers the Garrett Package. Via a recent acquisition of Foresight Systems (Los Angeles), FORESIGHT, a financial modeling and management language, and FORETAX, a corporate state income tax program, are also available.

LOCAL SERVICES VENDORS AND SPECIALTY FIRMS

Because of the geographic concentrations of firms in the petroleum business, there tends to be high concentrations of local general services companies and petroleum specialty services firms in Houston, Dallas, Denver, Tulsa, New Orleans, and parts of California. The general purpose services companies tend to provide accounting and financial reporting for smaller oil companies and satellite industries. The specialty firms support exploration, engineering, and oil field accounting activities. The major

specialty is, as noted earlier, seismic exploration and data reduction. Companies discussed in this section on specialty firms include:

- Chemshare Corporation (Houston)
- Engineering Numerics (Dallas)
- Garrett Computing Systems (Dallas)
- Petroleum Software, Inc. (Dallas)
- Seiscom Delta (Houston)
- Spenco Systems Division of Dresser Industries (Austin, TX)

• Chemshare Corporation is an independent engineering company devoted to developing process engineering technology. Simulation programs are available in gas, chemicals, refining, and petrochemicals, via the facilities of CDC, UCC, and UCS. Programs are also available on a lease or purchase basis, and the service is also available directly from Chemshare. Thus, the company is both a user and a vendor of computer services, with over 150 major customers world-wide. Chemshare's clients include the process engineering departments in engineering/construction companies, as well as consulting companies and operating plants. The company is seven years old, is privately held, and has 20 employees.

• Engineering Numerics Corporation is a five year old joint partnership of CDC (48%) and Core Labs (52%). They are mainly consultants, whose clients include independent U.S. producers, and foreign governments and oil producers. They primarily deal in scientific software for reservoir analysis, field development, economics of oil and gas, and reservoir simulation. Their staff includes engineers and geologists originally from Core Labs, comprising about 25 people. While most of their data processing is via terminals to CDC 6600 sites, they also have their own in-house computer.

- Garrett Computing Systems, Inc. is a large user and vendor of computer services. All their business is directed at petroleum and engineering and economics. They buy time wholesale from GEIS and UCS, and offer their comprehensive 20 program package via the same vendors, with client access via Garrett. The programs are mainly directed toward reservoir engineers, exploration and production. A 12 year old company, with 10 employees, Garrett has 150-200 users in the U.S. and Europe. They are currently experimenting with a turnkey mini system to perform one of their applications.

- Petroleum Software, Inc. is a large user of timesharing, and a vendor of a full line of petroleum accounting and reservoir analysis applications Their major product is an economics package. Their products are offered via remote batch from their in-house Univac terminals, and via service companies with Univac 1108 equipment, e.g., UCC (Dallas), Intertek (Huntsville), and Utility Network of America (Chicago). Clients include banks as well as oil companies. A subsidiary of Garies Engineering Petroleum Consultants, Inc., they have their own subsidiary, Petroleum Software International.

- Seiscom Delta is the largest independent seismic data acquisition and processing company, with data centers in Houston, Calgary (Canada), and in England. 1975 revenues were $29 million, approximately 1/3 of which came from EDP. The company has 750 employees - 1/3 of whom are in EDP. Seiscom Delta works from the beginning of an exploration job right through to multi-color displays of the Seismic data.

- Spenco Systems Division of Dresser Industries operates at the gasoline retail end of the business, reporting on the performance of automated self-service stations with their product, NETSIL. Spenco has a NOVA 2 mini which polls the pumps daily, and is tied to a Greyhound IBM 370

service in order to store data for several days, and to calculate and print out reports.

SOFTWARE PRODUCTS VENDORS AND CONSULTANTS

Software products are developed by specialists in this industry. Many are affiliated with consulting, engineering or construction firms, and offer those products via the firms' own EDP resource. Others, like many oil companies, offer their products through commercial remote computing services vendors. The following sample of vendors fall in various categories, but have in common a proprietary software product base.

- Bonner and Moore (Houston)
- Intercomp Resource Development and Engineering (Houston)
- Profimatics (Woodland Hills, CA)
- Swanson Analysis, Inc. (Elizabeth, NJ)
- Swan Wooster Engineering Co., Ltd. (Vancouver, B.C.)

