

PERFORMANCE BENCHMARKS FOR I/S IN CORPORATIONS

**ANNUAL REPORT &
DATA WAREHOUSE
1990-1999**

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**PERFORMANCE BENCHMARKS FOR
INFORMATION SYSTEMS IN CORPORATIONS**
Survey of I/S Directors

About ITR Program

The IT Returns Program (ITR) is an industry-university cooperative research program conducted by the Center for Research on Information Technology and Organizations (CRITO) at the University of California, Irvine. It is supported by grants from the U. S. National Science Foundation (NSF) and the CRITO Consortium (a NSF Industry-University Cooperative Research Center) whose members include: ATL Products, The Boeing Company, Canon Information Systems, Conexant Systems, IBM Corporation, Microsoft, Nortel Networks, Seagate Technology, Inc. and Sun Microsystems. The program's earlier years were supported by grants from NSF and CSC Research and Advisory Services. Our purpose is to further the state of the art of I/S performance measurement and to improve I/S performance in practice. ITR conducts annual surveys of management practice, business value, and I/S performance in corporations. It feeds back the knowledge gained to survey participants and to ITR sponsors through publications, workshops, and client programs. For further information on the ITR Program, please contact Dr. Kenneth L. Kraemer at (949) 824-5246 or kkraemer@uci.edu.

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PERFORMANCE BENCHMARKS FOR INFORMATION SYSTEMS IN CORPORATIONS

I. INTRODUCTION

QUALITY, PERFORMANCE AND MEASUREMENT

Companies have come to see quality as a strategic tool in competition and to engage in total quality management. As a result they have begun to develop measures of performance which go beyond the traditional concern for financial performance. The measures involve broader concern for successful performance in national, international, and global markets. This broader view of performance leads them to look at measures such as market share, client satisfaction, defect rates, response time, and delivery commitments to evaluate the performance of their products, services, and operations.

In addition, advanced companies are no longer satisfied with looking only internally at their own performance in relation to prior period results, current budget, or results of other departments within the company. They are increasingly interested in comparative benchmarking.

Benchmarking involves identifying companies in other industries that exemplify best practice in some activity, function, or process and then comparing one's own performance to theirs. This externally oriented approach makes people aware of improvements that can be orders of magnitude beyond what they would have otherwise thought possible. But, benchmarking also goes beyond measurement. It involves networking with the better performing companies to learn more about *how* they achieve better performance, and *how what they do might fit* another company's circumstances.

THE IT RETURNS PROGRAM

The IT Returns Program (ITR) is aimed at such performance measurement and benchmarking in order to improve I/S practice. The focus is on information systems, including computer, networking (intranet, extranet, Internet) and, telecommunications equipment, and related software and services.

The Program focuses on information systems because they represent the single largest capital expenditure that many corporations make. Information systems are also increasingly recognized as a critical factor in corporate competitiveness, both at home and abroad.

Yet the management of information systems is a complex task which is not well understood. In fact, the top managers of many organizations believe that they are not receiving an adequate return on their investments in information technologies. This has manifested itself in many ways, ranging from the decision by some organizations to outsource their information systems function to the absence of measurable gains in the productivity statistics of American industry.

The IT Returns Program, which is a collaborative effort between industry and academia, is aimed at meeting the challenge of performance measurement, benchmarking, and improvement of I/S practice.

Framework for I/S Services Production

The provision of I/S services can usefully be viewed as comprised of two major subsystems (Exhibit 1):

- (1) The production subsystem, and
- (2) The use subsystem.

I/S Performance in Corporations

The *production subsystem* is concerned with the major production processes that constitute information systems: systems development and computer operations. The *use subsystem* is concerned with the processes of delivering information services and their integration with business processes and decision making. *Resource inputs* of labor, capital, and technology are transformed into business applications and information services for the business as a whole and for end-users. *I/S management practices* are a key determinant of the efficiency and effectiveness of the production sub-system. Among the various management practices of importance in production are the *arrangements for service provision*. Services might be provided by I/S departments, user departments, or outsourcers. These different arrangements have implications for both production processes and outcomes.

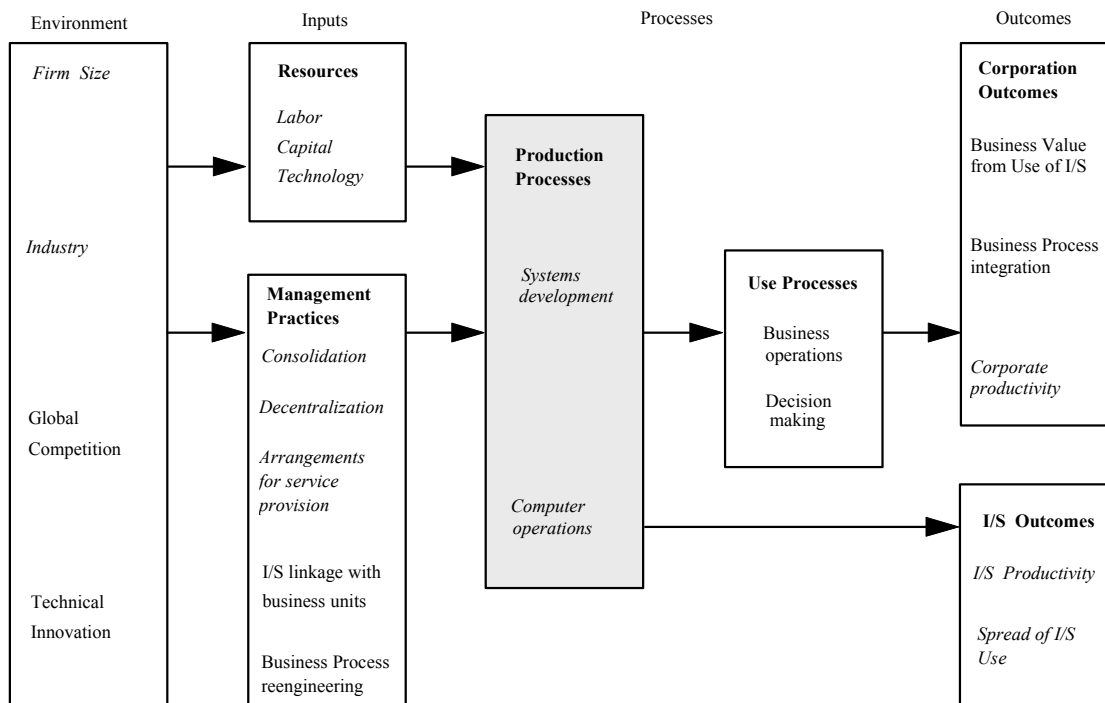
(e.g., labor-capital ratio, or the relative mix of personnel and hardware in production), *the penetration of I/S use* in the corporation, and the *business value derived from I/S use*.

In this report, we focus on the production subsystem, which is shown as the shaded area of Exhibit 1. Within the production system, we systematically examine production by I/S departments and their relationship with both the productivity of I/S service provision and the penetration of I/S use. We also note the roles of end-user computing and outsourcing in services provision, but do not examine them systematically. Throughout the report, we examine whether there are differences due to industry sector.

The specific variables of interest in this analysis are shown in italics in Exhibit 1 below.

The *outcomes* of production and use can be described by the *productivity of service provision*

Exhibit 1. Framework for I/S Services Production*



*Variables in *italics* are focus of this report.

ITR Approach to Performance Measurement

Our approach is to produce a "balanced scorecard" that is based on the Kaplan and Norton I/S framework (*Harvard Business Review*, 1991). We look at performance measurement and benchmarking for the I/S function as involving four major perspectives (Exhibit 2).

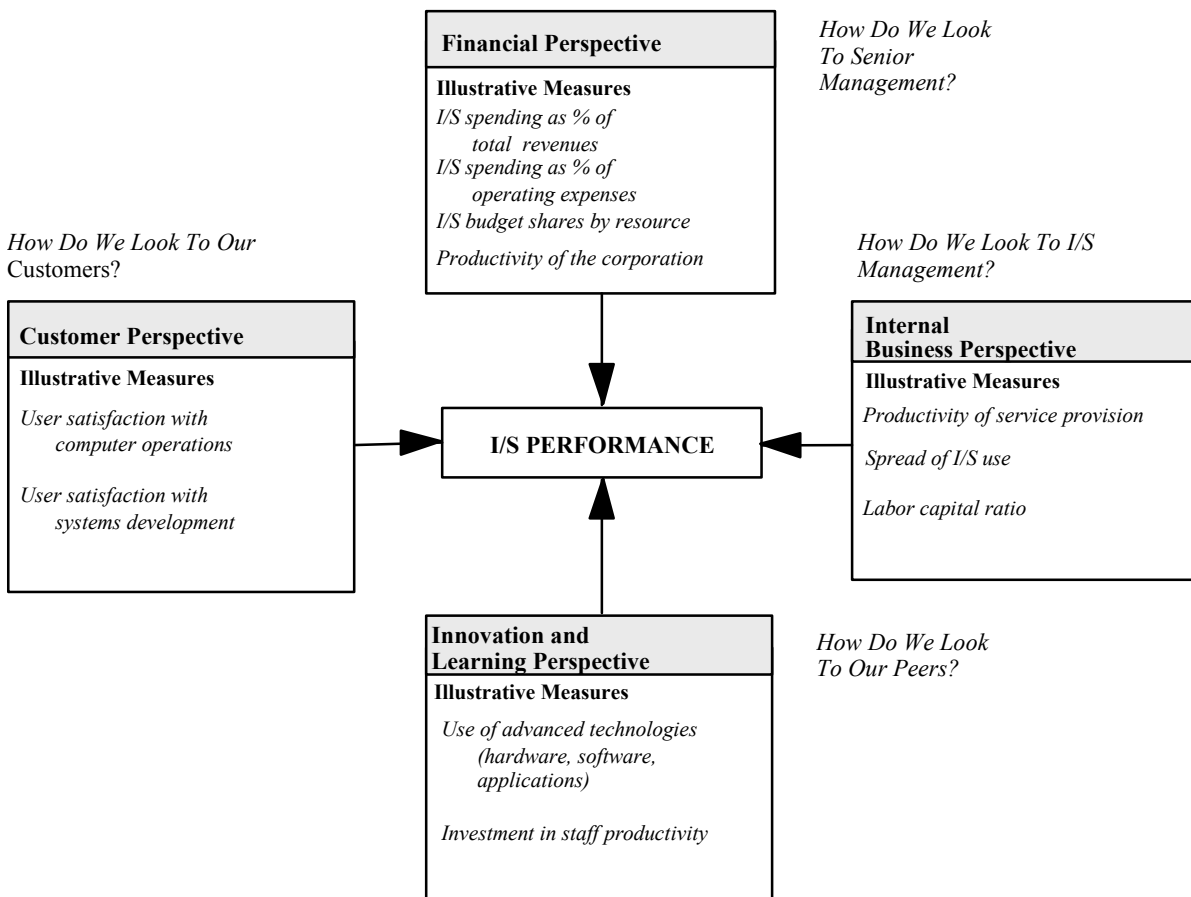
The financial perspective looks at I/S budgets as indicators of the relative cost structure and performance of I/S departments.

The internal business perspective focuses on the performance of systems development and data center operations within I/S departments.

The innovation and learning perspective examines the extent of R & D into new technologies and applications, and use of new tools and techniques by I/S departments.

The customer perspective analyzes the relationship of I/S departments to the broader business and the satisfaction of clients with I/S products and services.

Exhibit 2.
Balanced Scorecard for Information Systems



Adapted from Kaplan and Norton, *Harvard Business Review*, 1991

SURVEY OF I/S DIRECTORS AND USER MANAGERS

We gather data for ITR through a national survey of I/S directors and user managers. Over 100 corporations have participated in the survey since its beginning in 1987. Nearly half have participated more than once and some have participated every year. The Data Warehouse accompanying this report contains a list of the corporations that have participated in the survey.

This report presents the findings *for the corporation as a whole*. It is based on the ninth annual survey of the IT Returns Program (fiscal year 1999), and provides a comparison with the findings of two previous years (1990 and 1995).

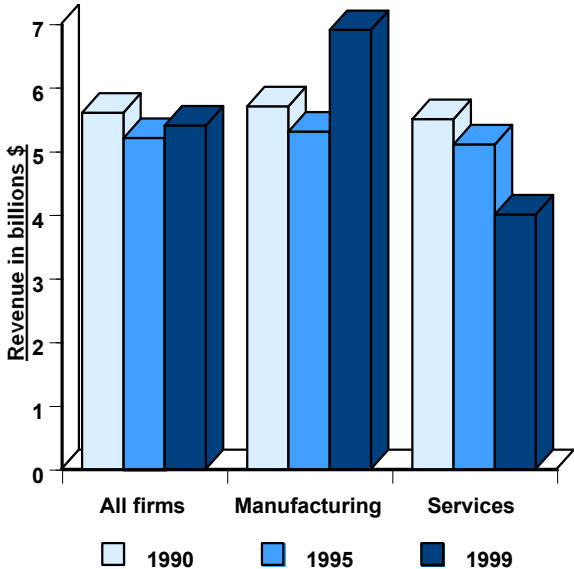
This type of longitudinal analysis is capable of generating some of the most significant and interesting findings. However, the survey and the performance measures which it produces are only one aspect of benchmarking. An equally critical aspect is networking among I/S directors, the client managers they serve, and the corporate managers to whom they report. This aspect of the ITR Measurement Program is carried out through discussions at meetings, problem solving in workshops, and intercorporate exchanges. This report, and related reports, provide the stimulus and the beginning point for these discussions and exchanges.

II. THE CORPORATE ENVIRONMENT OF I/S

CORPORATE SIZE

The average corporation in the current survey has \$5.4 billion in revenues, \$2.5 billion in operating costs, and 26,000 employees (Exhibits 3 & 4). While the manufacturing firms in 1999 tend to have more employees and higher revenue and the services firms fewer employees and lower revenues than the 1990 and 1995 samples, the differences are not statistically significant. See Section VII for comparisons of the three samples. On this basis, it is possible to compare the companies in our data warehouse over time.

Exhibit 3. Revenue, 1990, 1995, 1999

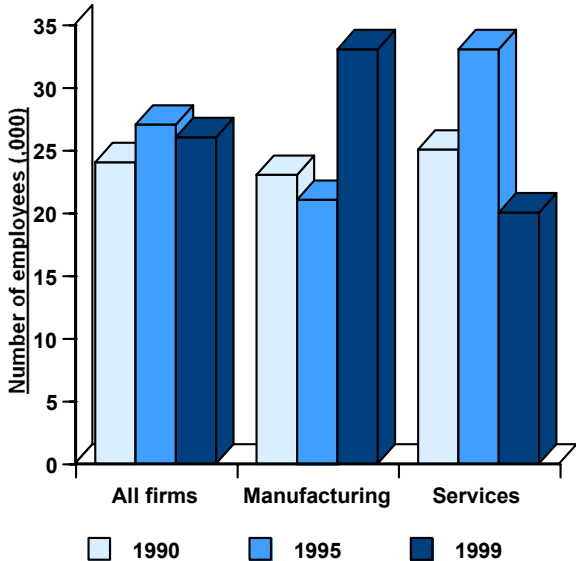


INDUSTRY SECTOR

We classify the corporations participating in the study into two broad sectors: manufacturing and services.

The services firms are primarily from the retail, insurance, financial, transportation and business services sectors; the manufacturing firms are primarily from the food, wood products, electronics and electrical machinery, and pharmaceutical sectors.

Exhibit 4. Number of Employees, 1990, 1995, 1999



The capital and information intensity of manufacturing and services firms are expected to have implications for the provision of information services. Manufacturing tends to be more capital intensive and services more labor intensive.

A parallel issue arises with regard to the information intensity of industry. In the services industry, information is the primary product or service and is integral to everything that goes on in a services firm. In manufacturing, information is only one input, either as part of a product, or as a means of coordination and control of processes in, and related to, manufacturing. In the last five years, information has become especially important to manufacturing firms as a substitute for inventory, traditional distribution channels, and labor. It has also become critical to integration of firm activities across the value chain. Consequently, manufacturing firms have invested heavily in information systems to achieve greater productivity.

III. RESOURCE INPUTS TO PRODUCTION OF I/S IN CORPORATIONS

I/S SPENDING

Corporate spending can be usefully benchmarked by two different but related measures: 1) percent I/S expenses of total corporate revenue, and 2) percent I/S expenses of total corporate operating expenses.

These measures are useful for several reasons. First, they are widely used and have been used for a decade or longer. Therefore, comparison measures usually can be found quite readily for different industries. Second, an absolute measure such as average I/S spending is not useful for comparison because of size differences among firms. These two measures take size into account. When used together, these two measures help to identify firms which have low operating expenses compared to revenues. Third, the measures show different things. The ratio of I/S spending to revenue tends to be more stable than the ratio to operating expenses because of differences in how firms define operating expenses. On the other hand, the ratio of I/S spending to operating expenses is sometimes a more realistic figure because some firms (e.g., firms in the oil and gas industries) have very high revenues relative to operating expenses and therefore a revenue-based ratio masks the real level of spending.