• Bonner and Moore are consultants in petro chemical refining, and technical specialists in linear programming. The company has 80 employees, and is owned by Fluor Corp. There is a separate computing company with a Xerox Sigma 7 installed, and a 370/155 on order, and a software company. Thus, Bonner and Moore are consultants, users and vendors of computer services. The computing company offers software packages on a "piggyback" royalty basis, and are looking for more to offer. Present products include structural programs from Engineering Dynamics, Inc., (EDI - New Orleans), and surface and contour mapping. They are in the process of developing a comprehensive oil and gas accounting package. About 50% of the computing company's revenues come from raw time sales. There are 20 employees in the computing company.

- Intercomp Resource Development and Engineering (Intercomp) is a team of professionals in engineering, geology, petrophysics, economics, management, and computer simulation of oil and gas reservoirs and pipeline networks. Incorporated in 1968 in Calgary, Alberta, Canada, the firm now has major offices in Houston and the Hague, Netherlands. Intercomp is the only company of its type that carries on an extensive basic R & D program to improve reservoir engineering technology and modelling techniques. Intercomp licenses its models for reservoirs, pipelines - and atmospheric - simulations, which are included in a library of some 20 products. Intercomp products are available via CDC service bureaus.
- Profimatics provides a line of software products and services relating to process control. With 12 employees, Profimatics' annual sales volume is $750 thousand, derived from all sizes of oil companies, from Exxon down. Two-thirds of that is EDP related. They provide software services, feasibility studies and control system design for refineries using Foxboro, GE, DEC, and other process control hardware. Off-line software is generally delivered on a one year full pay out lease. A typical product is GRTMPS (Generalized Refining - Transportation - Marketing - Planning System).
- Swanson Analysis, Inc. produces only one product - ANSYS, an engineering analysis system computer program, which is a large scale general purpose computer program employing finite element technology for the solution of several classes of structural, and heat transfer analysis problems, as well as piping, pressure vessel, and thermal analyses. The product is licensed on a royalty basis. There are over 200 companies using ANSYS, with about 20% of them in the petro-chemical industries.

- Swan and Wooster Engineering Co., Ltd. is a consulting company in marine engineering, structural design, and other engineering activities. Offices are in Portland, Atlanta, Montreal, and St. Catherine, Ontario. Swan and Wooster are both users and vendors of computer services. They purchase time and applications from BCS, Digitek (Canada), and Multiple Access (Canada). Their major product, GASP, (General Analysis of Structural Engineering Problems), is a frame analysis program consisting of GASPEX and ADGASP which is available exclusively via CSC Infonet.

CONSTRUCTION FIRMS

Construction firms are separately listed because they are the source of EDP revenues for construction done by the oil industry. Some of the engineering firms described above are sometimes in the same situation. Construction contractors usually serve many industries, and are buyers and sellers of construction computer services, as part of the contract to build a refinery, plant, or pipeline network.

In 1975, the oil industry spent $3.7 billion in capital budgets for refining, an amount 57% higher than 1974, and 15% higher than is forecast for 1976. Assuming that 10% of the expenditure goes for engineering services, and 10% of that for EDP, the construction and engineering firms will spend over $30 million on EDP in 1976, for refinery applications.

Many of the construction firms have their own EDP capability. Computer service firms obtain revenues from these companies because of the issues of turnaround time and the ready availability of specialized

software. However, these construction firms also compete with the services vendors for major petrochemical projects.

• Brown and Root is the largest U. S. contractor, with revenues exceeding $5 billion. Two other subsidiaries of the Halliburton Company, Ebasco and Horn Construction Company, rank numbers 5 and 118 respectively. Both Brown and Root and Halliburton have EDP capability, and offer computer services to the petroleum industry.

Brown and Root Data Processing Department (Houston) has over 100 employees, including managers, project leaders, systems analysts, programmers, operators, and keypunch personnel. Their library exceeds 2000 programs and their work load is 55% commercial processing and 45% engineering processing, on an IBM 370/155 system. For RJE, terminals and work stations are located in London, Anchorage, Dallas and Belle Chasee, LA. The center supports over 25,000 employees in its engineering and construction activities. Brown and Root is also a purchaser of computer services.

The parent company, Halliburton, also buys and sells computer services in the course of its interactions with the petroleum industry. Halliburton Services, and the Halliburton Company, offers computer analysis at the well site via a mini computer based logging digitizer. Halliburton Services, with its own in-house computer, uses GEIS to enable world wide access for its services.

• Lummus, a subsidiary of Combustion Engineering (CE) is another major contractor to the oil industry. Although CE has a major EDP capability, and presumably does all of Lummus' EDP, a casual tour of the facility reveals commercial remote computing

terminals. Both Lummus and CE do use outside services. Software products such as AUTOFLEX (for pipe stress analysis) are leased.

- Fluor Corp. is the parent company to Bonner and Moore, described above. Fluor has its own EDP, and also uses outside services and products.

Thus, although these companies are significant sources of revenue for computer services firms, their expenditures when part of construction contracts for petroleum companies are not included in the petroleum industry expenditure data base, but will be included in a future analysis of the construction industry. Their total expenditures for computer services for petroleum industry engineering and construction are estimated at over $30 million in 1976.

DATA BASE VENDORS

Because most data bases are not created by the services vendor, and are often available on a non-exclusive basis, remote computing vendors can choose to provide information of their choice to their target client populations. Some firms, like Lockheed and System Development Corp. (SDC) have made a business out of data base offerings. Other firms, like ADP/Cyphernetics, offer the widely used Chase Econometrics data base as one of many general business applications packages. One data base market is credit verification, as practiced by National Data Corp. (NDC - Atlanta). This is currently not a remote computing services application, as voice response is the method of inquiry/response, and updates are batch processed. However, it is being converted to a remote processing service.

• Lockheed (Palo Alto), as an example of a generalized supplier, offers 35 data bases via their DIALOG Online Information Retrieval Service. None of the data bases is specifically oriented toward the petroleum industry, although they provide literature searches in science, technology, business, education, psychology, social science, agriculture, and economics. An average search costs $10 to $20. There is no minimum or subscription fee, and data print-outs can be at the customer's terminal, or mailed from a nearby data center. The system can be accessed by direct dial telephone, TELENET, or Tymshare user terminals.

El Paso Natural Gas Company librarian uses Tymshare to access the SDC data base for NTIS, COMPENDEX, and GEOREF. Northern Natural Gas Company and Public Service Electric and Gas Company librarians use Lockheed's DIALOG, as does Consolidated Edison of New York.

- Petroleum Information Corporation (P. I. - Denver) previously part of CSC, and now a subsidiary of A. C. Nielsen Company, is a 50 year old company, with 700 employees, who maintain a computerized history of almost 900,000 oil wells drilled in the U. S. since 1890. P. I. operates from 31 offices in the U. S, annually providing hundreds of publications and computer reports to oil clients as exploration - production aids. The firm operates its own IBM 370/145.
- PETROEX is made available via GEIS, and was discussed earlier, as the data base product of Williams Pipe Line.
- PDS (Petroleum Data System) is available via GEIS, and was described earlier as an oil and gas pool and field data base originated by the University of Oklahoma.
- OPS (offices of pipeline safety), in conjunction with the University of Oklahoma, offers a computerized record called OPS Automated Leak and Test Failure Reporting System.

- EPA (Environmental Protection Agency) and the Coast Guard have terminals to access data on 90 items related to chemical spills and cleanup. The data was prepared by Battelle Memorial Institute. The Coast Guard is now developing their own system CHEMTREC, sponsored by the Chemical Manufacturer's Association.

MINICOMPUTERS AS COMPETITION

Minis, Micros, and Turn-Key Systems are not a threat to the computer services vendor in the petroleum industry, except as competition at entry level general business EDP for small companies (EDP expenditures less than $2000 per month) and for some preliminary processing activities in fields such as seismic processing. Thus, only the smaller, local service bureaus, particularly those which are batch oriented, and national business/batch oriented companies like ADP and Tymshare's United Data Centers need be concerned. This competitive structure is not oil industry specific, but is the well known battle field for manual vs. services vs. minicomputers which exists across all industries at the small business level.