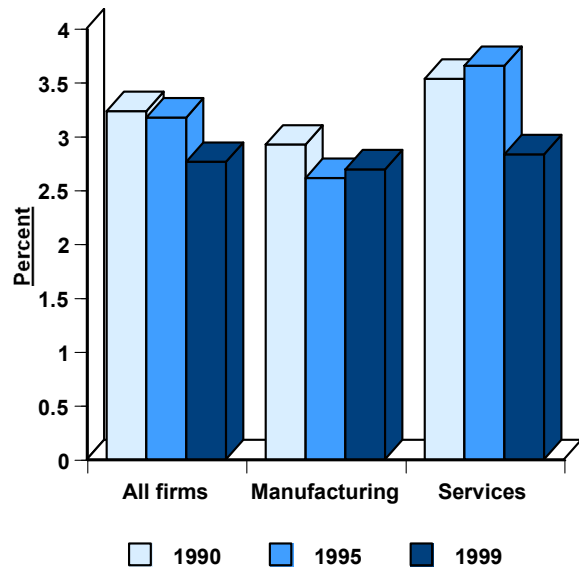
The appropriate level of spending is best determined on an individual basis. The benchmarks here show that the average firm spent around 3% of revenues and 10% of operating expenses on the I/S function in 1999. The best way to determine the appropriate level for a particular firm is to compare spending with other firms in the industry, especially firms considered to be serious competitors.

In order to facilitate such comparison, this report breaks down spending by the manufacturing and services sectors. Because of the number, size, and geographic distribution of firms in the study, we feel the benchmarks are reliable for these two sectors.

Percent I/S Expenses of Total Corporate Revenues

The average corporation's total spending on information systems through I/S departments accounted for approximately 3% of total corporate revenue in 1999 which has trended downward over the decade. (Data Warehouse, Table 5). I/S spending as a percent of revenues is similar between manufacturing and services corporations in 1999 although services previously tended to have a slightly higher percent allocation than manufacturing(Exhibit 5).

Exhibit 5. Percent I/S Spending of Total Corporate Revenues, 1990, 1995, 1999

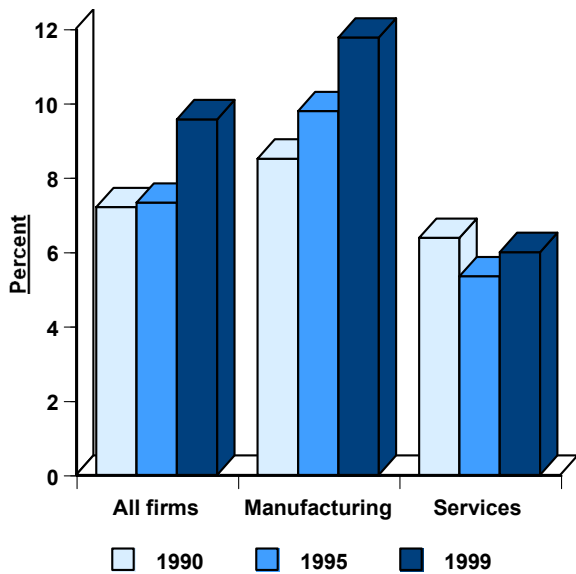


Percent I/S Expenses of Total Corporate Operating Expenses

I/S spending as a percent of corporate operating expenses shows a different pattern overall. Here I/S expenses show a steady increase among all firms since 1990 with the mean around 10% of total corporate operating expenses (Data Warehouse, Table 6).

The pattern differs between the two industry sectors(Exhibit 6). Manufacturing firms show a steady increase over the ten-year period from 8% in 1990 to 12% in 1999. Services, on the other hand, have been relatively stable at around 6% over the ten-year period; a figure that is half that of the manufacturing sector. This difference reflects the capital intensity of the manufacturing sector and the use of IT in capital-intensive production processes.

Exhibit 6. Percent I/S Spending of Total Corporate Operating Expenses, 1990, 1995, 1999

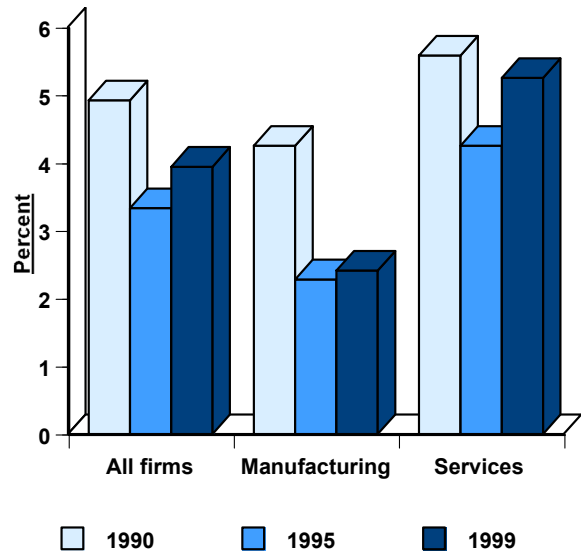


I/S PERSONNEL

In 1999, approximately 4% of the total employees in a corporation worked in the I/S function compared to around 6% in 1995 (Data Warehouse, Table 7).

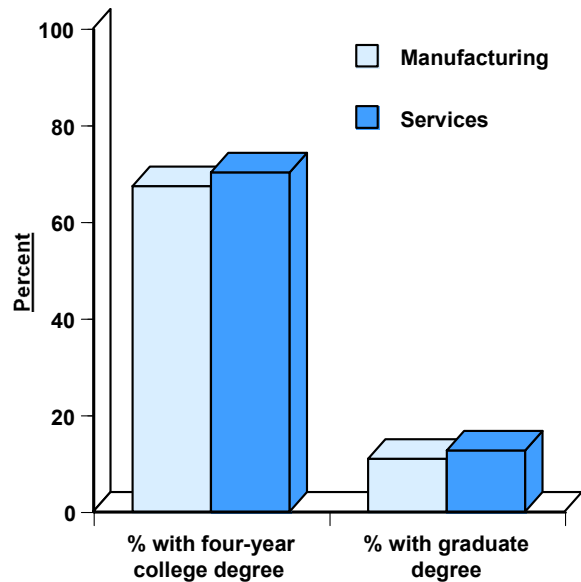
Manufacturing and services firms differ on the proportion of corporation employees allocated to the I/S unit (Exhibit 7). Services firms, on average, have more than two times the ratio of I/S employees to total employees than is found in manufacturing firms. In 1999, approximately 2.5% of manufacturing employees were in I/S, while on average 5.25% of services employees were in I/S.

Exhibit 7. Percent I/S Employees of Total Corporate Employees, 1990, 1995, 1999



I/S technical staff are highly educated with over two-thirds with a four-year college degree and a little over 10% with a graduate degree. There are no differences between manufacturing and services firms on level of education (Exhibit 8).

Exhibit 8. Educational Level of I/S Technical Staff, 1999



I/S BUDGET SHARES

The budget shares allocated to different I/S resources such as software and personnel show remarkable stability over the last ten years although important trends are discernible during the last part of the decade(Exhibit 9).

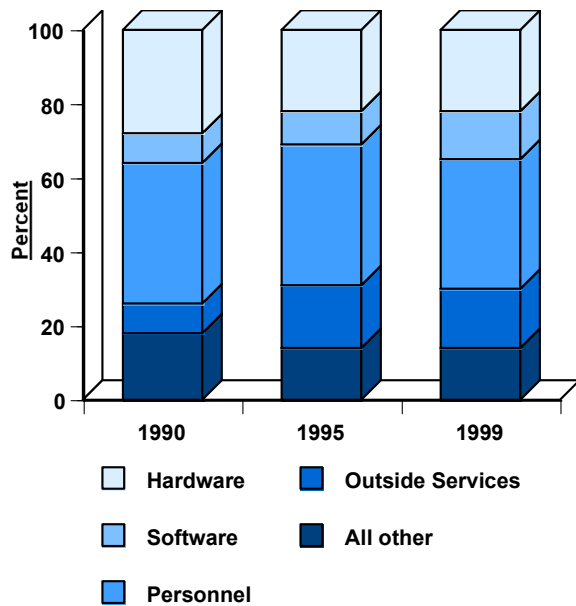
Personnel expenses continue to consume more than one-third of the budget. However, over the decade staff expenses show a steady *decline* from over two-fifths of expenses in 1990 to slightly more than one-third of expenses in 1999.

Hardware also displays a decline, going from one-quarter of the budget to almost one-fifth.

Purchased software accounts for about 13% of the budget in 1999; in 1990 it accounted for about 7%.

Outside services, such as outside time sharing, telecommunications, consulting, and outside training also has steadily *increased* from 8% in 1990 to 16% in 1999. Finally, about 14% of I/S budgets are **other expenses**, such as rent, utilities, supplies, overhead, and in-house training. The allocations of I/S budgets by resource do not significantly differ between manufacturing and services firms.

Exhibit 9. Distribution of I/S Expenses, 1990, 1995, 1999



IV. ARRANGEMENTS FOR THE PRODUCTION OF INFORMATION SERVICES

ORGANIZATION OF SERVICE PROVISION

The production of information services has been changing for years from a single mode of provision by a central in-house department to provision by additional sources, such as I/S departments in different business units, end-user computing in individual departments, and outsourcing firms.

Despite this diversity, most corporations continue to have the I/S function provided in-house. With the overall rise in end-user computing, it is often difficult to capture the total information systems costs in a firm. For example, I/S managers in 1999 estimated that from as little as 1% to as high as 95% of total corporation computing expenses occurred outside the I/S units. On average, approximately 87% of I/S services were provided by in-house I/S departments in 1999.

ALTERNATIVE ARRANGEMENTS FOR SERVICE PROVISION

Although most firms continue to provide information services through in-house departments, there has been a growing diversity in the arrangements for service provision within a single corporation. The share among different arrangements can be seen by examining the distribution of total corporation I/S spending among three primary sources:

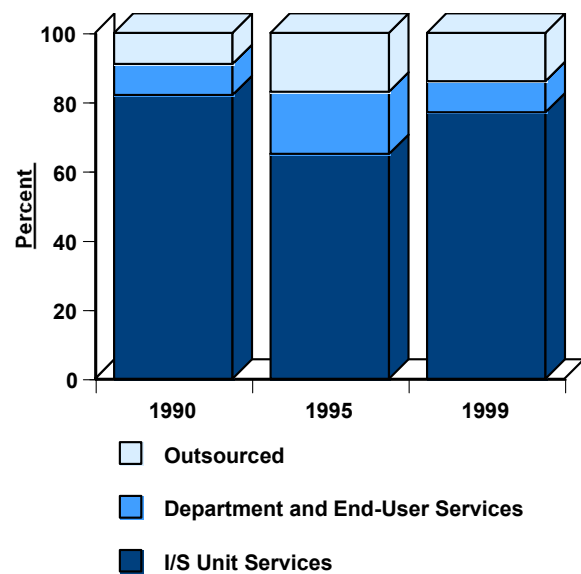
- In-house I/S departments
- User departments
- Outsourcers

"Total corporation I/S budgets" refers to the total of moneys spent by

- (1) formal I/S departments for in-house services,
- (2) user departments for their own services (estimated by CIOs), and
- (3) formal I/S departments for outside services.

The percent of total corporation spending for I/S by formal I/S departments for in-house services has declined from 82% in 1990 to 77% in 1999 (Exhibit 10).

Exhibit 10. Percent of Total I/S Services Provided by In-House I/S Unit, Departmental End-Users, and Outsourced, 1990, 1995, 1999



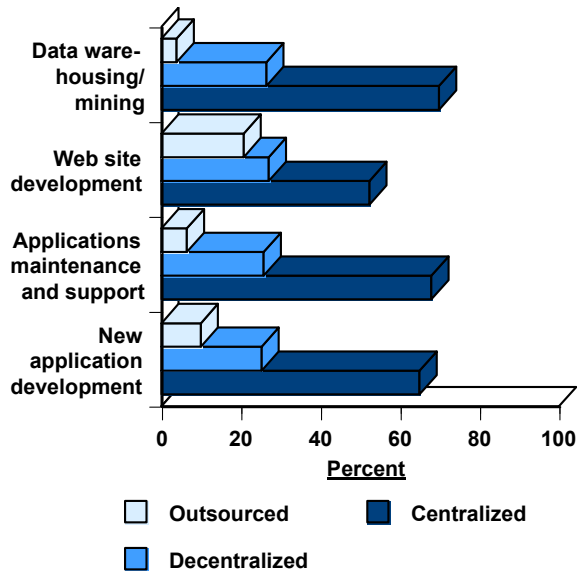
An important change in the production of information services is the provision by user departments themselves. Approximately 10% of the total I/S services in the corporation are produced outside of the I/S department in user departments in the form of departmental computing, distributed computing, or networked personal computers. This trend is equally strong in manufacturing and services firms (Exhibit 10 and Data Warehouse, Table 10).

Location of User Services

Firms are utilizing different mixes of centralized, departmental and outsourcing arrangements for the provision of user services. User services include software, hardware and training.

Software-related services. Nearly one-third of the firms either outsource the majority of these services or decentralize to the business units or departments (Exhibit 11). However, services firms are significantly more likely than manufacturing firms to centralize all these services (Data Warehouse, Table 11).

Exhibit 11. Percent of Software-Related User Services Centralized, Decentralized or Outsourced, 1999



Hardware-related services. Hardware-related services continue to be primarily the responsibility of the central unit (Exhibit 12). In contrast to software-related services, user-related hardware services are infrequently outsourced. However, from one-quarter to one-third of the firms have located responsibility for data backup and networking at the department level. Services firms are significantly more likely than manufacturing firms to centralize all hardware-related services (Data Warehouse, Table 12).

User-assistance services. Centralized help desks continue to be the preferred method for providing user support especially for services firms (Exhibit 13). While 60% of manufacturing firms provide centralized help desks, nearly all

(90%) of services firms have centralized this function. On the other hand, there is no difference between manufacturing and services firms with respect to location of responsibility for user training. Choice of location is about equally divided between the central unit (42%) and the departments (40%) (Data Warehouse, Table 13).

Exhibit 12. Percent of Hardware-Related User Services Centralized, Decentralized or Outsourced, 1999

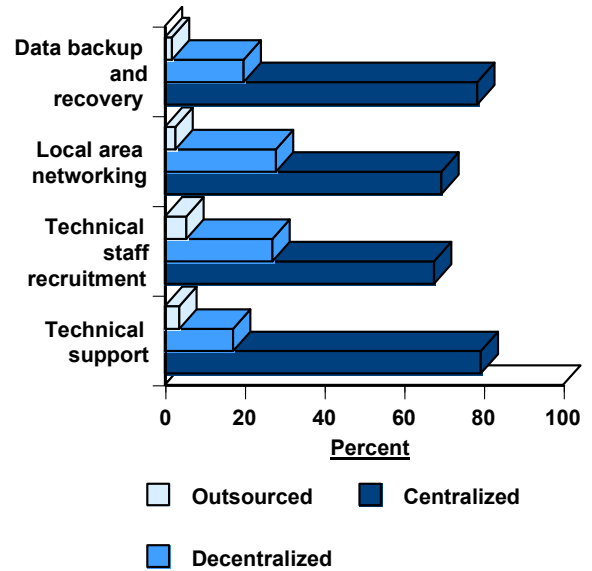
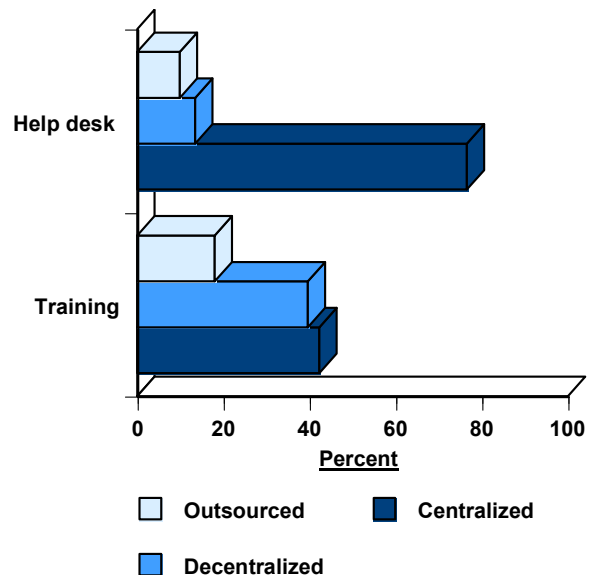


Exhibit 13. Percent of User-Assistance Services Centralized, Decentralized or Outsourced, 1999



Outsourcing of I/S Activities

The use of outsourcing continues to be on the rise. Approximately 14% of I/S services are outsourced. The proportion of outsourcing of an activity varies by activity and by type of industry (Exhibit 14 and Exhibit 15).

New systems development is increasingly being outsourced; 85% of firms outsourced on average about one-quarter of this activity (Exhibit 14). A high percent of desktop computing activities including installation, maintenance, and management also are outsourced by firms. Seventy-two percent of the firms outsourced some segment of desktop computing -- on average approximately 36% of the activity is outsourced (Exhibit 14 and Exhibit 15).

Manufacturing and services firms significantly differ in outsourcing as well as the percent of the activity outsourced. Manufacturing firms are significantly more likely than services firms to outsource the maintenance and enhancement of existing applications (90% vs. 52%) and the installation, maintenance and management of desktop computing (90% vs. 57%) (Data Warehouse, Table 14). When data center operations are outsourced, services firms on average outsource over half of the activity while manufacturing firms outsource on average only about one-fifth of the activity (Data Warehouse, Table 14).

Exhibit 14. I/S Unit Outsourcing of I/S Activities, 1995 and 1999

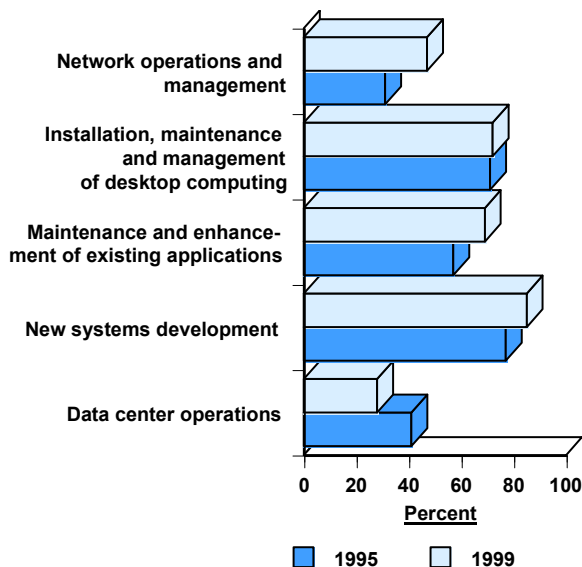
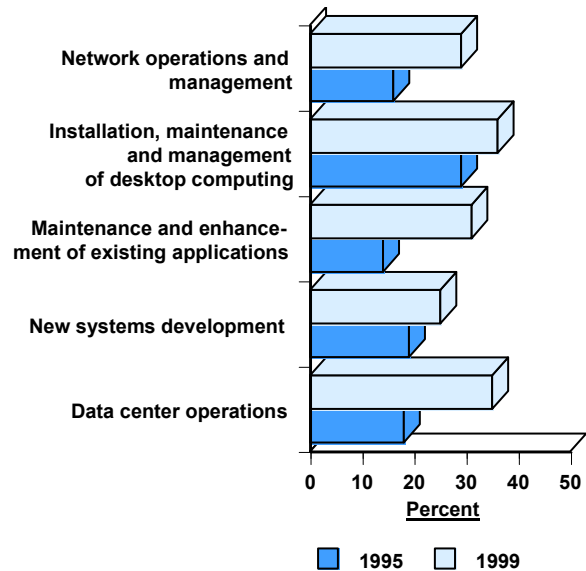


Exhibit 15. Percent of Activity Outsourced, 1995 and 1999



MANAGEMENT OF SYSTEMS DEVELOPMENT

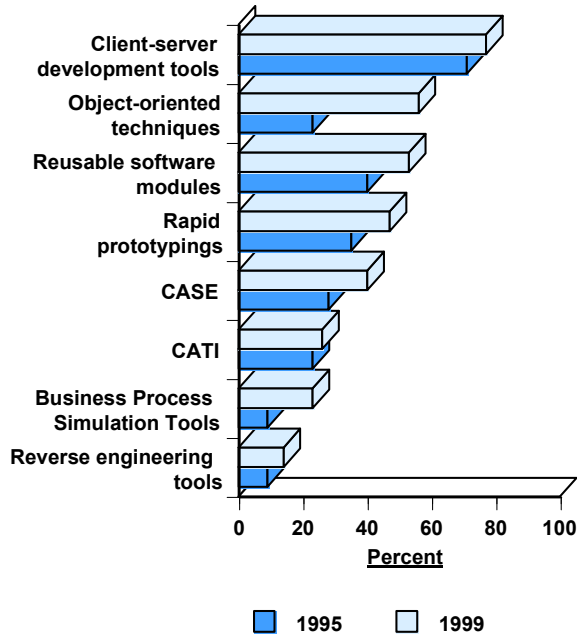
The management of systems development involves three interrelated aspects: the allocation of staff resources, the investment in staff productivity, and the use of modern development tools and techniques. Firms continue to invest in tools, techniques, and hardware aimed at increasing staff productivity.

Use of Development Tools and Techniques

The use of development tools has increased from 1995 to 1999 (Exhibit 16 and Data Warehouse, Table 16). Services firms tend to use all forms of development tools more than manufacturing firms. The difference is statistically significant.

The use of reusable software modules has increased from about two-fifths in 1995 to over half of the firms in 1999. Business process simulation tools (BPST) has increased from less than 10% of the firms in 1995 to nearly one-quarter of the firms in 1999. Object-oriented techniques have increased from one-quarter of the firms in 1995 to over half in 1999. The use of rapid prototyping has similarly increased from 1995 to 1999. (Data Warehouse, Table 16)

Exhibit 16. Use of Development Tools, 1995, 1999



In 1999, the most frequently used development tools are client-server tools (Exhibit 16). Over three-quarters of the I/S units use these tools; in contrast, only 15% use reverse-engineering techniques. One-quarter of the firms use CATI with manufacturing significantly more likely to use this tool than services (40% vs. 13%).

The use of development techniques also has risen since 1990 (Exhibit 17). Over half of all firms use Joint Application Development (JAD) and data modeling. There are no differences between services and manufacturing firms in the use of these types of development techniques.

Effectiveness of Systems Development

Firms which have widely implemented development tools and techniques appear to be more effective in their development activities than those who have not when measured by the percent of delivered projects which were completed on time, within budget and meeting all functional requirements (Exhibit 18).

Exhibit 17. Use of Development Techniques, 1990, 1995, 1999

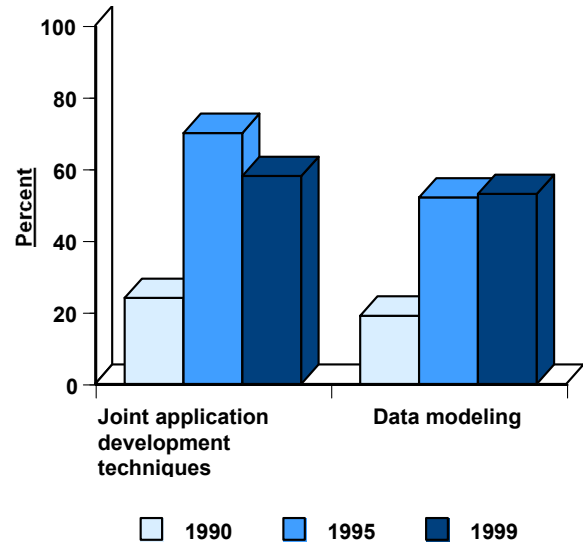
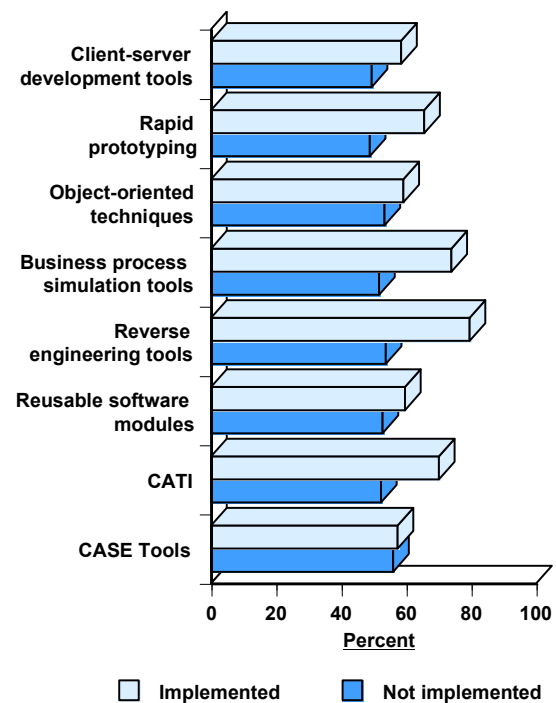


Exhibit 18. I/S Effectiveness (Percent "Successful" Projects) and Use of Advanced Technologies and Techniques, 1999



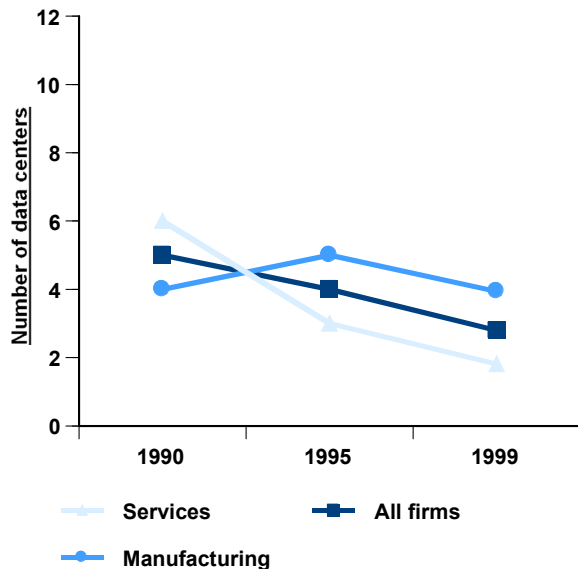
MANAGEMENT OF COMPUTER OPERATIONS

Data centers support the computing infrastructure for the operations of the firm, and therefore are a critical component of I/S performance. The goal of data center operations is to provide stable, reliable, consistent, and low cost computing services. A number of management practices are used by firms to achieve this goal. These include consolidation and automation of data centers, the standardization of technology platforms and operations, and the deployment of advanced technology.

Consolidation of Data Centers

The biggest change occurring in the management of computer operations is the consolidation of data centers and their automation. Merger of data centers is greater in services firms than in manufacturing, but most firms have been consolidating data centers (Exhibit 19). The average number of data centers in services firms is 2 while the mean is 4 in manufacturing firms.

Exhibit 19. Number of Data Centers in Corporation, 1990, 1995, 1999



Allocation of Computer Technology

The allocation of mainframe and minicomputer hardware has been remarkably stable over the last four years hovering around 4 mainframes and 60-65 minicomputers (Exhibits 20 and 21) per corporate I/S unit. The overall distribution, however, masks the significant drop in mainframe use within services firms. The number of minicomputers in contrast is more stable.

Exhibit 20. Number of Mainframes, 1990, 1995, 1999

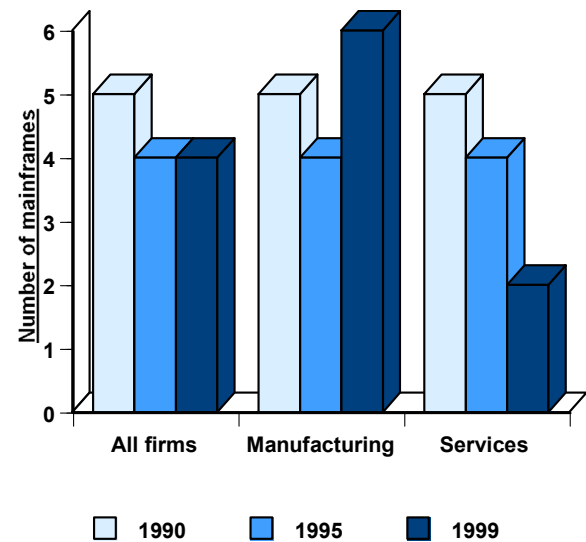
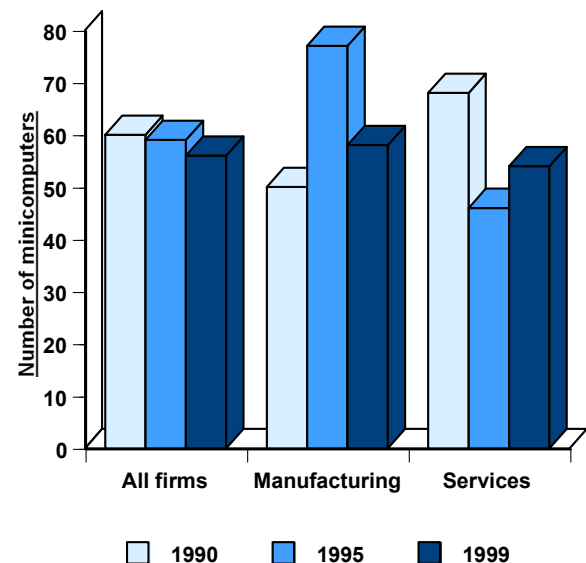


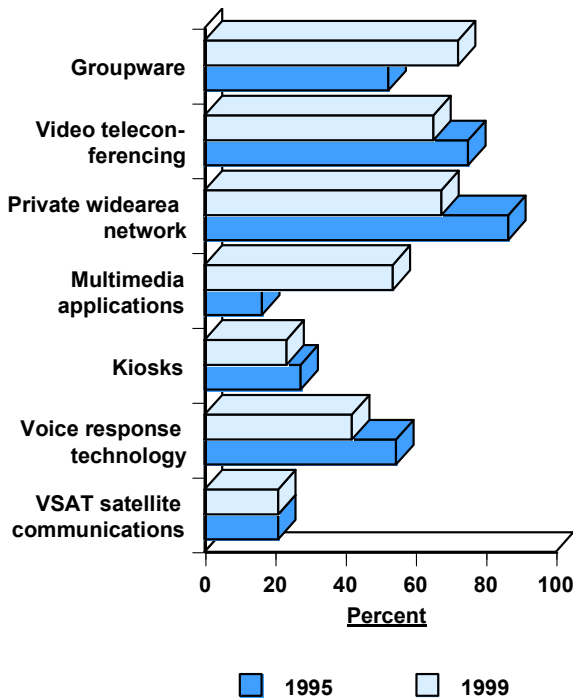
Exhibit 21. Number of Minicomputers, 1990, 1995, 1999



Deployment of Advanced Technology

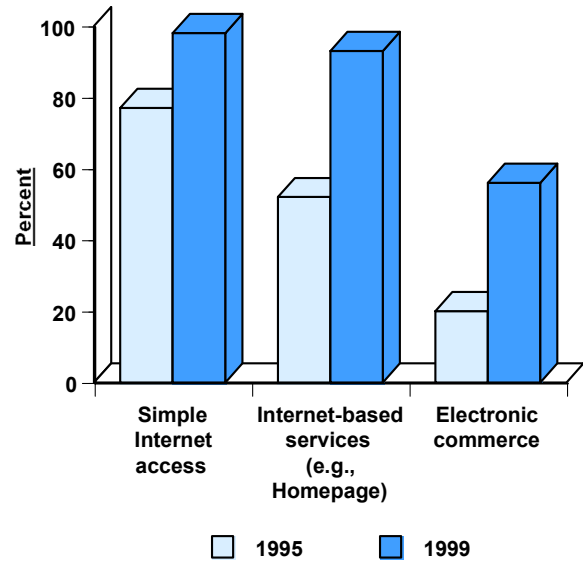
Communications support. There has been steady growth in the use of hardware technologies over the past five years most notably those supporting the Internet (Data Warehouse, Tables 22 and 23). Communications technology has been rapidly changing which makes comparisons with even the short time period of 5 years difficult. High speed networks, global and wide area networks as well as video teleconferencing and groupware have been adopted by more than half of manufacturing and services firms (Exhibit 22). Both groupware and multimedia applications show the greatest increase in adoption between 1995 and 1999. On the whole, manufacturing firms are more likely to have a wider array of communications technology available than the services firms.

Exhibit 22. Communications Support Technology, 1995 and 1999



Internet. The growth within companies of the use of Internet is widely reported. Exhibit 23 displays the changes between 1995 and 1999. The percent of companies with a Homepage doubled between 1995 and 1999. Similarly, transactions on the Internet, "E-commerce," nearly tripled in this time period. There were no differences between manufacturing and services firms.

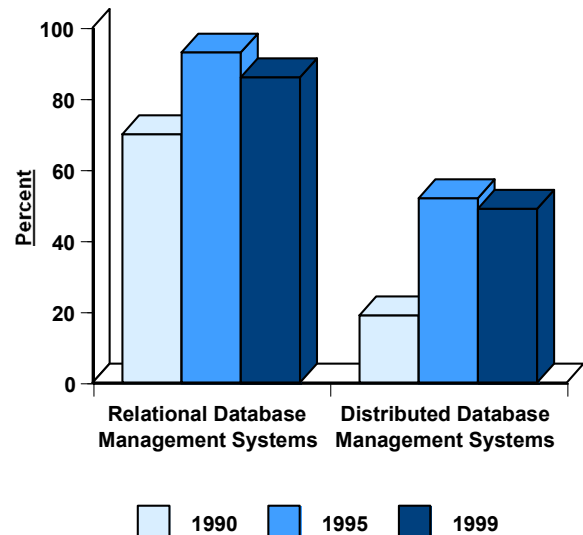
Exhibit 23. Internet Technology, 1995 and 1999



Software Technology

The use of advanced software technologies also has increased over the past ten years (Exhibit 24) with the major jump in the period 1990-1995. Relational Database Management Systems (RDMS) are used in 86% of the I/S units, with manufacturing firms leading services firms in the use of this technology. Distributed Database Management Systems are used by approximately 52% of the corporate I/S units (Data Warehouse, Table 24).

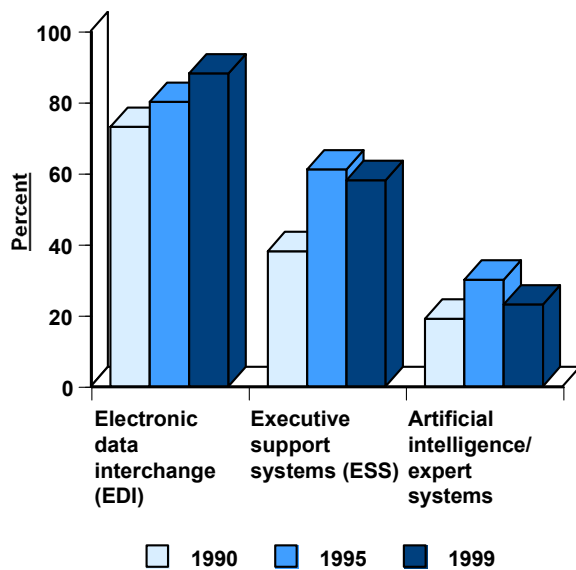
Exhibit 24. Use of Advanced Software Technologies, 1995



Advanced application technologies exhibits an increase in use over the ten-year period (Exhibit 25). During this period there has been steady growth in the use of Electronic Data Interchange (EDI), while the percent of firms using Executive Support Systems (ESS) and artificial intelligence or expert systems rose from 1990 to 1995 and has remained steady from 1995 to 1999 (Data Warehouse, Table 35).

EDI adoption has grown from 60% of the firms to 80%, while ESS has demonstrated only slight changes in reported figures (Exhibit 25). EDI is used equally by manufacturing firms (85% in 1999) and services firms (91% in 1999). Executive support systems are more frequently used by services firms (70%) than manufacturing firms (45%) (Data Warehouse, Table 25).

Exhibit 25. Use of Advanced Application Technologies, 1990, 1995, 1999



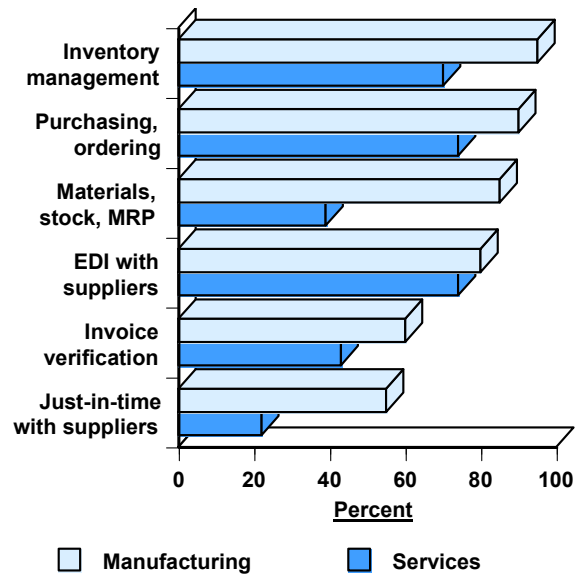
Application Portfolio

The intensity of computing within a company is indicated by the number of functions where computer support has been implemented whether on a central system or PC network. Application areas for the company were categorized using a variant of the value chain.

Supplier relations. Differences between manufacturing and services firms reflect the nature of each type of industry (Exhibit 26). Most manufacturing firms have implemented inventory management, purchasing, MRP and

EDI with suppliers. Less frequent are applications surrounding JIT with suppliers. Services firms show a similar pattern but at a lower rate. Of the total of 6 application categories, manufacturing firms, on average, have implemented 4.7 applications while services firms have implemented 3.2.

Exhibit 26. Supplier Relations Applications, 1999



Manufacturing operations. A wide range of operations applications have been implemented in manufacturing firms. On average, manufacturing firms have implemented 8.5 of a possible 12 applications listed. Nearly universally implemented are applications related to production orders, order processing, product costing, facility and equipment inventory and MRP (Exhibit 27). Much less frequently automated (although still present in roughly 50% of the firms) are the more sophisticated and specialized applications such as JIT, capacity requirements planning and engineering change management.

Services operations. On average, services firms reported implementing only one of the 3 applications listed. The most frequently implemented is that of sales and operations planning with nearly three-fifths of services firms reporting implementation of applications in this area (Exhibit 28). Services firms are least likely to have implemented service requirements and staff planning.

Exhibit 27. Manufacturing Operations Applications, 1999

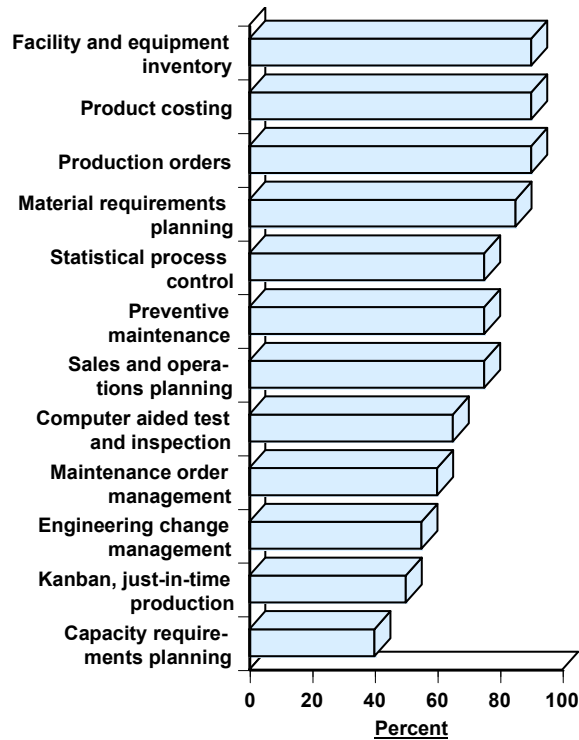
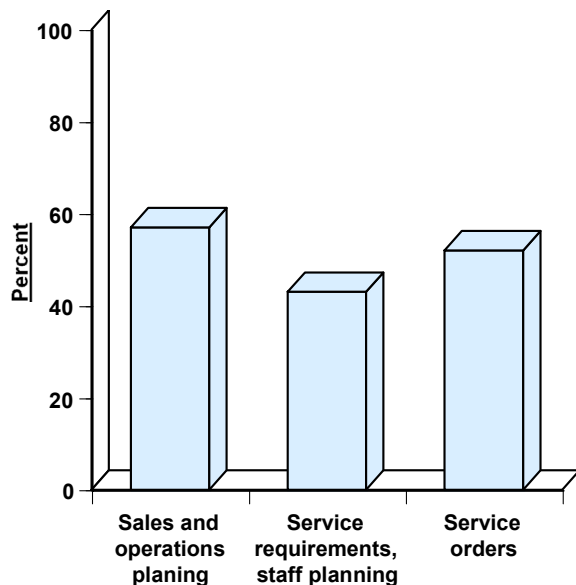
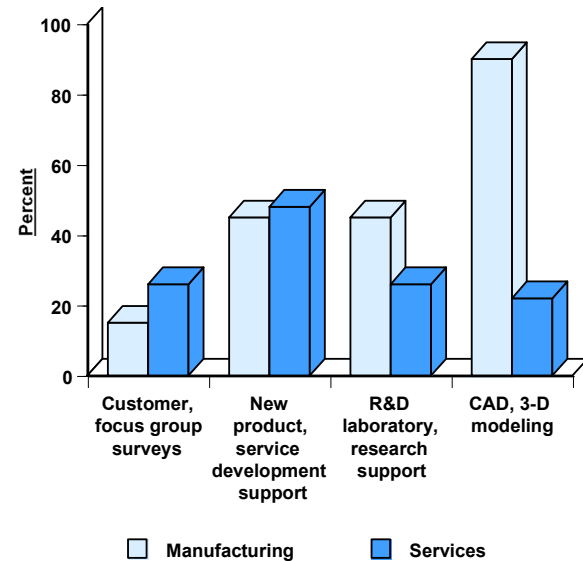


Exhibit 28. Services Operations Applications, 1999



Product and service enhancement. Less than half of both manufacturing and services firms have implemented applications which support new product/service development or research support (Exhibit 29). Nearly all manufacturing firms, however, have implemented CAD and/or 3-D modeling. The average number of applications for manufacturing firms is 1.95 and for services firms is 1.22.

Exhibit 29. Product and Service Enhancement Applications, 1999



Marketing and sales. All firms have implemented a wide variety of marketing and sales applications although there are significant differences between manufacturing and services firms. The average number of applications implemented by manufacturing firms is 5.7 and by services firms is 4.5. While the between industry difference with respect to shipping and delivery reflects the non-product component of some services firms, the significant differences with respect to sales force support and customer credit promotion are less obvious. Finally, nearly four-fifths of all firms have implemented EFT as well as EDI (Exhibit 30).

Customer relations. While customer relations is considered a top automation priority for firms, automation of critical functions varies among firms and between manufacturing and services. Less than one-third of the firms have implemented automated customer response and only two-thirds of the firms have in place a customer records information system (Exhibit 31). Manufacturing in contrast to services firms is twice as likely to have implemented a

customer service order management system (Data Warehouse, Table 31). On the other hand, services firms are more likely than manufacturing firms to have implemented a customer satisfaction monitoring system although less than 50% report such an implementation.

Exhibit 30. Marketing and Sales, 1999

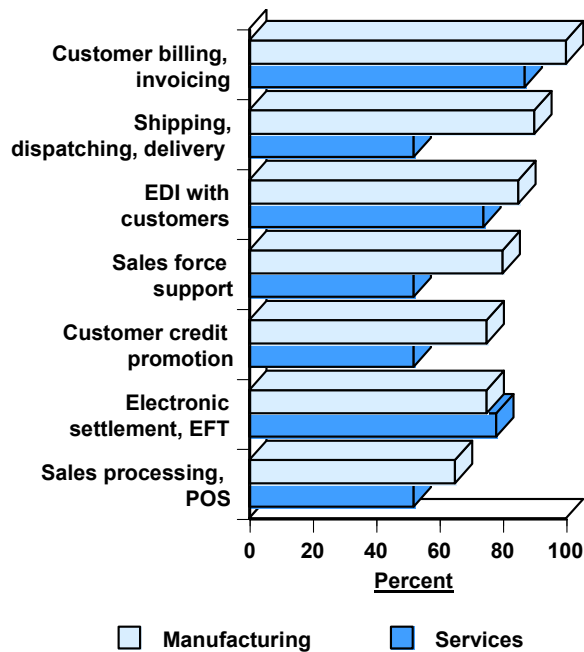
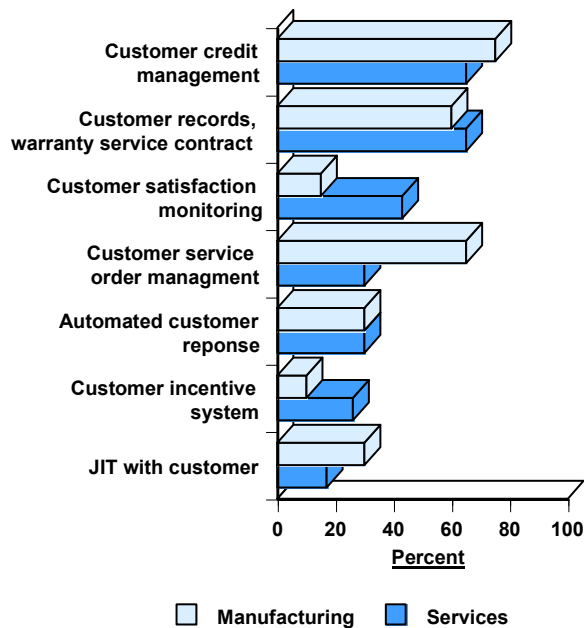


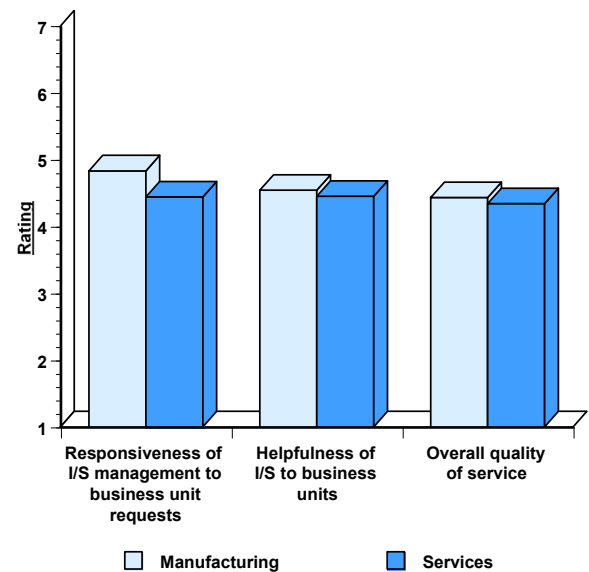
Exhibit 31. Customer Relations, 1999



Effectiveness of Computer Operations.

The effectiveness of computer operations is indicated by user ratings of the overall quality of service, the helpfulness of I/S staff to users (e.g., the help desk), and the responsiveness of I/S management to user department requests. In general, user executives are positive about computer operations, as they consistently rate operations services above 4.0 on a 7.0 scale (Exhibit 32). Executives in services firms are similar in their ratings to those in manufacturing firms except for 'responsiveness of I/S management.' Services firms executives in contrast to manufacturing firms are significantly less positive that I/S management is responsive to their needs.

Exhibit 32. User Manager Ratings of Computer Operations, 1999



V. MEASURES OF PERFORMANCE IN I/S SERVICES PRODUCTION

We use four broad measures of the outcomes of resource investments and management practices in the production of I/S services. The first is the productivity of service provision. The second is the penetration of I/S services throughout the corporation. The third is overall corporate productivity. And the fourth is overall user satisfaction with I/S services.

PRODUCTIVITY OF I/S SERVICE PROVISION

A central issue in I/S services provision is determining the productivity or relative efficiency of I/S departments. The ratio of labor expenditures to capital expenditures is a useful measure of the internal productivity of I/S departments. It says nothing about the return on investment or the business value of I/S in the corporation as a whole, but it is useful for assessing the efficiency of a single I/S department over time, or comparing several I/S departments at any point in time.

The labor-capital ratio can serve as a useful management tool because it measures production efficiency. The ratio reflects the capital intensity of the production process underlying the delivery of information services. For clarification, labor refers to personnel expenses whereas capital refers to hardware expenses.

Economists have used this measure with considerable success to explain differences in productivity in other sectors of the economy. In particular, it is argued that labor and capital are substitutes in production. That is, different ratios of labor and capital can be utilized to produce any given level of output. For a given set of labor and capital costs, there is an optimal ratio of labor to capital. As the level of capital to labor is increased towards the optimal point, output increases. However, when the optimal point is exceeded, the increases in productivity are too small to compensate for the costs of the incremental capital investment.

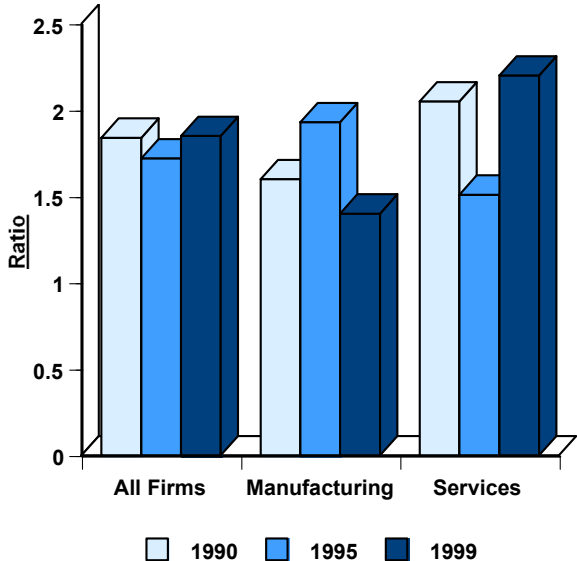
Labor-Capital Substitution and I/S Productivity

In the case of information systems, since the unit costs of hardware (capital) are dropping very rapidly relative to personnel costs, a critical method of improving the productivity of I/S is by continually substituting capital for labor. However, it is difficult to determine the optimal ratio of labor to capital in the presence of rapidly changing costs and technologies.

In such circumstances, estimates of the labor-capital expenditure ratios for corporations that are leading edge users of information services can have considerable value. These ratios provide a benchmark for I/S managers who are trying to assess the productivity of their departments. In the absence of special circumstances, a ratio that is significantly higher than the norm suggests the possible existence of inefficiencies in the production of information services and should be further investigated.

Moreover, it will be shown that the time trends in the ratio of these expenditures can also serve as a valuable planning tool for I/S managers who are trying to determine future levels of investment in hardware and personnel.

Exhibit 33. Labor to Capital Ratio, 1990, 1995, 1999



Labor-Capital Ratios for Corporate I/S

The average ratio for the 1999 sample (Exhibit 30) indicates that *corporations spend about 1.85 times as much on information systems personnel as on hardware*. The ratio continues to be fairly consistent over time (Data Warehouse, Table 33). By industry sector, however, there is a curious pattern over the past decade. In 1995, the manufacturing firms had a higher labor capital ratio than services firms (1.93 vs. 1.51) while in 1999, the difference reverses with services firms, on average, having 2 times the labor capital ratio of manufacturing firms (2.20 vs. 1.40) which is a pattern observed in the 1990 data. It is difficult without additional datapoints to assess the significance of this mid-decade reversal.

The magnitude of this ratio and its constancy over the past seven years at the aggregate level, however, is consistent with other studies of I/S budgets. These studies show that even though the unit costs of hardware have decreased at the rate of 20% per year while personnel unit costs have increased slowly in inflation-adjusted terms, the ratio of these expenditures has not changed in the last 15 years.

The knowledge that labor-capital expenditure ratios have stayed relatively constant is a useful benchmark, which should be of particular significance to I/S managers who are responsible for estimating future hardware capacity and staffing requirements.

PENETRATION OF I/S USE WITHIN THE CORPORATION

The overall penetration of technology within organizations is usually considered one useful measure of success, and can be applied to I/S as well. The penetration of I/S use within the corporation is affected by the provision of services through both the I/S function and the individual departments or so-called "distributed" and "end-user" computing. We currently measure the penetration of I/S primarily through the I/S function and formal I/S departments.

The overall penetration of information systems through the I/S department has been remarkably

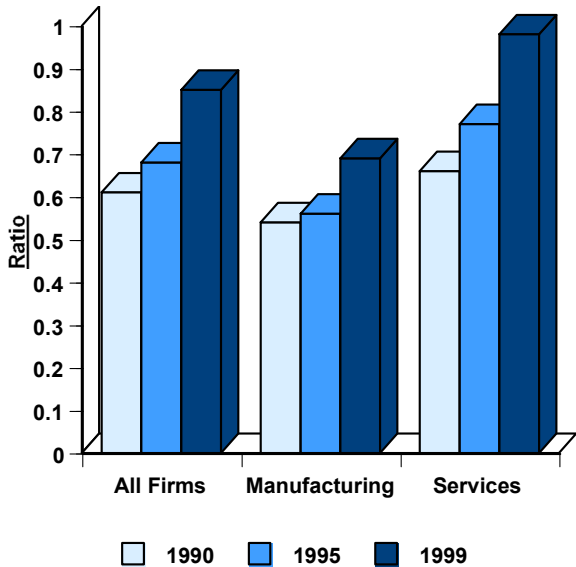
stable over the past seven years. However, there are interesting differences between manufacturing and services firms. Two broad indicators provide the basis for this conclusion:

- (1) The *extent* of I/S penetration, measured by the ratio of end-user devices to corporate employees.
- (2) The *intensity* of I/S penetration, measured by the mean *I/S department spending* per corporate employee, and the mean *total corporate I/S spending* per employee.

Extent of I/S Penetration

The average number of end-user devices such as terminals, PCs, or workstations per employee is around 0.85 for 1999 and has been steadily climbing over the decade (Data Warehouse, Table 34). This means that there is nearly one end-user device for each employee in the firm.

Exhibit 34. Ratio of End-user Devices to Employees, 1990, 1995, 1999

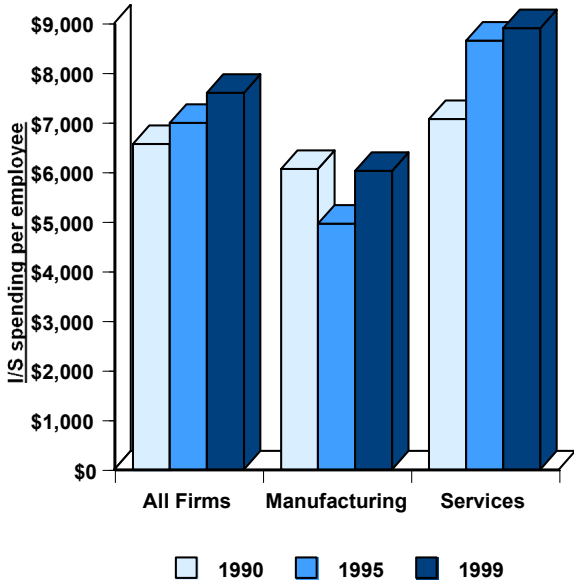


Penetration is higher in services firms than in manufacturing firms. The average number of end-user devices per employee in services firms is .98, whereas in manufacturing firms it is around .69. This pattern is as expected, and is a reflection of the higher information intensity of services firms.

Intensity of I/S Penetration

The mean spending per corporate employee by corporate I/S departments increased from \$6,989 in 1995 to \$7,594 in 1999 (Data Warehouse, Table 35).

Exhibit 35. I/S Department Spending Per Corporate Employee, 1990, 1995, 1999



The mean I/S department spending for services firms (\$8,894) is significantly higher than that for manufacturing (\$6,020). Historically this ratio between services and manufacturing has been fairly constant since 1991.

PRODUCTIVITY OF CORPORATIONS

Corporate revenue per employee is probably the most frequently used benchmark for the productivity of the corporation as a whole. Total revenue per employee for all firms shows a steady increase over the decade (Exhibit 36). This pattern is more in evidence for manufacturing than for services firms and mirrors the findings from other surveys which shows substantial productivity gains for manufacturing but less so for services firms. Many have posited that the lack of findings in the service sector is more a function of the measure used rather than a gain in productivity. However, as many have noted the 'jury is still out' for the services sector.

Exhibit 36. Total Revenue Per Corporate Employee, 1990, 1995, 1999

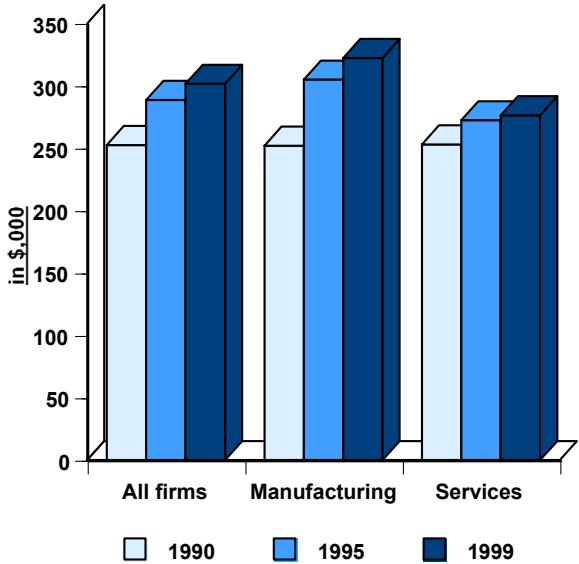
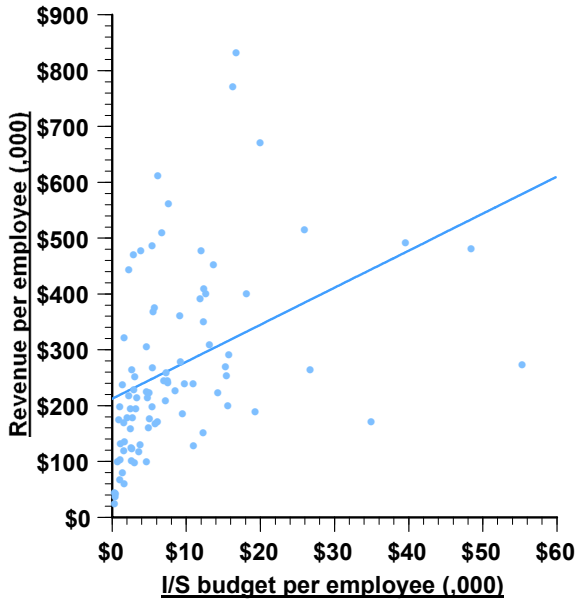


Exhibit 37. Association of I/S Spending Levels With Corporate Productivity, All Corporations, 1999



As Exhibit 37 indicates, the greater the level of spending for I/S the greater the payoff (corporate productivity) from I/S use. Exhibits 38 and 39 depict the association for manufacturing firms and for services firms.

Exhibit 38. Association of I/S Spending Levels With Corporate Productivity, Manufacturing Firms, 1999

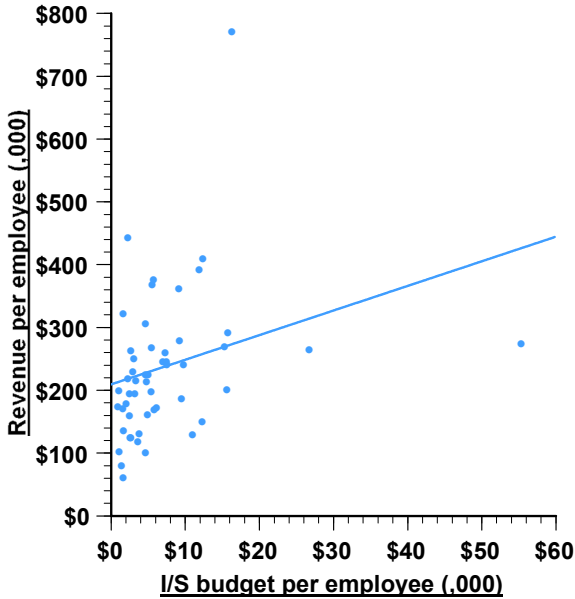
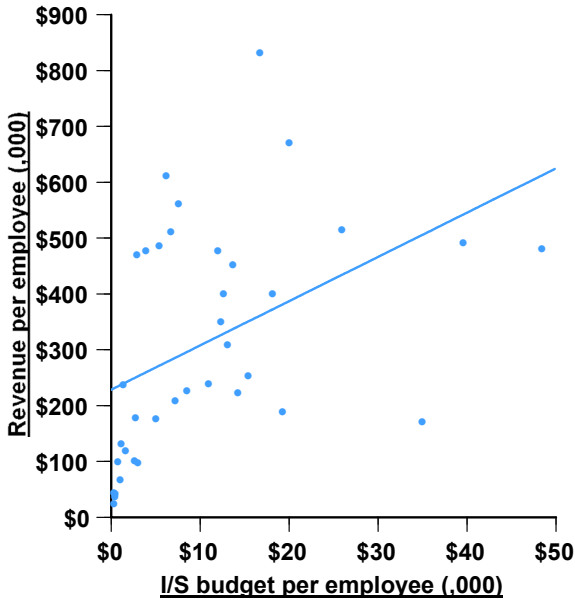


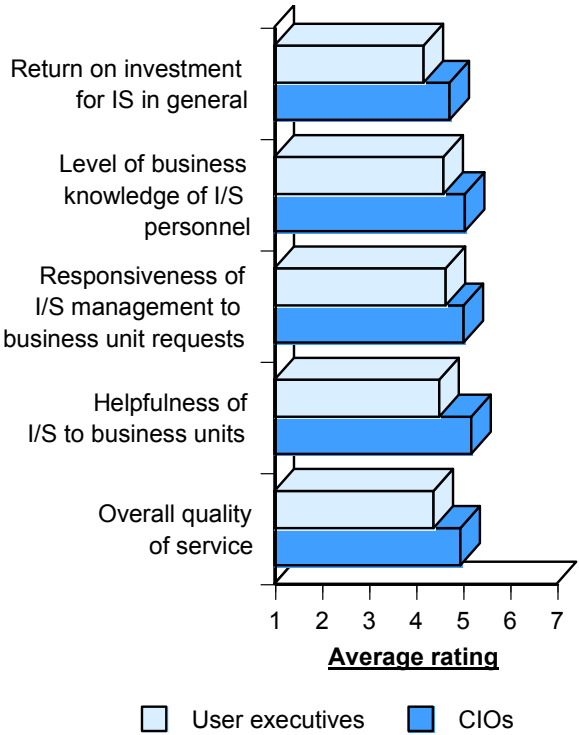
Exhibit 39. Association of I/S Spending Levels With Corporate Productivity, Services Firms, 1999



USER SATISFACTION WITH I/S SERVICES

While corporate productivity is the bottom line on I/S spending for senior executives, user satisfaction is usually the bottom line for user managers and for end-users themselves. Accordingly, the ITR survey had user managers rate the performance of the I/S units which serve them. In addition, the I/S managers were surveyed regarding how they would rate their company's senior executives' satisfaction with I/S services.

Exhibit 40. User Manager Ratings of I/S Units, 1999



In general, the user managers are positive about the services they receive. However, the juxtaposition of I/S managers' ratings and executives' ratings highlight a continuing problem between I/S and users. While overall the executives perceive I/S in a positive light, the I/S executives believe that it is even more positive. This discrepancy between the views of I/S executives and those in the units they serve is significant particularly since the question asks them to assess their company's senior executives' satisfaction rather than their own assessment. This difference is consistent across all areas queried both overall and by industry.

VI. SUMMARY

This report highlights that I/S departments in manufacturing and services firms are on very different development trajectories. Each reflects key features of their industry environment. Consequently, it is important to provide benchmarking profiles within industry. In Exhibit 41, we display the summary of I/S in manufacturing and services firms as we observed them at the beginning of 2000.

Exhibit 41. Profile of Manufacturing and Services Firms, 1999

Manufacturing Firms	Services Firms
I/S Spending	
<ul style="list-style-type: none"> • 2.7% of revenue • 11.8% of operating expenses 	<ul style="list-style-type: none"> • 2.8% of revenue • 5.9% of operating expenses
I/S Personnel	
<ul style="list-style-type: none"> • 2.4% of total employees • 67.4% with college degree • 11 years of experience 	<ul style="list-style-type: none"> • 5.3% of total employees • 70.2% with college degree • 9 years of experience
I/S Budget Shares	
<ul style="list-style-type: none"> • 24% hardware • 12% software • 34% personnel • 17% outside services • 13% all other expenses 	<ul style="list-style-type: none"> • 22% hardware • 13% software • 35% personnel • 15% outside services • 15% all other expenses
Alternative Arrangements for Service Provision	
<ul style="list-style-type: none"> • 77% by in-house department services • 8% by user departments • 15% outsourced 	<ul style="list-style-type: none"> • 77% by in-house department services • 10% by user departments • 13% outsourced
<i>Software related user services:</i>	<i>Software related user services:</i>
<ul style="list-style-type: none"> • between 40% to 60% centralized 	<ul style="list-style-type: none"> • between 62% to 80% centralized
<i>Hardware- related user services:</i>	<i>Hardware- related user services:</i>
<ul style="list-style-type: none"> • between 48% to 66% centralized 	<ul style="list-style-type: none"> • between 79% to 90% centralized
<i>Training- related user services:</i>	<i>Training- related user services:</i>
<ul style="list-style-type: none"> • between 34% to 60% centralized 	<ul style="list-style-type: none"> • between 49% to 90% centralized
Outsourcing	
<ul style="list-style-type: none"> • 35% outsource about 21% of data center operations; • 79% outsource about 26% of new systems development; • 90% outsource about 28% of maintenance and enhancement of existing applications; • 90% outsource about 36% of desktop computing; • 55% outsource about 22% of network operations and management 	<ul style="list-style-type: none"> • 22% outsource about 54% of data center operations; • 91% outsource about 24% of new systems development; • 52% outsource about 35% of maintenance and enhancement of existing applications; • 57% outsource about 37% of desktop computing; • 39% outsource about 37% of network operations and management

Manufacturing Firms**Services Firms****Use of Development Tools***Most frequently used development tools:*

- Client-server development tools (80%)
- Object-oriented techniques (60%)
- Rapid prototyping (50%)
- CASE tools (50%)

Most frequently used development tools:

- Client-server development tools (74%)
- Reusable software modules (61%)
- Object-oriented techniques (52%)
- Rapid prototyping (44%)

Use of Development Techniques

- 60% use joint application development techniques
- 50% use data modeling

- 57% use joint application development techniques
- 57% use data modeling

Use of Advanced Software Technology

- 90% use RDMS
- 50% use DDMS

- 83% use RDMS
- 48% use DDMS

Use of Advanced Application Technologies

- 85% use EDI
- 45% use ESS
- 30% use AI

- 91% use EDI
- 70% use ESS
- 17% use AI

I/S Unit Structure

- average of 6 data centers in organization

- average of 4 data centers in organization

Computer Technology

- 6 mainframes
- 58 minicomputers
- 434 LANs
- 592 servers
- 22,715 end-user devices

- 2 mainframes
- 54 minicomputers
- 73 LANs
- 163 servers
- 11,714 end-user devices

Communications Support Technology

- 85% with groupware
- 75% video teleconferencing
- 75% high speed digital network
- 70% global network
- 65% private wide area network
- 60% electronic meetings
- 60% multimedia applications

- 70% with private area network
- 61% groupware
- 61% high speed digital network
- 57% video teleconferencing
- 52% global network

Internet Technology

- 95% with simple Internet access
- 90% with Internet-based services
- 50% electronic commerce
- 51% of employees connected to Internet
- 60% connected to Intranet
- 5% connected to Extranet

- 100% with simple Internet access
- 96% with Internet-based services
- 61% electronic commerce
- 34% of employees connected to Internet
- 45% connected to Intranet
- 8% connected to Extranet

Manufacturing Firms

Services Firms

Productivity in I/S Service Provision

- Labor:capital ratio is 1.40

- Labor:capital ratio is 2.20

Penetration of I/S Use Within Corporation

- Ratio of end-user devices to employees is .69

- Ratio of end-user devices to employees is .98

Productivity of Corporations

- I/S unit spending per employee is \$6,020
- Revenue per employee is \$322,200

- I/S unit spending per employee is \$8,894
- Revenue per employee is \$276,400

VII. DATA WAREHOUSE

A. METHODOLOGY OF THE SURVEY

The target population for empirical analysis was Fortune 1000 corporations. The sample was stratified in order to insure an adequate distribution on one key control variable: industry sector (manufacturing and services).

We used this variable because both theory and other research indicate that it must be taken into account. Type of industry is important both intuitively and theoretically. Intuitively, manufacturing tends to be more capital intensive and services more labor intensive, but it is unclear whether this relationship also holds for the production of information services. Theoretically, the type of industry is important because various scholars (e.g., Daniel Bell, Simon Nora and Alain Minc, James Beniger, and Marc Porat, Alvin Toffler) argue that services industries will be at the heart of the information economies of the future to which all post-industrial societies are evolving. In the services industry, information is the primary product or service; and, it is integral to everything that goes on in a corporation. In manufacturing, information is only one input, either as part of a product, or as a means of coordination and control of processes in, and related to, manufacturing.

These differences in manufacturing and services firms are expected to have structural implications for the provision of information services. Therefore, it was important that the sampling and data collection schemes ensure adequate representation of each type of industry. We used the two-digit Standard Industrial Classification (SIC) code for typing industries similar to what is done in the Malcolm Baldrige Award Program. In addition, we have taken note of size.

Data Collection. The ITR survey expands on an annual survey which CRITO conducted up until 1996. These earlier surveys encompass the fiscal years for 1988 through 1995. For each of the surveys, data collection was performed by mail questionnaires sent to the chief information officers (CIOs). This report uses the 1999 ITR survey findings and wherever possible compares it with results from the 1990 and 1995 surveys.

Survey Responses. This report focuses on corporations and corporate I/S units. The total

number of corporations responding for each year is shown in Exhibit 51. The number of corporations providing data for fiscal year 1991 is significantly less than for the other years. Because of the smaller number of corporations represented in 1991, care should be exercised in interpreting the 1991 results.

Exhibit 51. Number of Corporations Participating in Each Fiscal Year

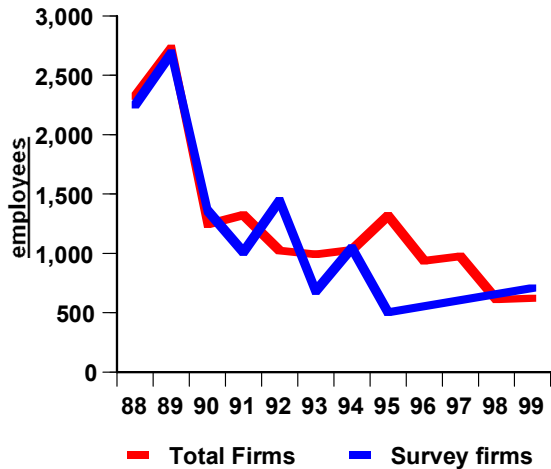
	Manufac- turing	Services	All Firms
1988	20	27	47
1989	14	15	29
1990	20	19	39
1991	7	8	15
1992	17	14	31
1993	22	24	46
1994	20	22	42
1995	21	21	42
1999	20	23	43

Applicability of Findings. As part of the ITR survey, we have been collecting existing data on corporate I/S from sources such as the *Computerworld* 100 and *Information Week* 500 for the fiscal years 1988-1999. Data on these corporations as well as the ITR survey corporations has also been augmented from data obtainable through Compustat. This database currently contains a total of 997 corporations represented over the 8 year span. Per fiscal year we have data on total I/S employees and I/S budgets that ranges from approximately 250 corporations in 1988 to nearly 450 corporations in 1999. This database provides a comparison for the ITR sample in order to determine the applicability of the ITR findings to the general population of corporations.

In Exhibits A1 to A5, comparisons between the two databases are made with respect to corporation demographics and selected I/S demographics.

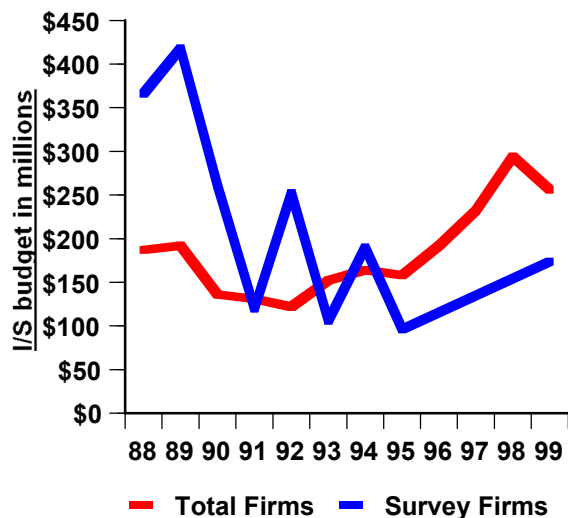
Corporation I/S Characteristics. *The trend lines for both total number of I/S staff and total I/S budget are similar between the ITR sample and the larger sample of corporations. The ITR sample and the larger sample of corporations evidence a similar pattern -- large drop in the total number of I/S staff from 1989 to 1990 and a fairly flat level of I/S staffing 1990 through 1999 (Exhibit A.1).*

Exhibit A.1 Total I/S Staff in Corporation,



The 'total firms' trend line for I/S budgets shows a remarkably flat pattern for the period 1988 to 1995, while there is more variation in the ITR firms' trend line (Exhibit A.2). Part of the reason for the fluctuation is, of course, the smaller number of cases. Indeed, none of the differences between the ITR firms and all firms is statistically significant.

Exhibit A.2 Corporate I/S Expenses



Both percent of I/S employees of total corporation employees and percent I/S budget of total corporation revenues (Exhibits A.3 and A.4) reflect similar patterns in the two samples although, the ITR sample peak and decline is primarily one fiscal year later than the comparison sample of corporations.

Exhibit A.3 Percent I/S Budget of Total Revenues, 1989-1995

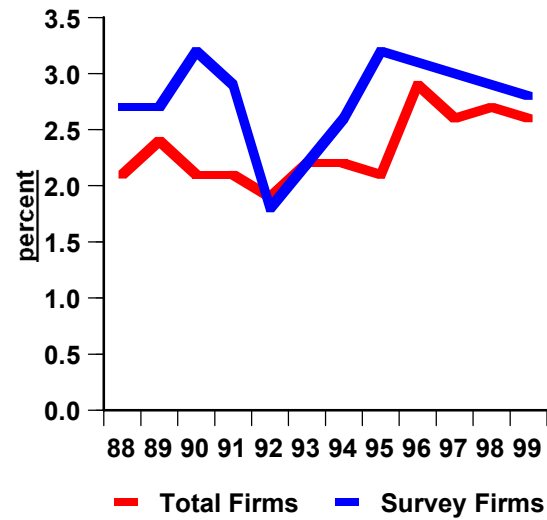
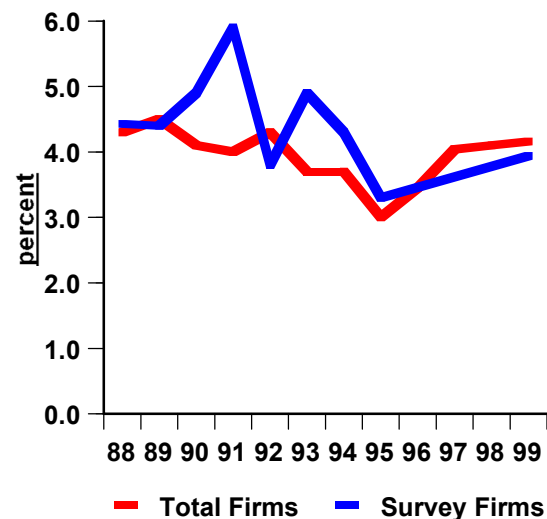
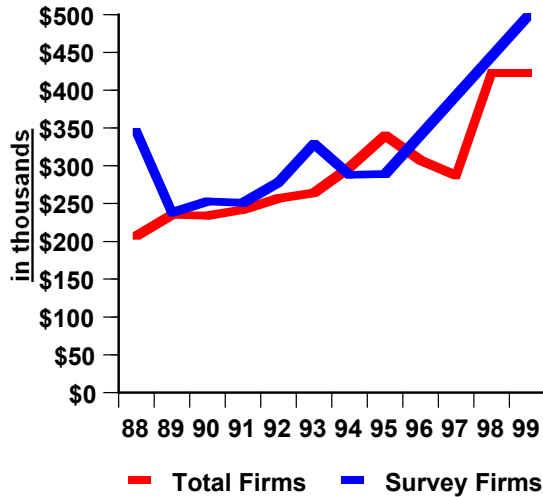


Exhibit A.4 Percent I/S Employees of Total Employees in Corporation



Corporate Productivity. Measure of corporate productivity by fiscal year is remarkably similar for the two samples. None of the differences between means per fiscal year are statistically significant.

Exhibit A.5 Corporate Revenue Per Employee (in thousands)



Conclusions. *In general, the trend lines indicate that the relationships found in this survey apply to the general population of I/S departments and corporations.* Furthermore, support for this view is provided by the fact that our benchmarks on I/S budgets and labor-capital ratios fit well with existing research on the economics of information systems. Thus, although the I/S departments in the survey are larger and more leading edge as a whole, the trends in these I/S departments could be considered a harbinger for other corporations and other I/S departments.

List of Participating Corporations, 1989-1995, 1999

21 st Century Industries	Battelle Memorial Institute	Davy Stockbrokers
AAA of Southern California	Beckman Coulter, Inc	Del Monte Foods
Accbank	Bell Atlantic	Dell Computer
Ace Hardware Corporation	BellSouth Telecommunications	Dexter Corporation
Aer Lingus	Bergen Brunswig	Diebold
Aetna Life and Casualty	Bethlehem Steel Corporation	Dimon
AGL Resources	Blue Cross Blue Shield of MI	DSC Communications
AIB Bank	Boeing	Duke Energy
Aid Association for Lutherans	Bord Gais	Earle M. Jorgensen Co.
Airborne Freight Corporation	Bord Na Mona	Eastman Kodak Company
Allergan	Borden Chemicals & Plastics	Eaton Corporation
Allstate Insurance	Borden, Inc.	EBS Building Society
Alliant Techsystems	Bowater	Ecolab
Amdahl Corporation	Bowne & Co.	Edison International
Ameren Services	Bristol-Myers Squibb	El Paso Natural Gas Company
America West Airlines	British Columbia Telephone	Electricity Supply Board
American Airlines, Inc.	Brooklyn Union Gas	Electronic Payment Services
American Cyanamid Company	Browning-Ferris Industries	Elf Atochem North America
American Electric Power Corp.	Burroughs Wellcome Company	Eli Lilly & Company
American Family Insurance Group	Campbell Soup Company	Engelhard Corporation
American Greetings	Cargill	ENSERCH Corporation
American President Companies	Centex Corporation	Entergy Services
Ameritech Services	Certified Grocers of California	Exxon Corporation
AMP	Chubb & Sons	FBD Plc.
Amoco Corporation	CIBA-GEIGY Corporation	Federal Express Corporation
Anacomp	CIGNA	Ferguson Enterprises Inc.
Analog Devices	CNA Insurance Companies	Fina
Anglo Irish Bank	Coach USA, Inc.	First Active Plc.
Anixter Inc.	Coillte Teoranta	First of America Bank Corp.
Apple Computer	Colgate-Palmolive Company	Florida Power & Light Co.
Aramark	Colonial Life Insurance	Fluor Corporation
Ashland Oil, Inc.	Conectiv	Ford Motor Company
AST Research	Conexant Systems	Foster Farms
AT&T	CONOCO	Foster Wheeler Corporation
ATL Products	Consolidated Edison Co.of NY	Friends First Holdings Ltd.
Avery Dennison	Consolidated Freightways, Inc.	Furr's Inc.
Baltimore Gas & Electric	Consolidated Paper, Inc.	Gateway
Bandag	Consumers Power Company	Gaylord Container
Bank of America	Corning, Incorporated	GE Plastics
Barnett Banks, Inc.	Curwood	General American Life Insurance

General Dynamics	Land O'Lakes	North Atlantic Energy Service
General Electric Company	Lear Corporation	Northrop-Grumman Corporation
Genesis Health Ventures	Lejeune Steel	Northwestern Mutual Life
Georgia-Pacific	Lever Brothers	Norwich Union Life
Getty Petroleum Marketing	Levi Strauss & Company	Novell
Golden Vale Plc.	Lexis-Nexis	Occidental Petroleum Services
Goodyear Tire and Rubber Co.	Liz Claiborne	Oracle
Grand Metropolitan	Lockheed Corporation	Owens & Minor
Granite Construction Inc.	London Life Insurance	Owens-Corning Fiberglas Corp.
Greencore Group Plc.	Los Alamos National Lab	Pacific Bell
GTE Service Corporation	Louisville Gas and Electric	Pacific Bell Directory
Gulfstream Aerospace	MacMillan Bloedel	Pacificare
H&R Block	Mallinckrodt Medical, Inc.	Paktank Oil Nederland BV
Hallmark Cards, Inc.	Marriott Corporation	Parker Hannifin
Handleman	Maytag Corporation	PaylessCashways, Inc.
Heitons	McDonald's Corporation	Pennsylvania Power and Light
Hewlett Packard	Mead Paper	People's Bank
Hibernian Group	Mercantile Bank N.A.	Pennzoil
Hilton Hotels	Mercedes-Benz	PepsiCo, Inc.
Hoechst Celanese Corporation	Merrill Corporation	Petro-Canada, Inc.
Honeywell	Michaels Stores	Pharmacia & Upjohn
Household International	MicroAge, Inc	Phillips Petroleum Company
IAWS	Miller Brewing Company	Pillsbury Company
ICS Building Society	Modine Manufacturing	PMI Food Equipment
Independent News & Media	Moen, Inc.	Portland General Electric Co.
Ingram Micro	Montgomery Ward	Pratt & Whitney Canada Inc.
Irish Express Cargo Ltd.	Moore Corporation	Principal Financial Group
Irish Life and Permanent	Morrison Knudsen	Progressive Corporation
Irish Times	Mutual of New York	Public Service Electric & Gas
J&L Specialty Steel	Mutual of Omaha	Rayonier
JB Hunt Transport Service	NAC Reinsurance	Reliance Electric Corporation
JC Penney	Nabisco Foods Group	Rexnord Corporation
JM. Huber Corporation	National Fuel Gas	Reynolds Metals Company
Johnson & Johnson	National Semiconductor	Riverwood International
Humana, Inc.	Nationwide Mutual Insurance	Roadway Express
IBM Corporation	National Semiconductor	Rockwell International
IBM Canada, Ltd.	NCR Corporation	Rogers Cantell
Illinois Power Company	NCS	Rohm and Haas Company
Int'ntl Flavor & Fragrances	New Ireland Assurance Co.	Roundy's Inc.
JC Penney	Niagara Mohawk	Royale Sun Alliance
Kansas City Power and Light	Nike Corporation	RPM, Inc
KeyCorp	Nordstroms	Ryder Transport
Kroger	Nortel Networks	Sage Software

Sandia National Laboratories
Sandoz Pharmaceuticals Corp.
SBC Communications
Scott Paper Company
Seagate Technology
Sealy
Shoney's
Simplified Telesys
Simpson Paper
Smurfit-Stone Container
Soletron
Solutia, Inc.
Sonat, Inc.
Southern California Edison
So. New England Telecomm
Sports Authority
Springs Industries
Sprint Cellular
SPS Payment Systems
Standard Life
Standard Register
Staples, Inc.
Storage Technology Corp.
Stussy, Inc.
Sun Healthcare Group
Sun Microsystems
Sun Life of Canada
Sunbeam Corporation
Sundstrand Corporation
Syntex Laboratories, Inc.
Taco Bell Corporation
Tektronix
Telecom Eireann
Temple Inland
Tennessee Valley Authority
Tesco Ireland
Texaco
Texas Instrument
Texas Utilities Services, Inc.
Textron Inc.
The Southern Company
Toyota Motor Sales
Toys "R" Us, Inc.
Transatlantic Holdings
Transamerica Insurance Group
Transcanada Pipeline
The Travelers Companies
Turner Corporation
UCAR Carbon Company
UNUM Life Insurance Co.
Ungermann-Bass, Inc.
Union Camp Corporation
Union Electric
Uniroyal Chemical Company
Unisys Corporation
United Airlines
United Drug, Plc.
United Healthcare Corporation
United Jersey Banks
United Parcel Service
Universal Health Services
Unocal
Upjohn Company
USAIR
US West Technologies
Utilicorp United
Valassis Communications Inc
Valspar Corporation
Vanguard
Varian
Venator Group
Voluntary Health Insurance
Waterford Crystal
Wellpoint Health Networks
Western Digital
Western-Southern Life Insurance
Westinghouse Energy Systems
Weyerhaeuser Company
Whirlpool
Wickes Inc
Witco Corporation
Xerox Corporation
Yellow Corporation

DATA TABLES

The tables listed below provide the data used to construct the graphs in the report. Unless otherwise indicated, the mean values were used to construct the report graphs. Each table provides the mean and the median values for manufacturing firms, service firms and all firms combined. The table number is the same as the exhibit number in the report.

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B. DATA TABLES FOR THE EXHIBITS

Table 3. Revenue and Operating Expenses, 1988-1995, 1999

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
<i>Total revenue from operations in billions</i>						
1988	\$5.7	\$3.6	\$7.3	\$5.9	\$4.7	\$2.8
1989	\$6.1	\$4.8	\$6.2	\$4.8	\$5.9	\$4.9
1990	\$5.6	\$3.1	\$5.7	\$2.2	\$5.5	\$4.3
1991	\$5.7	\$4.0	\$4.3	\$4.0	\$6.9	\$4.1
1992	\$6.0	\$4.2	\$5.5	\$3.7	\$6.9	\$6.5
1993	\$4.5	\$3.4	\$4.2	\$3.4	\$4.7	\$3.6
1994	\$4.9	\$3.3	\$4.9	\$3.1	\$4.9	\$3.6
1995	\$5.2	\$2.8	\$5.3	\$1.9	\$5.1	\$2.8
1999	\$5.4	\$1.2	\$6.9	\$2.0	\$4.0	\$1.1
<i>Total operating expenses in billions</i>						
1988	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1989	\$3.5	\$2.2	\$3.7	\$1.6	\$3.3	\$2.8
1990	\$2.7	\$1.4	\$2.3	\$1.4	\$2.9	\$1.4
1991	\$3.2	\$2.1	\$3.1	\$2.1	\$3.4	\$1.8
1992	\$2.9	\$0.9	\$2.8	\$0.9	\$3.1	\$1.6
1993	\$2.3	\$1.4	\$1.2	\$0.9	\$3.3	\$2.6
1994	\$2.9	\$1.5	\$2.0	\$0.9	\$3.5	\$2.5
1995	\$3.1	\$1.2	\$2.6	\$0.7	\$3.5	\$2.3
1999	\$2.5	\$0.7	\$2.1	\$0.7	\$3.1	\$0.7

Table 4. Number of Employees in Sample Corporations, 1988-1995, 1999

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1988	36,966	17,600	46,597	26,700	29,832	8,397
1989	31,621	19,627	35,202	28,129	28,517	19,453
1990	24,069	13,650	23,041	13,000	25,096	14,300
1991	28,079	21,000	27,114	24,000	28,923	10,941
1992	24,795	16,000	24,632	16,000	25,094	16,042
1993	19,553	10,000	18,398	9,230	20,658	12,000
1994	22,667	9,611	20,065	9,100	24,810	10,040
1995	27,369	8,200	21,092	8,150	32,828	8,758
1999	25,928	6,000	33,114	8,500	19,993	4,500

Table 5. Percent I/S Spending of Total Corporate Revenues, 1988-1995, 1999

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1988	2.70%	1.69%	2.69%	1.71%	2.71%	1.67%
1989	2.68%	1.98%	2.72%	1.84%	2.65%	2.18%
1990	3.23%	2.51%	2.92%	1.84%	3.53%	2.81%
1991	2.90%	2.83%	2.60%	2.07%	3.17%	3.22%
1992	1.81%	1.80%	1.84%	1.80%	1.74%	1.70%
1993	2.20%	1.75%	2.35%	1.75%	2.06%	1.73%
1994	2.57%	1.80%	2.28%	1.72%	2.81%	1.93%
1995	3.17%	1.72%	2.61%	1.20%	3.65%	2.51%
1999	2.76%	1.70%	2.69%	1.72%	2.83%	1.67%

Table 6. Percent I/S Spending of Total Corporate Operating Expenses, 1989-1995, 1999

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	5.44%	3.37%	6.16%	5.31%	4.79%	2.68%
1990	7.20%	5.47%	8.50%	5.73%	6.37%	4.71%
1991	7.40%	5.55%	6.37%	5.55%	8.31%	5.84%
1992	6.75%	5.88%	5.76%	5.88%	8.48%	6.16%
1993	6.81%	4.25%	8.55%	6.48%	5.15%	3.14%
1994	7.18%	4.51%	9.37%	6.13%	5.52%	3.50%
1995	7.32%	5.08%	9.78%	6.23%	5.34%	3.19%
1999	9.56%	7.35%	11.76%	10.20%	5.88%	5.32%

Table 7. Percent of I/S Employees of Total Corporate Employees, 1988-1995, 1999

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1988	4.43%	3.35%	3.30%	2.54%	5.22%	3.79%
1989	4.40%	3.55%	3.39%	2.53%	5.42%	4.81%
1990	4.92%	3.88%	4.25%	3.33%	5.58%	4.65%
1991	5.95%	4.62%	3.15%	2.76%	8.40%	9.80%
1992	3.81%	2.33%	2.18%	1.84%	6.81%	5.10%
1993	4.87%	3.42%	3.26%	2.59%	6.49%	4.54%
1994	4.31%	3.55%	3.24%	2.71%	5.26%	4.12%
1995	3.33%	2.50%	2.28%	1.70%	4.25%	3.59%
1999	3.94%	2.30%	2.41%	1.85%	5.25%	4.14%

Table 8. Education and Experience Level of I/S Technical Staff, 1999

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
<i>Percent I/S technical staff with 4-year college degree</i>						
1999	68.8%	75.0%	67.4%	75.0%	70.2%	72.5%
<i>Percent I/S technical staff with graduate degree</i>						
1999	11.8%	10.0%	10.9%	10.0%	12.6%	9.0%
<i>Average number of years of experience</i>						
1999	10	9	11	10	9	8

Table 9. Distribution of I/S Expenses, 1989-1995, 1999

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
<i>Total hardware expenses</i>						
1989	26.3%	27.1%	26.5%	25.6%	26.2%	27.1%
1990	27.9%	28.2%	28.7%	29.4%	27.1%	26.3%
1991	28.1%	29.8%	26.5%	29.6%	29.6%	30.1%
1992	26.7%	27.5%	25.0%	24.7%	29.4%	27.7%
1993	27.5%	26.6%	27.0%	26.6%	28.0%	27.2%
1994	26.4%	25.1%	27.1%	26.6%	25.8%	24.8%
1995	22.1%	22.5%	22.1%	22.5%	22.0%	22.4%
1999	22.5%	20.8%	23.7%	25.6%	21.5%	17.0%
<i>Total software expenses</i>						
1989	6.0%	5.7%	5.6%	5.7%	6.4%	5.0%
1990	7.5%	6.3%	6.9%	6.8%	8.1%	6.1%
1991	7.2%	6.8%	6.8%	5.7%	7.6%	7.3%
1992	7.7%	7.2%	7.3%	6.7%	8.2%	7.3%
1993	8.4%	8.7%	8.5%	9.1%	8.3%	8.3%
1994	8.4%	8.2%	8.0%	6.7%	8.7%	8.8%
1995	9.4%	8.9%	9.7%	9.3%	9.0%	8.4%
1999	12.8%	11.3%	12.3%	9.9%	13.3%	11.9%
<i>Total personnel expenses</i>						
1989	40.9%	41.9%	39.2%	38.8%	42.5%	43.2%
1990	38.4%	38.0%	37.8%	36.2%	39.0%	38.7%
1991	42.7%	45.5%	43.0%	46.4%	42.3%	43.1%
1992	42.5%	45.1%	42.4%	41.9%	42.8%	46.7%
1993	42.5%	45.1%	42.4%	40.4%	39.3%	40.2%
1994	38.2%	37.6%	38.4%	38.1%	38.0%	37.2%
1995	38.2%	37.9%	37.7%	39.0%	38.8%	37.4%
1999	34.8%	34.7%	34.3%	34.4%	35.1%	34.7%
<i>Total outside services expenses</i>						
1989	8.6%	5.0%	10.5%	5.0%	6.8%	5.0%
1990	7.8%	6.2%	7.1%	5.0%	8.4%	7.6%
1991	9.5%	4.4%	7.1%	5.0%	8.4%	7.6%
1992	11.9%	7.9%	13.6%	7.2%	9.1%	8.4%
1993	13.4%	9.1%	14.5%	12.8%	12.4%	7.4%
1994	15.4%	10.1%	13.6%	8.0%	16.9%	10.6%
1995	16.9%	11.3%	14.9%	13.0%	18.9%	9.6%
1999	15.9%	13.6%	16.8%	13.5%	15.1%	14.3%
<i>All other expenses</i>						
1989	18.2%	14.4%	18.3%	14.9%	18.1%	13.0%
1990	18.4%	15.7%	19.4%	18.6%	17.5%	13.6%
1991	12.5%	11.2%	13.7%	12.1%	11.3%	10.4%
1992	11.2%	10.4%	11.7%	10.9%	10.5%	9.6%
1993	10.8%	9.1%	9.7%	6.6%	12.0%	11.1%
1994	11.7%	10.4%	12.9%	13.3%	10.6%	9.1%
1995	13.8%	12.7%	15.5%	15.0%	12.1%	11.2%
1999	14.0%	9.3%	12.9%	9.8%	15.0%	9.3%

Table 10. Percent of Total I/S Services Provided By In-House I/S Unit, Departmental End-users and Outsourced, 1991-1995, 1999

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
<i>Percent In-House I/S Department Services</i>						
1991	82.2%	81.4%	76.6%	78.8%	87.1%	91.1%
1992	62.6%	62.7%	61.0%	56.5%	65.6%	67.3%
1993	72.6%	73.3%	70.4%	72.8%	74.8%	78.0%
1994	69.9%	71.8%	71.2%	73.0%	68.9%	69.6%
1995	65.3%	70.9%	62.8%	70.9%	67.9%	70.9%
1999	77.2%	80.0%	77.1%	79.4%	77.3%	80.6%
<i>Percent Outsourced</i>						
1991	8.6%	3.9%	9.0%	3.6%	8.2%	5.7%
1992	11.1%	6.9%	13.5%	7.5%	6.8%	6.3%
1993	13.9%	11.3%	15.2%	13.8%	12.6%	7.5%
1994	15.4%	10.1%	13.6%	8.0%	16.9%	10.6%
1995	16.9%	11.3%	14.9%	13.0%	18.9%	9.6%
1999	13.5%	11.7%	14.8%	12.7%	12.6%	11.7%
<i>Percent Provided by Departments and End-users</i>						
1991	9.2%	5.0%	14.4%	15.0%	4.7%	2.5%
1992	26.3%	25.0%	25.6%	25.0%	27.6%	30.0%
1993	13.5%	10.0%	14.4%	10.0%	12.6%	7.5%
1994	15.0%	10.0%	14.7%	10.0%	15.3%	10.0%
1995	18.2%	10.0%	20.7%	10.0%	15.6%	10.0%
1999	9.3%	4.8%	8.1%	9.1%	10.2%	4.8%

Table 11. Percent of Software-Related User Services Centralized, Decentralized or Outsourced, 1999

	All Firms	Manufacturing	Services
<i>Data warehousing/mining</i>			
Centralized	69.8%	59.6%	78.0%
Decentralized	26.4%	38.3%	16.9%
Outsourced	3.8%	2.1%	5.1%
<i>Web site development</i>			
Centralized	52.3%	40.0%	62.3%
Decentralized	27.0%	40.0%	16.4%
Outsourced	20.7%	20.0%	21.3%
<i>Applications maintenance and support</i>			
Centralized	67.9%	52.1%	80.3%
Decentralized	25.7%	39.6%	14.8%
Outsourced	6.4%	8.3%	4.9%
<i>New application development</i>			
Centralized	64.9%	46.0%	80.3%
Decentralized	25.2%	42.0%	11.5%
Outsourced	9.9%	12.0%	8.2%

Table 12. Percent of Hardware-Related User Services Centralized, Decentralized or Outsourced, 1999

	All Firms	Manufacturing	Services
<i>Data backup and recovery</i>			
Centralized	78.4%	66.0%	88.5%
Decentralized	19.8%	32.0%	9.8%
Outsourced	1.8%	2.0%	1.6%
<i>Local area networking</i>			
Centralized	69.4%	58.0%	78.7%
Decentralized	27.9%	38.0%	19.7%
Outsourced	2.7%	4.0%	1.6%
<i>Technical staff recruitment</i>			
Centralized	67.6%	48.0%	83.6%
Decentralized	27.0%	46.0%	11.5%
Outsourced	5.4%	6.0%	4.9%
<i>Technical support</i>			
Centralized	79.3%	66.0%	90.2%
Decentralized	17.1%	28.0%	8.2%
Outsourced	3.6%	6.0%	1.6%

Table 13. Percent of User Training-Related User Services Centralized, Decentralized or Outsourced, 1999

	All Firms	Manufacturing	Services
<i>Help desk</i>			
Centralized	76.6%	60.0%	90.2%
Decentralized	13.5%	22.0%	6.6%
Outsourced	9.9%	18.0%	3.3%
<i>Training</i>			
Centralized	42.3%	34.0%	49.2%
Decentralized	39.6%	46.0%	34.4%
Outsourced	18.0%	20.0%	16.4%

Table 14. Distribution of I/S Unit Outsourcing by Type of Activity: Percent Firms Outsourcing Portion of Activity and Mean Percent of Activity Outsourced, 1993-1995, 1999

	All Firms		Manufacturing		Services	
	% Firms Out-sourcing	Mean % of Activity Out-sourced	% Firms Out-sourcing	Mean % of Activity Out-sourced	% Firms Out-sourcing	Mean % of Activity Out-sourced
<i>Data center operations</i>						
1993	30.5%	22.5%	40.9%	33.7%	20.8%	2.5%
1994	40.6%	13.3%	57.1%	19.5%	27.8%	8.6%
1995	40.9%	17.8%	47.4%	19.2%	36.0%	16.8%
1999	27.9%	34.8%	35.0%	20.9%	21.7%	54.4%
<i>New systems development</i>						
1993	71.8%	22.0%	68.2%	25.5%	75.0%	19.1%
1994	75.0%	18.1%	78.6%	16.3%	72.2%	19.5%
1995	76.7%	18.9%	73.7%	16.3%	79.2%	21.0%
1999	85.4%	24.6%	79.0%	26.1%	90.9%	23.5%
<i>Maintenance and enhancement of existing applications</i>						
1993	47.9%	25.3%	40.9%	19.0%	54.2%	29.7%
1994	56.3%	15.1%	53.6%	9.3%	58.3%	19.5%
1995	56.8%	14.5%	47.4%	5.7%	64.0%	21.2%
1999	69.1%	30.8%	89.5%	28.0%	52.2%	34.8%
<i>Installation, maintenance and management of desktop computing</i>						
1993	69.6%	39.9%	72.7%	37.7%	66.7%	42.1%
1994	73.4%	29.9%	75.0%	27.5%	72.2%	31.8%
1995	71.4%	28.7%	63.2%	19.8%	78.3%	36.0%
1999	72.1%	36.4%	90.0%	35.7%	56.5%	37.3%
<i>Network operations and management</i>						
1993	30.5%	20.7%	36.4%	15.6%	25.0%	27.5%
1994	32.8%	11.3%	50.0%	13.6%	19.4%	9.6%
1995	31.0%	15.6%	42.1%	15.3%	21.7%	15.9%
1999	46.5%	28.7%	55.0%	21.7%	39.1%	37.2%

Table 16. Use of Development Tools, 1990-1995, 1999

	All Firms Percent use	Manufacturing Percent use	Services Percent use
<i>CASE Tools (Upper, Lower, Integrated)</i>			
1990	52.0%	48.4%	57.9%
1991	75.0%	63.6%	88.9%
1992	73.1%	70.6%	77.8%
1993	63.3%	63.6%	63.0%
1994	71.9%	71.4%	72.2%
1995	64.6%	47.8%	80.0%
1999	39.5%	50.0%	30.4%
<i>Computer-Assisted Testing and Implementation</i>			
1990	13.5%	10.5%	16.7%
1991	26.7%	14.3%	37.5%
1992	23.3%	17.7%	30.8%
1993	9.1%	0.00%	16.7%
1994	18.8%	22.2%	16.2%
1995	23.0%	32.0%	17.0%
1999	25.6%	40.0%	13.0%
<i>Reusable software modules</i>			
1990	18.92%	10.5%	27.8%
1991	20.0%	28.6%	12.5%
1992	19.35%	23.5%	14.3%
1993	28.3%	18.2%	37.5%
1994	34.4%	22.2%	43.2%
1995	40.0%	35.0%	44.0%
1999	53.5%	45.0%	60.9%
<i>Reverse engineering tools</i>			
1990	8.11%	10.5%	5.6%
1991	13.33%	14.3%	12.5%
1992	19.35%	17.7%	21.4%
1993	10.9%	9.1%	12.5%
1994	9.2%	10.7%	8.11%
1995	9.3%	11.0%	8.0%
1999	14.0%	15.0%	13.0%
<i>Business Process Simulation Tools</i>			
1990	8.3%	5.6%	11.1%
1991	6.7%	0.0%	12.5%
1992	6.7%	5.9%	7.7%
1993	8.7%	9.1%	8.3%
1994	13.6%	17.2%	10.8%
1995	9.3%	16.0%	4.17%
1999	23.3%	25.0%	21.7%
<i>Object-oriented techniques</i>			
1990	0.0%	0.0%	0.0%
1991	0.0%	0.0%	0.0%
1992	6.5%	11.8%	0.0%
1993	17.4%	18.2%	16.7%
1994	21.2%	20.7%	21.6%
1995	23.0%	26.0%	20.0%
1999	55.8%	60.0%	52.2%
<i>Rapid prototyping</i>			
1995	41.9%	38.9%	44.0%
1999	46.5%	50.0%	43.5%
<i>Client-server development tools</i>			
1995	75.0%	73.7%	76.0%
1999	76.7%	80.0%	73.9%

Table 17. Use of Development Techniques, 1989-1995, 1999

	All Firms Percent use	Manufacturing Percent use	Services Percent use
<i>Joint application development techniques</i>			
1989	21.4%	23.1%	20.0%
1990	24.3%	36.8%	11.1%
1991	33.3%	14.3%	50.0%
1992	25.8%	35.3%	14.3%
1993	60.9%	45.5%	75.0%
1994	66.7%	58.6%	73.0%
1995	70.0%	58.0%	80.0%
1999	58.1%	60.0%	56.5%
<i>Data modeling</i>			
1989	32.1%	23.1%	40.0%
1990	18.9%	10.5%	27.8%
1991	26.7%	14.3%	37.5%
1992	30.0%	31.3%	28.6%
1993	41.3%	27.3%	54.2%
1994	47.0%	37.9%	54.1%
1995	52.0%	53.0%	52.0%
1999	53.5%	50.0%	56.5%

Table 18. I/S Effectiveness (Percent "Successful" Projects) and Use of Advanced Technologies and Techniques, 1999

	All Firms Mean	Manufacturing Mean	Services Mean
<i>CASE Tools</i>			
Not implemented	55.83%	51.78%	58.43%
Implemented	57.31%	55.83%	58.57%
<i>Computer Assisted Testing and Implementation</i>			
Not implemented	52.46%	47.60%	55.17%
Implemented	70.00%	65.00%	78.33%
<i>Reverse engineering tools, e.g., Bachman Tools</i>			
Not implemented	53.47%	50.79%	55.56%
Implemented	79.50%	90.0%	90.0%
<i>Business process simulation tools</i>			
Not implemented	51.36%	47.92%	53.94%
Implemented	73.88%	75.33%	73.00%
<i>Object-oriented techniques</i>			
Not implemented	53.29%	50.86%	55.00%
Implemented	59.11%	55.63%	61.64%
<i>Rapid prototyping</i>			
Not implemented	48.75%	43.75%	52.08%
Implemented	65.88%	64.43%	67.00%
<i>Client-server development tools</i>			
Not implemented	49.38%	58.33%	44.00%
Implemented	58.36%	52.17%	63.00%

Table 19. Total Number Data Centers, 1989-1995, 1999

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	11.36	2.50	14.44	7.00	9.23	2.00
1990	5.06	2.50	4.07	3.00	5.84	2.00
1991	3.17	2.00	5.75	4.50	1.88	1.50
1992	2.67	1.00	3.31	1.50	1.93	1.00
1993	4.02	2.00	6.47	3.00	2.29	1.00
1994	2.62	1.00	3.57	1.00	1.86	1.00
1995	3.86	2.00	5.00	4.00	3.00	1.00
1999	4.66	1.00	5.95	3.00	3.55	1.00

Table 20. Total Number of Mainframes, 1989-1995, 1999

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	6.55	3.00	4.44	3.00	8.00	4.00
1990	4.97	3.00	5.07	2.00	4.90	4.00
1991	5.42	3.00	6.50	5.50	4.88	3.00
1992	5.55	2.00	3.94	2.00	7.50	2.50
1993	3.60	2.00	4.14	1.50	3.09	2.00
1994	3.90	2.00	3.76	1.00	4.03	2.00
1995	3.86	2.00	4.22	1.00	3.58	2.00
1999	3.79	1.00	5.65	1.00	2.29	1.00

Table 21. Total Number of Minicomputers, 1989-1995, 1999

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	77.86	18.00	99.67	21.00	61.50	11.00
1990	60.12	7.00	50.47	9.00	68.17	6.00
1991	76.00	7.00	179.25	57.50	17.00	2.00
1992	66.13	15.50	63.06	20.00	70.15	11.00
1993	58.51	5.00	66.29	14.00	51.09	3.00
1994	65.05	5.00	79.76	12.00	53.91	5.00
1995	59.35	12.00	77.29	6.00	46.09	20.00
1999	55.97	10.00	57.53	20.00	54.41	6.00

Table 22. Communications Support Technology, 1995, 1999

	All Firms Percent implemented	Manufacturing Percent implemented	Services Percent implemented
<i>Groupware</i>			
1995	52.3%	52.6%	52.0%
1999	72.1%	85.0%	60.9%
<i>Video teleconferencing</i>			
1995	75.0%	84.2%	68.0%
1999	65.1%	75.0%	56.5%
<i>High speed digital network</i>			
1995	n.a.	n.a.	n.a.
1999	67.4%	75.0%	60.9%
<i>Global network</i>			
1995	n.a.	n.a.	n.a.
1999	60.5%	70.0%	52.2%
<i>Private wide area network</i>			
1995	86.4%	78.9%	92.0%
1999	67.4%	65.0%	69.6%
<i>Multimedia applications</i>			
1995	16.3%	16.7%	16.0%
1999	53.5%	60.0%	47.8%
<i>Electronic meetings</i>			
1995	n.a.	n.a.	n.a.
1999	46.5%	60.0%	34.8%
<i>Kiosks</i>			
1995	27.3%	26.3%	28.0%
1999	23.3%	35.0%	13.0%
<i>Voice response technology</i>			
1995	54.5%	26.3%	76.0%
1999	41.9%	35.0%	47.8%
<i>VSAT satellite communications</i>			
1995	20.9%	21.1%	20.8%
1999	20.9%	15.0%	26.1%

Table 23. Internet Technology, 1995, 1999

	All Firms Percent implemented	Manufacturing Percent implemented	Services Percent implemented
<i>Simple Internet access</i>			
1995	77.3%	94.7%	64.0%
1999	97.7%	95.0%	100.0%
<i>Internet-based services, e.g., Homepage</i>			
1995	52.3%	63.2%	44.0%
1999	93.0%	90.0%	95.7%
<i>Electronic commerce</i>			
1995	20.5%	26.3%	16.0%
1999	55.8%	50.0%	60.9%

Table 24. Use of Advanced Software Technologies, 1989-1995, 1999

	All Firms Percent use	Manufacturing Percent use	Services Percent use
<i>Relational Database Management Systems</i>			
1989	75.9%	78.6%	73.3%
1990	70.3%	68.4%	72.2%
1991	80.0%	71.4%	87.5%
1992	83.9%	82.4%	85.7%
1993	89.1%	86.4%	91.7%
1994	93.9%	93.1%	94.6%
1995	93.0%	89.0%	96.0%
1999	86.0%	90.0%	82.6%
<i>Distributed Database Management Systems</i>			
1989	17.2%	0.0%	33.3%
1990	18.9%	10.5%	27.8%
1991	20.0%	28.6%	12.5%
1992	16.1%	5.9%	28.6%
1993	33.3%	31.8%	34.8%
1994	40.9%	48.3%	35.1%
1995	52.0%	79.0%	32.0%
1999	48.8%	50.0%	47.8%

Table 25. Use of Advanced Application Technologies, 1989-1995, 1999

	All Firms Percent use	Manufacturing Percent use	Services Percent use
<i>Electronic data interchange (EDI)</i>			
1989	58.6%	78.57%	40.00%
1990	73.0%	89.47%	55.56%
1991	60.0%	85.71%	37.50%
1992	71.0%	88.24%	50.00%
1993	76.1%	95.5%	58.3%
1994	72.7%	93.1%	56.8%
1995	80.0%	95.0%	68.0%
1999	88.0%	85.0%	91.0%
<i>Executive support systems (ESS)</i>			
1989	53.6%	61.5%	46.7%
1990	37.8%	31.6%	44.4%
1991	46.7%	57.1%	37.5%
1992	51.6%	58.8%	42.9%
1993	45.7%	50.0%	41.7%
1994	57.6%	44.8%	67.6%
1995	61.0%	37.0%	80.0%
1999	58.0%	45.0%	70.0%
<i>Artificial intelligence/expert systems</i>			
1989	20.7%	21.4%	20.0%
1990	18.9%	26.3%	11.1%
1991	53.3%	42.9%	62.5%
1992	45.2%	35.3%	57.1%
1993	23.9%	22.7%	25.0%
1994	27.3%	24.1%	29.7%
1995	30.0%	32.0%	28.0%
1999	23.3%	30.0%	17.4%

Table 26. Application Portfolio – Supplier Relations Applications, 1999

	All Firms Percent implemented	Manufacturing Percent implemented	Services Percent implemented
Materials, stock, merchandise requirements planning	60%	85%	39%
Purchasing, ordering	81%	90%	74%
Inventory management	81%	95%	70%
Invoice verification	51%	60%	43%
EDI with suppliers	77%	80%	74%
Just-in-time with suppliers	37%	55%	22%

Table 27. Application Portfolio – Manufacturing Operations Applications, 1999

	Manufacturing Percent implemented
Sales and operations planning	75%
Statistics process control	75%
Computer-aided test and inspection	65%
Facility and equipment inventory	90%
Preventive maintenance	75%
Maintenance order management	60%
Capacity requirements planning	40%
Material requirements planning	85%
Production orders	90%
Product costing	90%
Kanban, just-in-time production	50%
Engineering change management	55%

Table 28. Application Portfolio – Services Operations Applications, 1999

	Services Percent implemented
Sales and operations planning	57%
Service requirements, staff planning	43%
Service orders	52%

Table 29. Application Portfolio – Product and Service Enhancement Applications, 1999

	All Firms Percent implemented	Manufacturing Percent implemented	Services Percent implemented
New product, service development support	47%	45%	48%
R&D laboratory, research support	35%	45%	26%
Customer, focus group surveys	21%	15%	26%
CAD, 3-D modeling	53%	90%	22%

Table 30. Application Portfolio – Marketing and Sales Applications, 1999

	All Firms Percent implemented	Manufacturing Percent implemented	Services Percent implemented
Sales processing, POS	58%	65%	52%
Shipping, dispatching, delivery	70%	90%	52%
Customer billing, invoicing	93%	100%	87%
Customer credit promotion	63%	75%	52%
Sales force support	65%	80%	52%
EDI with customers	79%	85%	74%
Electronic settlement, EFT	77%	75%	78%

Table 31. Application Portfolio – Customer Relations Applications, 1999

	All Firms Percent implemented	Manufacturing Percent implemented	Services Percent implemented
Customer records, warranty, service contract, information systems	63%	60%	65%
Automated customer response	30%	30%	30%
Customer service order management	47%	65%	30%
Customer satisfaction monitoring	30%	15%	43%
Customer credit management	70%	75%	65%
Customer incentive system	19%	10%	26%
Just-in-time with customer	23%	30%	17%

Table 32. User Manager Ratings of Computer Operations, 1990 – 1995^a, 1999^b

	All Firms Mean	Manufacturing Mean	Services Mean
<i>Operations: Overall quality of service</i>			
1990	6.92	6.92	6.92
1992	7.02	6.52	7.48
1993	6.71	6.26	7.00
1994	6.74	6.77	6.72
1995	6.89	6.82	6.92
1999	4.38	4.43	4.34
<i>Operations: Helpfulness of I/S staff to users</i>			
1990	6.75	6.82	6.67
1992	7.13	6.74	7.49
1993	6.65	6.34	6.84
1994	6.64	6.66	6.62
1995	6.93	6.69	7.02
1999	4.50	4.54	4.45
<i>Operations: Responsiveness of I/S management</i>			
1990	6.26	6.27	6.25
1992	6.50	5.97	6.25
1993	6.35	5.96	6.59
1994	6.26	6.26	6.25
1995	6.55	6.40	6.60
1999	4.64	4.83	4.44

^aScale runs from 1 (low) to 10 (high)

^bScale runs from 1 (low) to 7 (high).

Table 33. Labor to Capital Ratio, 1989-1995

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	1.79	1.59	1.56	1.57	2.00	1.63
1990	1.84	1.36	1.60	1.31	2.05	1.52
1991	1.65	1.39	1.82	1.39	1.50	1.36
1992	1.94	1.76	1.98	1.76	1.87	1.76
1993	1.67	1.57	1.66	1.57	1.68	1.63
1994	1.49	1.31	1.53	1.45	1.46	1.26
1995	1.72	1.33	1.93	1.54	1.51	1.29
1999	1.85	1.67	1.40	1.40	2.20	1.90

Table 34. Ratio of End-user Devices to Employees, 1988-1995

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1988	.42	.41	.39	.41	.45	.42
1989	.66	.58	.45	.41	.81	.61
1990	.61	.52	.54	.47	.66	.52
1991	.70	.77	.44	.46	.96	.92
1992	.65	.50	.46	.42	.97	1.02
1993	.67	.61	.58	.53	.75	.72
1994	.66	.63	.59	.55	.72	.72
1995	.68	.66	.56	.48	.77	.77
1999	.85	.75	.69	.60	.98	.80

Table 35. I/S Department Spending Per Corporate Employee, 1988-1995

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1988	\$6,685	\$3,998	\$7,297	\$4,501	\$6,285	\$3,947
1989	\$5,346	\$4,474	\$4,553	\$3,501	\$6,082	\$5,388
1990	\$6,559	\$5,475	\$6,055	\$5,278	\$7,063	\$7,734
1991	\$7,171	\$5,623	\$4,470	\$3,131	\$9,534	\$10,228
1992	\$5,070	\$4,211	\$3,581	\$3,653	\$7,800	\$6,502
1993	\$7,781	\$5,127	\$5,819	\$4,820	\$9,507	\$6,772
1994	\$7,345	\$4,900	\$5,838	\$4,549	\$8,625	\$5,127
1995	\$6,989	\$4,820	\$4,951	\$4,170	\$8,646	\$5,043
1999	\$7,594	\$5,963	\$6,020	\$5,556	\$8,894	\$7,250

Table 36. Total Revenue Per Corporate Employee (in thousands), 1988-1995, 1999

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1988	\$344.8	\$155.3	\$428.8	\$122.1	\$283.4	\$160.3
1989	\$238.2	\$189.8	\$223.8	\$149.8	\$250.8	\$232.4
1990	\$252.6	\$189.2	\$252.1	\$190.4	\$253.0	\$188.0
1991	\$250.7	\$204.6	\$174.9	\$163.0	\$309.7	\$350.1
1992	\$278.1	\$214.0	\$232.0	\$200.7	\$385.6	\$441.5
1993	\$329.1	\$254.1	\$245.3	\$216.5	\$399.0	\$305.7
1994	\$287.7	\$240.0	\$269.3	\$223.1	\$302.8	\$263.3
1995	\$288.7	\$248.3	\$305.0	\$253.9	\$272.4	\$194.1
1999	\$301.7	\$222.2	\$322.2	\$228.8	\$276.4	\$222.2

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