Few firms attempt to specialize in this field in the petroleum industry. One typical custom house, oriented toward small business in-house systems, PAS (Programmers/Analysts Services - Houston) is having modest success in pursuing small turn-key installations. Hardware will continue to increase its applications in the process control stream, and in code conversion for data acquisition of stream analyzer outputs.

APPENDIX A - DATA BASE

INPUT

FORECAST USER EXPENDITURES FOR COMPUTER SERVICES
BY MODE OF SERVICE

INDUSTRY CATEGORY: PROCESS MANUFACTURING - PETROLEUM

Category Of Service	EXPENDITURES ($ Millions)					Average Annual Growth Rate
	1976	1977	Growth Rate	1979	1981	
Remote Computing Services	61.0	75.0	23%	105	141	18%
Batch Processing Services	14.0	15.4	10%	17	18	5%
Facilities Management	1.0	1.1	10%	1	2	10%
Professional Services	5.0	5.4	8%	6	7	8%
Software Products	14.5	17.3	19%	20	26	12%
TOTAL	95.5	114.2	20%	149	194	15%

FORECAST USER EXPENDITURES FOR PROCESSING SERVICES

BY TYPE OF SERVICE

INDUSTRY CATEGORY: PROCESS MANUFACTURING - PETROLEUM

Processing Services	Expenditures ($ Millions)		Average Annual Growth Rate
	1976	1981	
General Business	12	30	20%
Scientific	16	34	16%
Specialty Applications			
• Seismic	15	30	15%
• Data Bases	2	9	25%
• Reservoir Modeling	2	5	20%
• Lease & Well-head Accounting	3	6	15%
• Other	4	15	30%
Sub-Total	26	65	20%
Utility	24	32	6%
TOTAL	76	161	16%

DISTRIBUTION OF USER EXPENDITURES
FOR PROCESSING SERVICES IN 1976

BY MODE AND TYPE OF SERVICE

INDUSTRY CATEGORY: PROCESS MANUFACTURING - PETROLEUM

($ Millions)

Type of Service	Mode of Service					Total
	Interactive	Remote Batch	Data Base	Batch	FM	
General Business	4	4	1	2	1	12
Scientific	4	8	-	4	-	16
Specialty Applications						
• Business Oriented	2	2	1	1	-	6
• Scientific Oriented	2	14	1	3	-	20
Sub-Total	4	16	2	4	-	26
Utility						
• Business Oriented	8	4	-	2	-	14
• Scientific Oriented	4	2	-	2	-	8
Sub-Total	12	6	-	4	-	22
TOTAL	24	34	3	14	1	76

FORECAST USER EXPENDITURES FOR COMPUTER SERVICES
BY SIZE OF USER

Size of User	Expenditures ($ Millions)				Average Annual Growth Rate
	1976	1977	1979	1981	
Very Large	65.0	78.0	100	123	14%
Large	6.0	7.0	9	13	17%
Medium	6.0	7.0	10	15	20%
Small	18.5	22.2	30	43	19%
TOTAL	95.5	114.2	149	194	15%

APPENDIX B - 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:
    1. Interactive (timesharing) is 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.
    2. Remote Batch is where the user hands over control of a job to the vendor's computer which schedules job execution according to priorities and resource requirements.
    3. Data Base is characterized by the retrieval of information from a vendor-maintained data base: this may be owned by the vendor or a third party.
  - Batch Services. This includes data processing performed at vendors' sites of user programs and/or data which are physically transported (as opposed to electronically by telecommunications media) to and/or from those sites. Data entry and data output services, such as keypunching and COM processing are also included. Batch services include those expenditures by users which take

their data to a vendor site which has a terminal connected to a remote computer used for the actual processing.

- Facilities Management (FM) (also referred to as '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 users' 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 sub-categories are:

  1. Systems Packages are 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.

2. Applications Packages are 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.

- Processing Services encompasses FM, RCS, and Batch Services: They are categorized by type of service, as distinguished from mode of service, bought by users as follows:

- General business services are processing services for applications which are common to users across industry categories. Software is provided by the vendor; this can be 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 reptitive and transaction oriented.
- Scientific applications services are the processing of scientific and engineering problems for users across industries. The problems usually involve the solution of mathematical equations. Processing is generally problem solving and is non-repetitive, except in the sense that the same packages or 'tools' are used to address different, but similar, problems.
- Specialty applications services provide processing for particular functions or problems unique to an industry or industry group. The software is provided by the vendor either as a complete package or as an application 'tool' which the user employs to produce its unique solution. (Specialty applications can be either business or scientific in orientation; data base services where the vendor supplies the data base and controls access to it (although it may be owned by a third party) are also included under this category.

Examples of Specialty applications are: seismic data processing, numerically controlled machine tool software control development, and demand deposit accounting.

- Utility services are 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 'spin-off' 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 viewpoint and categorizes the expenditures according to the answer to the question 'What does the user perceive it is buying?'

Natural Gas Company and Public Servie Electric and Gas Company librarians use Lockheed's DIALOG, as does Consolidated Edison of New York.

Data bases specifically related to the petroleum industry include:

- Petroleum Information Corporation (P.I. - Denver), a subsidiary of A.C. Nielsen Company, previously part of CSC, is a 50 year old company, with 700 employees, who maintain a computerized history of almost 900,000 oil wells drilled in the U.S. since 1890. P.I. operates from 31 offices in the U.S., annually providing hundreds of publications and computer reports to oil clients as exploration - production aids. The firm operates its own IBM 370/145.
- PETROEX is made available via GEIS, and was discussed earlier, as the data base product of Williams Pipe Line.
- PDS (Petroleum Data System) is available via GEIS, and was described earlier as an oil and gas pool and field data base originated by the University of Oklahoma.
- OPS (offices of pipline safety), in conjunction with the University of Oklahoma, offers a coputerized record called OPS Automated Leak and Test Failure Reporting System.
- EPA (Environmental Protection Agency) and the Coast Guard have terminals to access data on 90 items related to chemical spills and cleanup. The data was prepared by Battelle Memorial Institute. The Coast Guard is now developing their own system CHEMTREC, sponsored by the Chemical Manufacturer's Association.

APPENDIX C - USER QUESTIONNAIRE

INPUT QUESTIONNAIRE

MAP/PETROLEUM

USER INTERVIEW

____Phone ____On-Site ____Mail

*This interview concerns user expenditures in (department, division, etc.)

1. Do you use outside computer services? (If no, skip to #5).

	% Total Services	76/75
a) Remote Computing	_____	_____
b) Batch Processing	_____	_____
c) Facilities Management	_____	_____
d) Software Products		
o System Packages	_____	_____
o Application Packages	_____	_____
e) Software Services	_____	_____
f) EDP Consulting (explain)	_____	_____

2. Describe applications:

2.1 a) ____% General Business

b) ____% Scientific

c) ____% Application Specialty (incl. data base)

2.2 a) ____Exploration & Research

b) ____Drilling

c) ____Distribution (Pipeline, Tanker)

d) ____Refining/Production

e) ____Distribution/Marketing/Retailing

2.3 Discussion:

3. Vendors

Name	Service	OK?	Rank Order of Use

4. Software Packages

Name	Vendor	Function	OK?

5. Do you have an in-house computer system? ____Yes ____No

6. For what applications do you use it?

7. Have you considered using computer services for any of the above?

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

9. What share of your budget now goes for outside services, compared with in-house expenditures?

10. How will that change in the next five years?

11. How will your overall EDP budget change in the next five years?

12. How significant are national/worldwide economic situations in determining your EDP expenditures for services, and in total?

13. Approximately how much per month are you paying now for outside computer services?

$_____

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

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

a) Geographic location of vendor _____

b) Vendors hardware/software system(explain)_____

c) Technical training/support available _____

d) Availability of national/international network _____

e) System total capacity _____

f) Price _____

g) Other _____

16. Under what conditions might you change vendors?

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

18. Where do you get information about what is available from vendors?

19. What changes or improvements would you like to see vendors adopt during the next five years, in order to make computer services more valuable to you?

20. What do you think is the potential for minicomputers in your firm?

21. Who else in your company should know about other areas of expenditures for computer services?

22. Ask for copy of recent annual report

Interviewer Notes: