PUTTING DOWNSIZING IN PERSPECTIVE

INPUT

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Putting Downsizing in Perspective

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Abstract

Downsizing may be more than just a means of cutting costs—it may signal the beginning of major changes in management philosophy and corporate culture. This report discusses the background, motivation for, and expected benefits of downsizing. It provides a framework for understanding the issues surrounding downsizing, and analyzes various management schools of thought that will either inhibit or promote the downsizing market. The report gives several recommendations for IS managers and vendors on how to proceed in today's downsizing market so as to take advantage of the many good opportunities while avoiding the pitfalls.

Many issues must be resolved and changes accommodated for the downsizing "revolution" to continue apace: IS management and vendors must clarify their positions on SAA versus open systems; users must realize that the true goal is actually "rightsizing" and must upsize from terminals or (more likely) downsize from mainframes accordingly; and, perhaps most revolutionary, the management mind-set must shift toward decentralization and the realization that humans must be empowered with access to information to most effectively contribute to organizational success.

Downsizing has already proved advantageous for many. According to an in-depth survey by INPUT, most IS managers have identified applications suitable for downsizing, and nearly half have already begun some type of downsizing project. The processing power now available on PCs and minis, the network capabilities to leverage this power, and new technologies such as image processing, AI, and expert systems, will all contribute to the success of downsizing efforts. It is now possible—with care—to make good on the promises, still unmet by information technology investment, that downsizing offers: decreasing costs and increasing performance.

The report contains 156 pages and 38 exhibits.

Industry Markets

A three-year summary of source of revenue follows:

COMPUTER HORIZONS CORPORATION
THREE-YEAR SOURCE OF REVENUE SUMMARY
($ millions)

	FISCAL YEAR					
	1992		1991		1990	
MARKET	REVENUE $	PERCENT OF TOTAL	REVENUE $	PERCENT OF TOTAL	REVENUE $	PERCENT OF TOTAL
Commercial/industrial (a)	$70.5	69%	$68.0	72%	$63.5	64%
Communications (a)	16.4	16%	14.2	15%	18.8	19%
Financial services	15.3	15%	12.3	13%	17.1	17%
TOTAL	**$102.2**	**100%**	**$94.5**	**100%**	**$99.4**	**100%**

(a) Includes revenue from IBM of approximately $15.3 million, $19.4 million, and $_____ million for 1992, 1991, and 1990, respectively.

(b) *Includes revenue from AT&T of approximately $11.2 million, $9.9 million, and $13.4 million for 1992, 1991, and 1990, respectively.*

Geographic Markets

One hundred percent of Computer Horizons' 1992 revenue was derived from the U.S.

Computer Horizons' operations are organized into six regions as follows:

- The Northeast Region has offices in Mountain Lakes (NJ), Hartford and Norwald (CT), and Boston (MA).
- The New York Region has an office in New York City.
- The Atlantic Region has offices in Washington, D.C.; Miami, Orlando, and Tampa (FL); Atlanta (GA); Raleigh (NC); Clark and Princeton (NJ); and Philadelphia (PA).
- The Ohio Valley Region has offices in Cincinnati, Cleveland, Columbus, and Dayton (OH); Indianapolis (IN); Louisville (KY); and Pittsburgh (PA).
- The Great Lakes Region has offices in Detroit (MI), Chicago (IL), Minneapolis (MN), and Houston (TX).
- The Western Region has offices in Phoenix (AZ), Los Angeles (CA), and Denver (CO).

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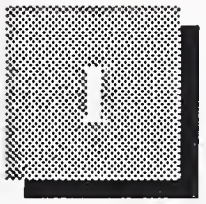
Exhibits (Continued)



Introduction

Downsizing has become a predominant theme in both the business environment and in information systems technology. This dominance comes at a time when there is increasing concern about the impact of information technology on white-collar productivity and bottom-line performance. Although the downsizing effort may appear to be just another means of cost cutting, it is being played out against a background that includes a longstanding battle between the central IS department and operating management for control of information systems resources.

Over the years, information technology has tended to concentrate planning and control on mainframes at the corporate level. This has been accomplished through a close partnership between the corporate IS department and IBM. This relationship suffered during the 1980s, but control of corporate data bases remains highly centralized.

There are indications that enlightened corporate executives are beginning to question the wisdom of highly centralized planning and control in a competitive environment that requires rapid response to changing market conditions. There may be more than cost savings associated with the current trend toward downsizing. It may represent major changes in both management philosophy and corporate culture.

The purpose of this report is to put downsizing in general perspective for IS and vendor executives. Will downsizing really cause major changes in the information systems and management infrastructures, or is it merely a passing phenomenon like so many in the computer industry? The goal of this report is to provide a technological and management framework to put downsizing into proper perspective.

A
Objectives

This report on downsizing has the following major objectives:

- To define downsizing and its associated terminology
- To establish an awareness of the importance of the integration of data, information and knowledge in making effective use of information technology, and the importance of downsizing in achieving this objective
- To evaluate the relative strengths and weaknesses of primary computer platforms (mainframe, minicomputer, RISC and PC) for various applications, processing functions, and data base residence
- To determine the extent and scope of downsizing, and the specific factors that are prompting and inhibiting its implementation
- To provide a general framework for isolating and assessing the competing forces involved in downsizing
- To identify the major issues associated with competing information systems technologies and architectures, so that these issues may be studied in more detail in 1992
- To provide a general model of the innovation process and its underlying technological and management considerations as they relate to downsizing
- To propose a general strategy for meeting the challenges associated with the rapid diffusion of downsizing technologies within the information systems infrastructure
- To emphasize the importance of "rightsizing" in order to make effective use of information technology in achieving major management objectives

This report was written to acquaint IS and vendor executives with the challenges and opportunities afforded by innovations in information technology and what are perceived to be significant changes in organizational culture and management mind-set.

B
Methodology and Scope

1. Methodology

For over 15 years, INPUT has emphasized the importance of a "proper" hierarchical computer/communications network; and, specifically, the need for the "orderly distribution" of processing and data from mainframes. Therefore, there was a wealth of information in past INPUT reports that had to be reviewed and analyzed, and which contributed substantially to this study. However, the primary focus of this research effort was to obtain information about the current plans and thinking of IS management concerning downsizing and its impacts in the 1990s.

In order to do this, INPUT developed a questionnaire that intentionally avoided the use of conventional rating scales, and substituted a combination of ranking questions to establish relative importance (or value) and simple true/false-type questions to obtain general opinions. Ranking questions are superior to rating questions in establishing relative importance, and true/false-type questions can be used to isolate significant differences of opinion more clearly than do rating questions. Though INPUT considers ranking questions to be particularly valuable, they do add considerable complexity for respondents who must think carefully when ordering their responses.

Since there were also time-dependent questions concerning downsizing implementation plans and impacts, the result was a lengthy and complex questionnaire with nearly three hundred data elements. This questionnaire was mailed to several hundred IS and vendor executives, and the results are based on fifty-two IS and twenty vendor responses.

In order to establish a framework for understanding downsizing (and for future studies) substantial additional desk research was conducted in the areas of hardware/software architectures, innovation diffusion, organization theory, decision sciences, and artificial systems.

2. Scope

The scope of this study is sufficient to project a general and dramatic shift away from mainframes toward more cost-effective platforms for a broad applications set, and to identify the factors perceived as prompting and inhibiting these changes in the information systems infrastructure. The study defines the general competitive environment for the 1990s, identifies a complex set of key issues that will determine success or failure of downsizing strategies, and provides a comprehensive model for evaluating these strategies.

While the study defines general markets that seem promising, it became obvious that the technological and management issues surrounding downsizing were far too numerous and complex to be analyzed in this study. Therefore, INPUT has not attempted to forecast the success or failure of competing hardware and software technologies in this report.

C
Report Structure

A brief description of the organization of the report is as follows:

- Chapter II, Executive Overview, provides a brief summary of research findings, analysis, conclusions and recommendations of the report.

- Chapter III, Understanding Downsizing, defines the terminology associated with downsizing, and positions the phenomenon in a broader technological and management context.

- Chapter IV, Downsizing and Architecture—A Framework, positions downsizing as a competitive architectural alternative to IBM's SNA and SAA, which have provided both the opportunity for and the challenge to downsizing.

- Chapter V, Current Architectural Thinking and Plans, provides a detailed view of IS and vendor responses to questions concerning anticipated shifts in information systems infrastructure during the 1990s, and the factors prompting and inhibiting downsizing.

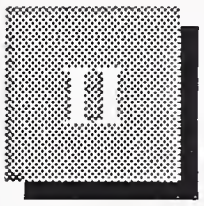
- Chapter VI, Analysis of Architectural Trends, analyzes IS and vendor responses to more detailed questions concerning the architectural trends identified in the previous chapter, with special emphasis on specific applications being planned and the anticipated benefits from these downsizing efforts.

- Chapter VII, A Market Analysis Framework, identifies major architectural, technological, management and human issues that will determine the course of downsizing in the 1990s, and provides a framework for analyzing these critical innovations.

- Chapter VIII, Conclusions and Recommendations, summarizes the findings of the report and makes recommendations for IS and vendor management.

- Appendix A is a copy of the questionnaire used to interview users about downsizing.

- Appendix B is a bibliography.



Executive Overview

A
Background and Methodology

Downsizing has become a predominant theme in the general business environment as well as in the information systems industry. This predominance comes at a time when management is questioning whether the investment in information technology during the 1980s paid off in terms of either improved white-collar productivity or improved bottom-line performance. However, there is no question that information technology has created today's fast-moving, international, competitive environment. It appears that business is suffering the consequences of the information technology boom without having yet received the benefits.

On the other hand, current downsizing efforts in business are beginning to impact white-collar workers at the professional and managerial levels, and there are some who feel that we are beginning to experience the inevitable technological unemployment of the "information age." Under any circumstances, the new management initiatives in downsizing seem to be inextricably connected with parallel trends in the information systems infrastructure.

INPUT has produced numerous studies over the past 15 years that have pointed out that there is a "proper" network hierarchy of mainframes, minicomputers and intelligent workstations; and that there should be the "orderly distribution" of processing and data from mainframes to more cost-effective levels in that hierarchy. However, there has been little progress in achieving the downsizing of mainframe business applications, and central data bases have continued to grow at an alarming rate—despite the fact that the 1980s saw the installation of enormous processing power (and storage capacity) on corporate desktops.

In this report, INPUT steps back and takes a holistic view of the current information systems infrastructure and how it is likely to change in the 1990s. INPUT developed a rather complex questionnaire designed to stimulate the respondents' thinking concerning these innovations rather than merely getting their reactions. It was successful in eliciting an enormous amount of valuable data that convinced INPUT that downsizing is the predominant architectural trend of the 1990s.

To put the downsizing trend into proper perspective, this report drew on a number of past INPUT (and other) reports on information systems architectures, and extensive desk research on management's view of the role of information technology in business enterprises. The results of this research are used in this report, but detailed analysis of these broader issues will be presented in a series of reports in 1992.

B

Downsizing, Architectural Trends, and Performance

1. Downsizing

Respondents confirmed the trend toward downsizing by answering a series of questions that asked them to:

- Evaluate the general hardware/software attributes of processor platforms (mainframe, minicomputer, RISC, and PC)
- Designate the current predominant platforms for selected applications, and project how the predominant platforms would change by 1995
- Indicate how their current downsizing plans (or thinking) would probably impact their information systems infrastructure in the future
- Specify when major structural changes to the information systems infrastructure were scheduled (or anticipated)
- Identify specific applications they felt were most promising for downsizing and indicate their current status (complete, planned for completion by 1992, or future)

IS management and vendor responses to these questions confirmed a significant, and surprising, shift away from mainframes toward RISC and PC LAN platforms. It is surprising for two reasons:

- IS management rated mainframes highest for the following attributes:

  - Very secure
  - Good connectivity
  - Good for commercial applications
  - Good reliability (hardware/software)
  - Good data management
  - Good network management
  - Good vendor support
  - Good applications software
  - Good architecture (hardware/software)

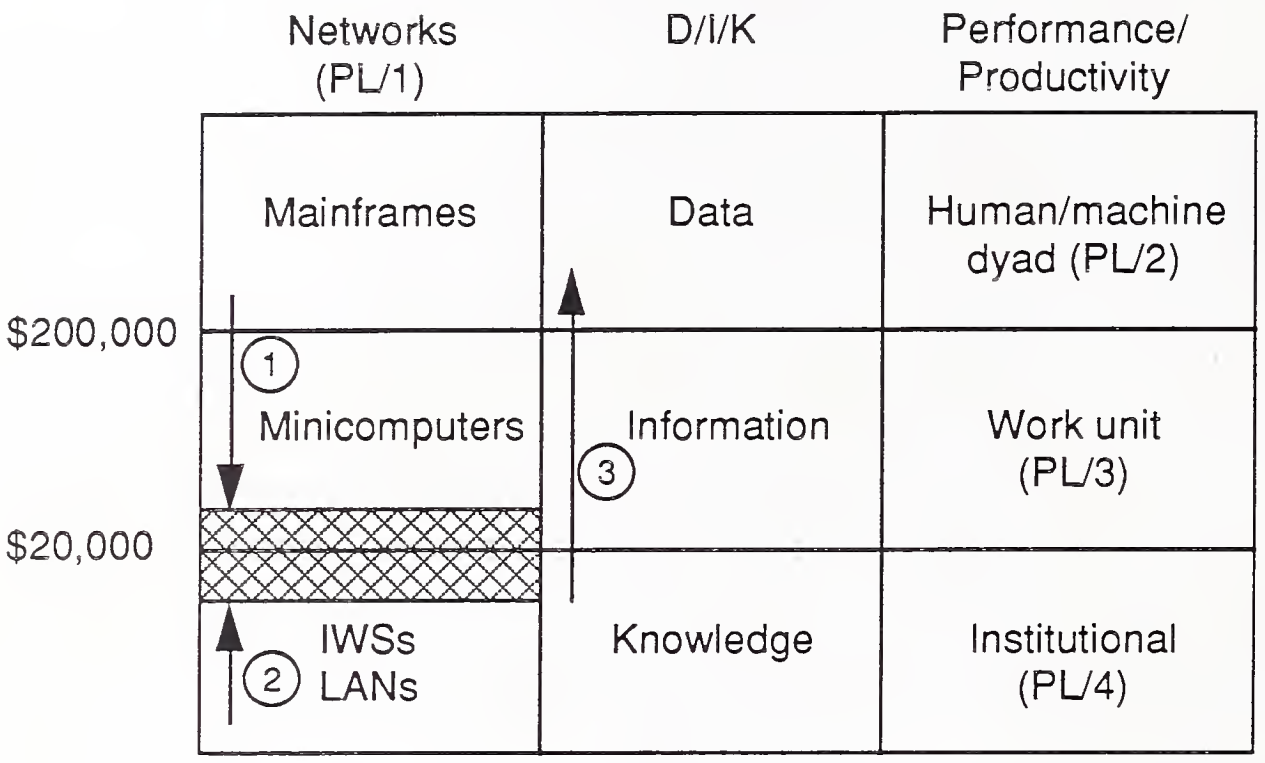
- Then, despite these high evaluations on practically everything IS management has traditionally considered important, they still stated they were going to downsize to more cost-effective platforms. And they did this even when asked to identify (by writing in, rather than checking applications off a list) specific applications they planned to downsize. Approximately 80% of IS executives had given sufficient thought to downsizing that they could identify a broad range of applications they considered most promising for downsizing, and approximately 40% of respondents had downsizing projects scheduled for completion in 1992. We find this surprising!

2. Architectural Trends

However, in parallel with downsizing, INPUT's research indicated that there is a trend toward upsizing by integrating intelligent workstations (IWSs) into client/server architectures. These parallel trends of downsizing from mainframes and upsizing from IWSs meet head-on in what we have identified as a "technological battle zone"—located around INPUT's border between minicomputers and IWSs ($20,000)—as shown in Exhibit II-1.

EXHIBIT II-1

Trends of the 1990s



1. Downsizing—Mainframe processing and data
2. Upsizing—WSs ⟶ file and data servers
3. Integration—Information and knowledge to data

⊠ Technological battle zone

This technological battle zone is where minicomputers, RISC workstations, and PCs are waging war to become the data (and file) servers of choice in the new information systems infrastructure. It is a fierce battle replete with major issues, any of which could be the subject of additional, major research efforts. For example:

- Open versus proprietary systems
- RISC versus CISC computer architectures
- MIPS versus more MIPS
- Three-tiered versus two-tiered network architectures
- Industry versus de facto standards
- Cooperative versus client/server architectures
- MS/DOS versus OS/2 versus OS/400 versus UNIX versus...
- UNIX strengths versus UNIX weaknesses
- UNIX versus UNIX versus UNIX...
- Centralized versus distributed data base management
- Relational versus "relational-like" and other data models
- Data access versus data quality

The list goes on, and as we stood back and took a look at the chaos of this technological battle zone, it seemed the better part of valor to retreat from these architectural issues and plan to return to fight another day. In fact, the "technological battle zone" metaphor hardly seems appropriate; what is going on where downsizing meets upsizing is more like a barroom brawl where you don't know your friends from your enemies from one minute to the next. Only two things seem certain:

- Downsizing is primarily a war between IBM and its proprietary Systems Applications Architecture (SAA), and "open systems"—which is to say, everybody else.

- There will be many casualties in this technological war and, like many wars, there may not be any winners.

We bring up these unpleasant issues because it makes IS management's rush to downsizing (and it appears to be just that) all the more inexplicable. Fortunately, we asked questions about the motivating factors and anticipated benefits of downsizing.

3. Performance

a. Motivating Factors

When INPUT asked respondents to evaluate the factors prompting downsizing, IS management clearly identified the following as the primary motivating factors:

- Cut total information systems costs
- Better price/performance of hardware
- Reduced systems development costs

It seems clear that IS is "under the gun" from corporate management to improve performance and cut costs. The fact that IS management is actually taking action to downsize may or may not mean that they are fully in accord with all the anticipated changes in the information systems infrastructure.

While the vendor respondents agreed that "cutting total information systems costs" was the most important factor prompting downsizing, and that "better price/performance of hardware" was also important, they identified other factors that were extremely important:

- Improved user service
- Users' desire to control information systems
- Improved quality of management information

All of these factors pinpoint dissatisfaction with the performance of the IS function, and implies that IS is under pressure from operating management to downsize so they can make better use of information technology at the working level.

It would appear that there has been a cultural change in the way information technology is viewed in the corporate world. The large mainframe and corporate data bases have obviously not satisfied user needs, and the central IS department—and its traditional "business partner" (IBM)—are no longer in control of the information systems resources.

b. Anticipated Benefits

The questionnaire asked respondents what they felt would be the actual benefits and consequences of downsizing. The responses revealed a major difference of opinion between IS and vendor management that is crucial to understanding what INPUT considers a significant shift in the role of information technology in the business environment.

IS management was in agreement that the following were the most likely benefits and consequences of downsizing:

- Improved responsiveness to user information requirements
- Broader range of choices (products and services)
- Faster, easier systems development
- More effective use of information technology

There was little consensus that IS management anticipated substantially reduced hardware or software costs, diminished expense in the central IS department, improved white-collar productivity or improved bottom-line performance. In other words, IS management (with the possible exception of faster, easier systems development) does not expect the improved cost effectiveness that is prompting downsizing.

Vendors, on the other hand, do not agree that there will be "faster, easier systems development" but do agree on a broad range of other benefits in addition to those anticipated by IS management. Specifically:

- Improved process, product, or service for customers
- Substantially reduced hardware costs
- Improved white-collar productivity
- Diminished role and expense of central IS department
- Better business planning and decision making
- Improved bottom-line performance
- Improved data and management information quality

Even given the natural tendency of vendors to be optimistic, this is an imposing array of benefits. Whereas IS management only anticipates benefits at performance levels 1 and 2 (PL/1 and PL/2) on Exhibit II-1, vendors are anticipating improvements at all four levels, including the all-important PL/3 and PL/4 (improved work unit productivity and improved institutional performance).

Performance improvement at PL/3 and PL/4 has long been the ultimate goal of information technology, but results to date have been disappointing. INPUT's research indicated that performance at these levels may actually improve as a result of downsizing, and that would make the vendor responses more than just another example of undue optimism.

c. The Management Factor

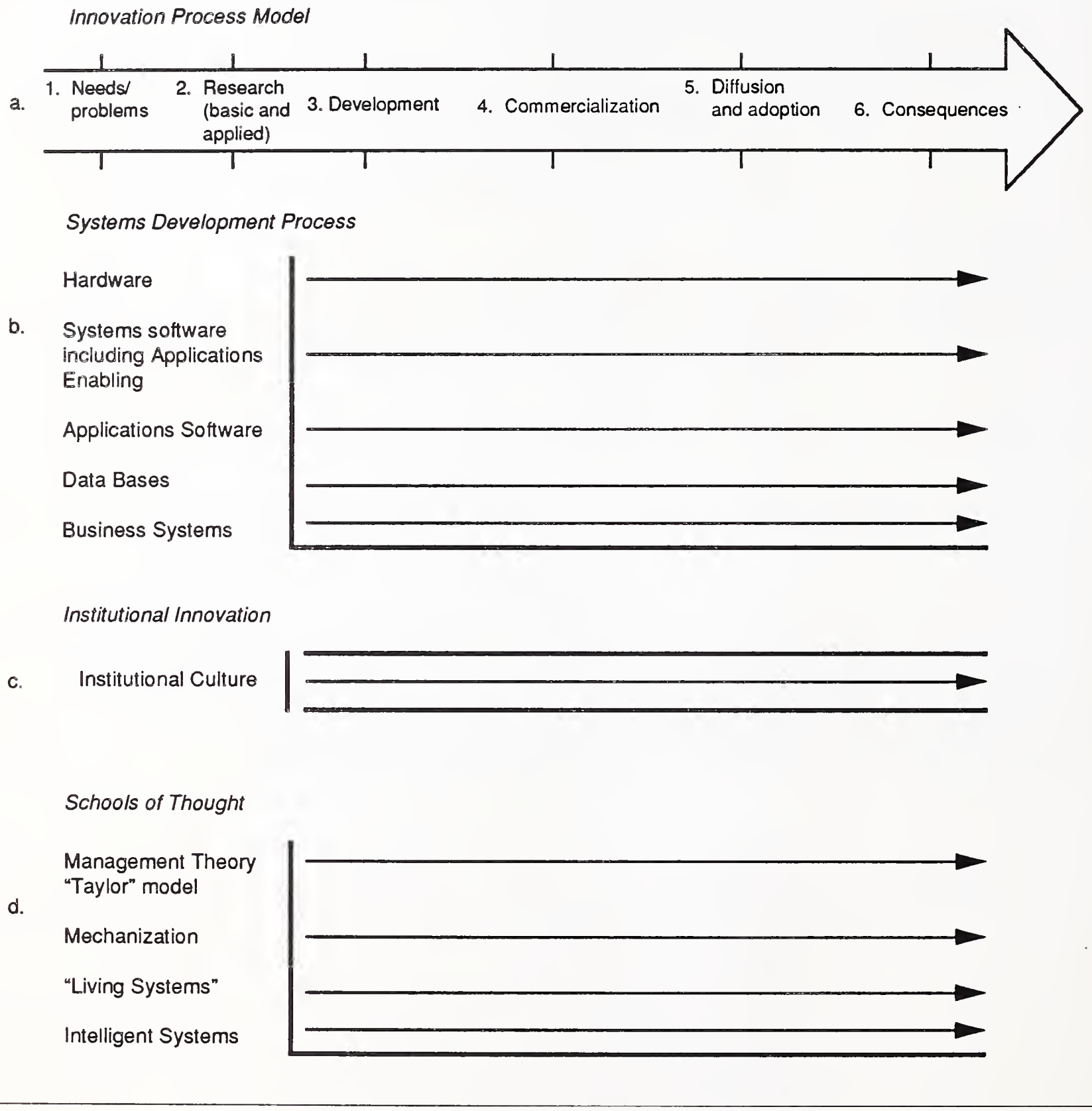
INPUT feels some optimism about the ability of downsizing to achieve some of the benefits that were elusive in the past because INPUT is convinced that downsizing is necessary in order to achieve the cost-effective integration of paper information and human knowledge with computer data. And the third major architectural trend of the 1990s (Exhibit II-1) has been identified as being just such integration. This integration will be accomplished with image processing systems that will reduce (or at least control) the paper glut in offices, and through the enhancement of existing business applications with expert (knowledge-based) systems.

Both of these developments require the ability to capture, store and process information and knowledge as close to the source as possible. The processing power required to drive the scanners and high-resolution displays necessary for image processing, and to run the algorithms and exhaustive searches of artificial intelligence for knowledge-based systems is finally becoming economically available—just at the time that optical disk technology is available to provide virtually unlimited, cheap storage.

However, all of this new technology will not achieve the benefits of downsizing without a change of management mind-set from the traditional industrial engineering and financial management models that emphasize highly centralized planning and control. The new schools of management thought will emphasize recognition and empowerment of the human elements in the information system, and the building of intelligent systems. Therefore, the market for downsizing products and services will be dependent upon not only traditional models for innovation, diffusion, and systems development, but upon a major cultural change resulting from shifts in management thinking (see Exhibit II-2).

EXHIBIT II-2

A Market Analysis Framework



Fortunately, there is every indication that enlightened management is, of necessity, developing a new mind-set; and decentralization is the watchword of the day. It makes little difference whether information technology is driving management or management is driving information technology; the fact remains that INPUT's research clearly shows that technological downsizing and organizational decentralization are predominant trends in the 1990s.

The question then becomes one of just how fast this will happen.

C

Downsizing, Data Management, SAA and Open Opportunities

IS management and vendors agree that problems of data quality in terms of data base integrity, synchronization and security will be the primary factors inhibiting downsizing. In the downsizing war between proprietary (SAA) and "open systems," the following must be recognized:

- Most data are currently resident on IBM mainframes and under the control of the central IS department.

- IBM has established an architecture for "rightsizing" in SAA, and at the heart of that architecture is distributed data base and network management.

- The AS/400 is the key to IBM's plan for distributed data base management and downsizing and is squarely in the fight going on in the technological battle zone. It should also be pointed out that:

  - Although the AS/400 is the most proprietary of systems, it has been highly successful in the business systems market.

  - Its tightly integrated hardware/software architecture is probably a sign of things to come—especially since raw processing power is becoming a commodity.

  - It is a superior product in a distributed data base environment, and INPUT's research shows that IS management considers minicomputers to be the best "distributed data servers."

  - It has been rapidly diffused in the business systems market, having cut directly through the layers of the systems development process that is plaguing both RISC and PC-based servers (Exhibit II-2).

  - It is an industrial-strength product that is highly regarded by its extensive customer base—most of whom do not have IS staff to implement advanced applications.

  - The AS/400 appears to be well positioned to serve as the point of integration between SAA and the open systems market.

  - IBM has been reluctant to sell the AS/400 for purposes of downsizing for obvious reasons (and also because of past internal technological and political wars).

- Therefore, while IS management and vendors alike consider SAA and the AS/400 "overrated" products, it appears that there is a significant opportunity for competitive vendors to take advantage of both SAA and the AS/400. Specifically by:

  - Leaving the problems of distributed data base management in a heterogeneous environment to SAA, and using the AS/400 as a distributed data base server

  - Using the AS/400 to speed downsizing from IBM mainframes (as some IBM customers have already done without very much assistance from IBM)

  - Using the AS/400 as the point of interface between the SAA and the open systems worlds, and developing customer applications solutions in support of data, information and knowledge integration

- SAA and the AS/400 are going to be major factors in downsizing during the 1990s. They may be viewed as either the ultimate challenge in the "technological battle zone" or as a major opportunity—especially since IBM is restructuring itself in a way that should eventually facilitate "cooperative processing" in more ways than one.

- Exhibit II-3 shows where SAA attempts to improve performance. All of the interesting and profitable opportunities occur in the areas of data, information and knowledge integration necessary to improve performance at PL/3 and PL/4; and those areas remain wide open.

- For those who can use SAA to solve, or at least alleviate, the very real problems of distributed data base management, and take advantage of new technologies that shift emphasis from raw processing power to real management solutions, the opportunities in the hybrid world of SAA and open systems will indeed be great.

EXHIBIT II-3

SAA and Open Opportunities

Networks (PL/1)	D/I/K	Performance/ Productivity
Mainframes	Data	Human/machine dyad (PL/2)
Minicomputers	Information	Work unit (PL/3)
IWSs	Knowledge	Institutional (PL/4)

☐ Addressed by SAA

☒ Technological battle zone

☐ Open opportunities

D

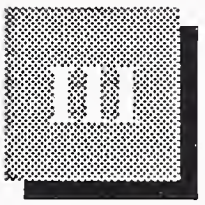
Conclusions and Recommendations

Exhibit II-4 contains a summary of the conclusions and recommendations from Chapter VIII of this report.

EXHIBIT II-4

Conclusions and Recommendations

- Downsizing is the predominant trend of 1990s
- Downsizing in parallel with upsizing results in chaos
- The battle is among various hardware/software architectures
- The war is between SAA and open systems
- SAA is armed with data and network management for quality control
- Open systems are armed with simplicity and high price/performance
- There are going to be heavy casualties in the battle but both sides will survive the war
- IS management wants, expects and deserves both high quality and reasonable cost
- Effective integration of SAA and open systems is key to effective downsizing
- Effective integration of data, information and knowledge is both the challenge and opportunity of the 1990s
- Customer executives want, expect and deserve tangible payback from investment in information technology
- Executive mind-set concerning the role of information technology is the key to its effective use
- IS and vendor management should look beyond the battle and the war and concentrate on improved white-collar productivity and institutional performance



Understanding Downsizing

The first thing to understand about downsizing is that it is real in the sense that it is happening. The fact that the term may be vague, or that there may be parallel observed trends, such as "upsizing", is irrelevant. Both IS and vendor management are in agreement that there are going to be major structural changes in the information systems infrasture during the 1990s. If you start with everything centralized on a large mainframe you are going to be downsizing. If you start with everything distributed to a bunch of standalone personal computers you are going to be integrating (upsizing). The important thing to keep in mind is that the objective is to "rightsize."

Unfortunately, with that said, it is necessary to clear up some terminology in order to understand downsizing.

A "Terminological Inexactitude"

We don't know what Winston Churchill was referring to when he said "terminological inexactitude" before the House of Commons in 1906, but the description was appealing enough to make its way into *Bartlett's Familiar Quotations*, and it remains especially apt for the computer industry.

Downsizing is only a recent example of an endless list of fuzzy terms that have hindered intelligent discussion and understanding of computer technology. We knew we were in trouble when we started to research downsizing and found a conference on the subject that included sessions on "upsizing" and "rightsizing." It reminded us of a technical seminar on "real-time monitors" in the early 1960s that went on for four days before the assembled "experts" discovered they did not agree on the definition of "real-time monitor."

While such technical misunderstandings may be amusing, they can lead to serious difficulties when they are misleading. For example, referring to personal computer packages such as spreadsheets and data base management systems as "applications" and "solutions" has done considerable harm to the credibility of all vendors of information technology.

The *Dictionary of Computing* (Oxford University Press, 1984) defines an applications program as follows:

"Any program that is specific to the particular role that a given computer performs within an organization and makes a direct contribution to performing that role. For example, where a computer handles a company's finances a payroll program would be an applications program. By contrast, an operating system or a software tool may both be essential to the effective use of the computer system, but neither makes a direct contribution to meeting the end-user's eventual needs."

Spreadsheet packages and data base management systems are obviously tools and not applications; and, as far as the term "solution" is concerned they are no more "solutions" than a calculator is the solution to a mathematical problem. Such "terminological inexactitude" in this case borders on misrepresentation, and there are many disenchanted customers who feel that information technology has been vastly overrated in making a direct contribution to the success of their organizations. It is our belief that such customers will no longer be so susceptible to new "solutions" to their problems.

The purpose of this study is to become somewhat more exact about what the term "downsizing" really means to both vendors and IS management in terms of their motivations and expectations.

B

What They Mean by "Downsizing"

Downsizing originated as a politically correct term for reducing the number of personnel in order to cut costs. It is designed to avoid the unpleasant connotation that an organization is in serious trouble by implying that a lean, more competitive organization will emerge. Used in this sense, downsizing is a relatively harmless synonym for layoff or reduction in force. Terminological inexactitude came into play only after the unfortunate adaptation of "downsizing" to computer technology.

Even if downsizing had been restricted to describing the physical size of memory and logic chips, there would still have been terminological inexactitude because capacity increases as size decreases. However, the computer industry took the latest fuzzy buzzword seriously and started

having national conferences and expositions on the subject. This, in turn, forces everyone to take a serious look at what all those people talking about downsizing really mean.

1. What They Seem to Mean

During the preliminary research for this study, INPUT found that downsizing was merely the latest term to describe (inexactly) the natural, continuing tendency of processing and data to seek their most cost-effective location in the processor hierarchy. Based on this research, INPUT published a Research Bulletin (see Appendix A) that briefly identified various concepts and products associated with downsizing (client/server, cooperative processing, RISC workstations, PC LANs, etc.). It was concluded that the term downsizing is:

- Explicit in describing the substitution of smaller (less costly) microprocessor-based platforms for larger mainframe and minicomputer platforms

- Implicit in assuming that smaller platforms with cheaper MIPS will be more cost effective

Downsizing is a simple concept, but it becomes complicated in practice. The closest synonym we can think of for downsizing is distributed processing, which is similar to cooperative processing , which is dependent on distributed data base management, which is dependent upon network management, which is dependent upon network architecture, which is dependent upon "connectivity" with other systems—and all of the above is just for building the downsized computer-communication infrastructure.

When it comes to the actual downsizing of applications, reprogramming, or conversion, or re-engineering, or porting, or whatever you want to call it, what is required is to move functions or applications from one platform to another. The success of these efforts will depend on systems software compatibility and functionality, the availability of CASE (and other) development tools, the availability of training in new technologies, and qualified personnel to do the job. Then, even with careful planning, the successful completion of any major downsizing effort is heavily dependent upon the complexity and interdependences of the application (or functions) being downsized.

While it may be simple and cost effective to downsize a compute-bound, scientific (or engineering) application from a mainframe or minicomputer to a RISC workstation, it is simple-minded to believe that the same can necessarily be said for data-dependent commercial applications. We do not believe that advocates of downsizing are simple-minded, but we do believe that some prefer to ignore the unpleasant fact that downsizing major commercial applications remains a daunting task for most customers regardless of new and improved tools for applications development and/or re-engineering.

Fortunately, users and vendors are more knowledgeable than they were in the early days of the personal computer revolution. The mere fact that conferences on downsizing include discussion of "upsizing" and "rightsizing" is encouraging, and even the most enthusiastic proponents of downsizing are issuing caveats concerning the implications and benefits of downsizing. In addition, actual experience is beginning to clarify some of the implications of downsizing.

2. Examples

a. Downsizing and Systems Staff

One of the early assumptions of downsizing to PC LANs was that the systems staff could be reduced. The experience at Turner Corp. does not support this assumption. [1]

- Turner Corp. started to downsize in the 1986 and by 1990 had eliminated 25 Series 1 minicomputers, and was estimating that savings on mainframe and minicomputer hardware/software costs would pay for the investment in new PCs and LANs within five years (1995).

- However, during the evolution of the downsizing effort "...it became clear that one central support group couldn't support the far-flung system of LANs." So Turner had to hire 25 systems engineers (one for each local office)—exactly the number it planned to reduce in the central systems group!

- In addition, while the IBM Series 1 minicomputers were replaced, mainframe replacement proved to be somewhat more difficult. It was acknowledged that processing payrolls, benefits and tax records on PC LANs was "a formidable task" and that: "We all need to learn how to do it properly and effectively."

It seems obvious that "downsizing" to PC LANs does not necessarily imply reducing the cost of systems personnel. In fact, some "experts" on the subject of downsizing, such as Dr. George Schussel, are warning that staff costs will actually increase because more people will be required in a distributed environment. [2]

Part of the difficulty with downsizing systems staff when going to PC LANs can be attributed to the discovery by William F. Zackmann that:

"Putting personal computers to work replacing mainframes and minis for key applications isn't as simple as popping the shrink wrap off word processing software, inserting a floppy disk and typing 'A:INSTALL'. Applications critical to the enterprise as a whole are seldom as generic as typical personal productivity applications. A certain amount of systems

analysis and custom programming are required." [3] (Mr. Zackmann claims to be among the first to predict that personal computers would replace mainframes and minis. He now goes to downsizing conferences to present the "The Myths of MIPS and The Shrinkwrap Fallacy.")

b. Downsizing and Software

It appears that downsizing to PC LANs requires upgrading of what vendors where selling as applications (or solutions) software for PCs during the 1980s. This, in turn, may require more—not fewer—personnel. However, downsizing from mainframes to client/server architecture employing minicomputers and UNIX seems to provide better results. Consider the case of Heileman Brewing Company.

- Heileman went from an IBM mainframe to a Pyramid open systems environment (UNIX) and the ORACLE relational data base management system. This resulted in $500,000 per year savings in software licensing and maintenance fees. [4]

- The IS base operating budget has decreased from $3.9 million to $1.5 million in two years. [5]

- During that time the personnel budget has remained virtually the same ($2.7 million versus $2.5 million) even though the staff has been decreased by approximately 25% (from 94 to 70). This is attributed to the fact that a different skill set is required (presumably fewer operational personnel and more professional staff).

- It is also stated that more applications are running on the Pyramid/Oracle system(s) than were previously running on the mainframe systems.

Paul Ricker, Heileman's vice president of information systems, is quoted as saying: "Any MIS manager who is a business manager and not just a technical manager has got to take a look at the financial aspects of moving to UNIX. There is a very big financial payoff to people who commit to move to this technology. Especially in small to medium-sized companies, they'll be doing their company a disservice if they don't look at it." [6]

The Heileman example demonstrates that downsizing can mean reduced staff, reduced IS budget, and reduced systems software costs. Unfortunately, in the Heileman case the downsizing of IS happened to coincide with a general downsizing of the business from 16 million barrels to 11 million barrels. The total IS budget (including personnel) decreased by 40% over the last few years, and business volume shrank by 32%. That is downsizing in an all-encompassing sense, but it still leaves open the possibility of additional downsizing from Pyramid minis to PC LANs—especially if the company continues to decrease in size.

c. The Null Hypothesis

In order to determine what is meant by downsizing, INPUT started with a null hypothesis that stated that:

- If mainframes and minicomputers are replaced
- If IS staff is reduced
- If hardware costs go down
- If software costs go down
- If users get better service
- If IS budgets are reduced—it is probable that "downsizing" has occurred.

INPUT then identified an actual example in which:

- Nineteen mainframe and minicomputers were replaced.
- IS staff (operators and systems programmers) was reduced.
- Computer hardware costs were reduced from $9 million per year to $2.8 million per year over a six-year period, and total network costs (including workstations and communications) were only $5.1 million per year.
- Systems software costs went down.
- Users got better service in terms of response time, turnaround, better applications development tools, and better management reports to control IS costs.
- Total IS budgets were reduced from approximately $16.1 million to $8.3 million.

This particular case study was documented by INPUT in *Economics of Computer/Communications Networks and Their Future Impact* in 1976, and it was accomplished by "upsizing" to the largest available mainframe computer and consolidating processing into a single large data center.

Based on this example, INPUT rejected the null hypothesis and decided that current advocates of downsizing are explicitly concerned with replacing mainframes and minicomputers with RISC-based workstations and PC LANs. Other considerations such as client/server architecture and open systems are just a lot of smoke, and even the implicit benefits (such as cost reduction) are not the key factors in defining downsizing.

C
Downsizing, Upsizing and Rightsizing

Economics of Computer/Communications Networks and Their Future Impact defined a four-tiered, hierarchical network consisting of mainframes, minicomputers, intelligent terminals (microprocessor based), and terminals; and assigned appropriate functions to each level. While the case study that was presented was based upon the economics of centralization (and replacement) of smaller, standalone systems on large mainframes, its emphasis was on rightsizing, and it went to some length to project the technologies included in the hierarchy into the 1980s.

The recommendation to users was to centralize in order to obtain the benefits of economy of scale (and software standardization) that existed within the IBM product line, and then to provide for the orderly distribution of function to take advantage of the improved price/performance characteristics of minicomputer and microprocessor technologies. INPUT soon came to refer to this as a "proper" hierarchical network.

It seems appropriate at this point to mention briefly a few of the projections, observations and recommendations that INPUT made 15 years ago. (This is not being done to show how "smart" INPUT was at the time, but merely to point out that technological projections can be helpful in anticipating changes in the information systems infrastructure. Downsizing was predictable and should not have caught vendors or customers by surprise.)

- It was observed that arrays of microprocessors with the potential of "...10 times the performance of the 168 (IBM's largest mainframe at the time) at one-tenth the cost resulting in price/performance of 100 times...would be available in ten years." (Advocates of downsizing currently are fond of stating that "one MIPS" on a 3090 costs about $100,000 compared to less than $1,000 on a PC—a price/performance ratio of approximately 100 to 1. [2])

- "Cheaper storage costs (by 1985) at Levels I, II, and III (mainframes, minicomputers and intelligent terminals) will encourage distribution of data bases, and the distribution of processing against these data bases will improve overall network performance."

- The report also projected "Level V terminals" that would appear in "substantial numbers" during the 1980s, and were defined as: "...mobile terminals that can connect into the network. These terminals are of two varieties...a) those that are 'on-line' via radio...b) and those that have the ability to be carried by an individual to record transactions for later transmission into the network...."

- "Large centralized data bases are neither required nor desirable for most data processing problems in a network environment....Anyone who establishes a centralized data base using today's software systems (IMS on large mainframes) has a substantial exposure to conversion problems as SNA and other network architectures develop." (An anticipated impediment to downsizing.)

- Then speaking about hardware/software trade-offs, the following statement was made: "...by the mid-1980s...many operating system functions, language processors, network control programs, terminal control programs, and common applications will be included in hardware." (IBM's SAA may not have been announced until 1987, but the AS/400 certainly points in that direction.)

- In establishing "guidelines for decision making" the following points were made:

  - "...the cost of establishing and operating such a network should be compared to the cost of purchasing comparable service through an outside vendor. An important consideration in addition to cost is the availability of the necessary technical talent to implement a private network."

  - "Be aware that adoption of the overall Systems Network Architecture and its supportive software may limit the choice of communications controllers, terminal controllers, minicomputers and terminal equipment."

  - "Once a distributed network is developed it will be extremely difficult to make a major operating systems change."

  - "Consider the fact it will probably be necessary to interface the network with others."

  - "Support packages from independent software vendors should be considered."

  - "Determine whether savings in programming cost associated with generalized systems (DBMSs, 4GLs, Query Languages, etc.) are real or are merely being hidden—and perhaps increased—by having operating personnel (end users) perform data processing functions."

The study also covered such subjects as privacy and security, and the regulatory issues being defined in the FCC's "computer inquiry."

The general theme of the report was that consolidation (upsizing) should be followed by the "orderly distribution of processing" (downsizing) back to appropriate levels in the processing hierarchy (rightsizing). The success of IBM's SNA and the personal computer revolution of the 1980s destroyed any hope that there would be orderly transition to a proper hierarchical network.

To understand what happened and where we stand today, it is necessary to clear up a little of the terminological inexactitude.

D

A Framework for Understanding

Shortly after Dr. Frederick P. Brooks, Jr. (of *The Mythical Man-Month* fame) moved from hardware engineering to software engineering, he was heard to observe: "We seem to have more terms than concepts here." This is an astute observation, and the fact that we do have more terms than concepts is a major contributing factor to terminological inexactitude in the computer industry.

1. More Terms Than Concepts

Problems of terminology are especially troublesome when networks are considered. For example, all you have to do to create complete chaos is get 100 computer and communications "experts" together in a room and tell them they can't come out until they explain in detail the differences between the following terms:

- Distributed data processing
- Distributed data base management
- Cooperative processing
- Client/server
- Network management

The trouble with computer/communication network terminology is that different sets of terms arise in each computer and communications discipline. For example, not many IS analysts are comfortable when discussing:

- Interconnect topology
- Connectivity
- Advanced peer-to-peer communications
- Advanced peer-to-peer networking

And not many communications experts are comfortable discussing:

- Data models
- Operating systems
- Applications systems
- IOCSs

Computer networking is the modern-day version of the Tower of Babel. People who are working on the problems of distributed data base management and those working on network management are working on precisely the same problems, but they have difficulty communicating with each other.

Downsizing encompasses such overlapping concepts as distributed data base management, shared file, and store-and-forward. Just get a relational data base expert, a UNIX enthusiast, and the local data communication guru together and start kicking those terms around.

It is apparent that downsizing is only one element in the network of babel that is expanding considerably faster than our networks of systems are evolving. Focusing on a single phenomenon at a given point in time can be extremely misleading. In order to put downsizing in perspective, it is necessary to take a more holistic view of networks. INPUT has long believed that computer networks are subject to hierarchical order and that the concepts of General System Theory (GST) [7] are convenient for describing how such networks evolve.

2. General Systems Theory

Ludwig von Bertalanffy, the father of General Systems Theory, developed a model of hierarchical order that included the following concepts:

- As systems become more complex, "there is progressive integration in which the parts become more dependent on the whole; and progressive differentiation, in which the parts become more specialized." This permits the human, organization or computer network to exhibit a wider range of behavior and function.

- This increased functionality is "paid for by progressive mechanization that is the limiting of the parts to a single function, and progressive centralization, in which there emerge leading parts...that dominate the behavior of the system." [8]

It is not difficult to identify an embedded microprocessor in a laser printer as an example of mechanization and an IBM MVS/ESA mainframe host as being the leading part that dominates the behavior of an SNA network. Nor is it difficult to identify the integration of PCs when they are linked to a mainframe or connected to a client/server LAN. And differentiation is

easy to recognize when mainframe applications are "offloaded" to departmental minicomputers or "cooperatively processed" between host and workstation. However, it is one thing to observe and recognize these trends, and quite another to anticipate and take advantage of them.

Difficulties arise because all of these progressive trends proceed in parallel, and are subject to influence by the human and paper-based systems that interface with the computer network. Therefore, if we concentrate on a particular trend such as downsizing—which is obviously associated with differentiation and mechanization—without regard for the natural "upsizing" trends toward integration and centralization, we may find we have totally misread the technological tea leaves and the market.

For example (like it or not), SAA is merely the latest manifestation of progressive centralization—a sort of leading part to end all leading parts. The fact that it is a little frayed around the edges at the OS/2 level shouldn't mislead anyone. The following are facts:

- Centralized data bases continue to grow faster than efforts to distribute them to downsized platforms.

- Despite the terms client/server and peer-to-peer, some servers and some peers are more equal than others; and our experience tells us that those who control the data control the relationship.

- After years of talk about open systems, SNA remains the predominant installed network architecture for business applications.

- Despite predictions of the demise of minicomputers and proprietary systems, the AS/400 (the most proprietary of the proprietary) had sales of $14 billion in 1990. For those who prefer to think of this as a "niche market", we can only say: some niche!

- SAA is IBM's model of the hierarchical order, and it should accommodate Bertalanffy's concepts of progressive integration, differentiation, mechanization and centralization. Unfortunately, IBM has traditionally been an "upsizing" company with emphasis on upward compatibility to ever larger mainframes.

Therefore, the "normal" parallel progression of the GST concept continues to be distorted in the actual implementation of SAA. Centralization on host mainframes remains the predominant feature of the architecture; downsizing, even within the SAA family, is resisted; and progress toward "rightsizing", as exemplified by co-operative processing, is painfully slow. Consider the fact that the AS/400 is well suited to be a distributed data base server, and IBM has yet to aggressively market it for that purpose.

Why? Because IBM's primary strategy is to control the diffusion of innovative information technology that would result in downsizing from mainframes—even if the target happens to be another SAA platform. The distortions in network architecture created by this strategy represent the most promising targets for downsizing.

The next section will describe pertinent network architectures, but first, a few general definitions are necessary.

E
Definitions

Over the years, INPUT has found it necessary to adopt certain somewhat arbitrary definitions to cut through the continuing "terminological inexactitude" described above.

1. Hardware

In the early 1970s it was possible to classify computers based on their architecture: mainframes (32-bit), minicomputers (16-bit), and microprocessors (8-bit). Fortunately, INPUT anticipated that this would not remain the case for long and adopted the following definitions based on price:

- Mainframe processors cost more than $200,000.
- Minicomputers (departmental processors, small business systems, etc.) cost between $20,000 and $200,000.
- Intelligent workstations (personal computers) cost less than $20,000.

This classification has held up rather well for nearly 20 years. While processing power and price/performance have increased by several orders of magnitude, and terminology has increased almost as fast, the proper roles of such systems have remained essentially the same.

A big battle is currently raging around the $20,000 level, with RISC workstations, high-end personal computers, and minicomputers all jockeying for position, but there isn't any question that when they venture over the line they are normally serving a different purpose (server rather than workstation), and are competing in a different market.

2. Data, Information and Knowledge

It is INPUT's opinion that downsizing, upsizing and rightsizing will be constrained and directed by considerations of data, information and knowledge management. Therefore, it is important to understand those terms. (It is also appalling how "sadly misused" these terms are in the computer industry.)

During the 1980s, INPUT adopted the definitions of data, information and knowledge developed by Fritz Machlup in "Semantic Quirks in Studies of Information" that was included in *The Study of Information* [13]. They are as follows:

- *Data.* After reviewing how far the term data had strayed from its original Latin definition of "the givens," Machlup stated:

  "This semantic muddle, however, need not cause any serious trouble, because the arguments in which data, whatever they are, play a central role are relatively simple: Data entry, data storage, data retrieval, data processing, data services, and all the rest, refer simply to things fed into a computer. These things, now data from the point of view of the programmers, operators, and users of the computer, *need not be data in any other sense*" (his emphasis).

- *Information and Knowledge.* Information and knowledge have a firm link, and the best way to define them is by distinguishing between them. The commonly accepted distinctions are as follows:

  - Information is piecemeal, fragmented, particular, whereas knowledge is structured, coherent, and often universal.

  - Information is timely, transitory, perhaps even ephemeral, whereas knowledge is of enduring significance.

  - Information is a flow of messages, whereas knowledge is a stock, largely resulting from the flow, in the sense that the "input" of information may affect the stock of knowledge by adding to it, restructuring it, or changing it in any way (though, conceivably, information may leave knowledge unchanged).

  - Information does not imply quality or value—it may be factual, it may be propaganda, or it may be outright lies. Knowledge implies that there is at least some consensus in being accepted as having more lasting value.

  - An additional fundamental distinction is that information is acquired by being told, whereas knowledge can be acquired by thinking (without new information being received).

After over thirty years of computer systems development, it is possible to draw some general conclusions about data, information and knowledge:

- Data, by definition, are things stored in computer systems; and they may now include encoded data, images, audio and video. However, it is possible to be more specific than that: data of institutional significance remain on host mainframes for any but the smallest organizations;

minicomputers are used primarily to concentrate data for specific work units; and personal computers store personal data bases and are used to generate paper documents (correspondence, reports, etc.).

- Information is transferred by voice (being told) or by paper documents. While the transfer of information by voice represents a substantially higher percentage of total office costs, the official communication of information remains on paper. If information of significance is generated in meetings or telephone conversations it normally is documented for purposes of validation, distribution and storage. Paper remains the primary information medium of organized human activity (business).

- Human minds remain the primary processors of information, and the brain remains the primary storage device of knowledge (a very small percentage of individual human knowledge is ever documented). The best research efforts in artificial intelligence have resulted in precious little knowledge as to how either the mind or the brain works (except the grudging admission that man did not create computers in his own image).

Machlup felt strongly that there has been "sad misuse" of the term information, and he deplored its use both in information theory (signal transmission) where it is mathematical, and in artificial systems (computers) where it is, at best, metaphorical. Since we happen to agree with Machlup, and have adopted his definitions, it is with some hesitancy that we present the following observations about data, information and knowledge.

- It is our opinion that data, information and knowledge (by our definition) are all three subject to entropy in at least a philosophical sense. That is to say that considerable human or machine energy must be expended if the natural (and perhaps irreversible) trend toward chaos is to be replaced with order. This is important for the following reasons:

  - It appears that entropy is higher in a distributed data base environment than it is in a highly centralized environment. This means that more energy will be required to maintain data quality (order) in a distributed (or downsized) environment.

  - The increased volume of paper documents and publications has contributed to a rise in information entropy. It is now possible to find information to support practically any conclusion, and executives are exposed to information that supports any decision. The result of "information overload" is an increased ratio of noise to new information and this increases uncertainty and lowers information quality regardless of how "pretty" the document or presentation may be.

  - Computer technology has created a high-entropy environment that extends beyond data and information to individual and professional knowledge. Whether one is a computer consultant or a medical doctor, we all seem to have to run twice as fast to maintain knowledgeable in our fields, and it is becoming increasingly difficult to filter out the noise and identify new knowledge. It is possible that knowledge-based systems, in which knowledge becomes data, will only contribute to the problem.

- Machlup's definition of information is founded on the need for an informant—someone who tells others (individuals or groups) something. This can be done by talking, writing, signaling etc., and he specifically points out that "information is addressed to human minds and is received by human minds." This becomes an important consideration in dealing with computer/communication networks in a downsized environment, because human beings will be communicating with, and through, an artificial system.

- It is possible, and perhaps even inevitable, that "artificial information" will result from downsizing. Information moves between human beings but gets changed as it draws on distributed data bases that lack integrity, are out of synchronization, or have been intentionally contaminated by an intruder. Such artificial information will flow with such speed among nodes in the network that it may be beyond human control and verification.

It is important to add *entropy* and *artificial information* to our already strained vocabulary when analysing the impact of downsizing on the information systems infrastructure of the 1990s.

3. Productivity-Performance

The purpose of interaction among knowledge workers, and between humans and computer/communications systems, is to improve the productivity of human beings and their institutions. In order to determine the effectiveness of these human-machine relationships and the complex interplay among data, information and knowledge, it is necessary to have a basic framework for understanding and measuring performance.

In 1983, when INPUT published *Impact of Office Systems on Productivity*, it adopted a framework for assessing the performance of white-collar workers that was originally developed by James W. Bair. This framework provides four performance levels that are briefly defined below, with comments:

- Performance Level I is the conventional hardware/software network where software is viewed in the sense of computer programs (both systems and applications programs). Performance is measured by the relative cost of MIPS, cost per transaction, response time at the workstation, etc. While performance measurement at this level is far from a science, at least there are some metrics we can all argue about. (However, we will state that cost per MIPS should never be the justification for downsizing—that is not even worth arguing about.)

- Performance Level II is the human/machine dyad. (Since 1983, it has become more acceptable to think of human beings as integral parts of the computer/communications network, but it was a relatively novel idea at that time.) At the human/machine dyad, it is possible for the computer (machine) to monitor certain aspects of human performance more accurately than any industrial engineer could with a stopwatch. The number of keystrokes, words written, lines of code generated, transactions processed, can all be counted with great precision in a continuing time and motion study. The problem is that, except for the most routine clerical functions, quantitative measures of individual knowledge worker productivity can be highly misleading and counterproductive. (It is a disturbing fact that the cost of preparing a piece of business correspondence has continued to increase since computers were substituted for typewriters at the human/machine dyad.)

- Performance Level III is the work unit. Just as with individual humans, it is becoming increasingly possible for the network to capture detailed quantitative data on office processes. The applicability of such measures will depend upon the particular work unit. However, it is possible to say that the quantity of information (paper) produced will seldom be a good measure of the productivity of an office work unit. The considerable investment made in information technology during the 1980s succeeded in increasing the volume of paper produced, but the overall productivity of white-collar workers in the United States declined during that period.

- Performance Level IV is that of the overall institution. Institutional performance continues to be measured by the good old reliable bottom line. The primary impact of information technology has been to provide faster results in greater detail. All attempts to establish significant, positive correlation between investment in information technology and the bottom line have failed; and American companies, on the leading edge in terms of investment in information technology, seem to be less competitive in international markets. Public accounting firms have become so immersed in information systems consulting that they have, on occasion, failed to fulfill their responsibilities to the public when auditing major financial institutions. It appears necessary to take a fresh look at the measurement of institutional performance as it relates to information technology.

What we are really concerned with is management—network management, data/information/knowledge management, and performance management. It is possible to present this management framework in a simple 3X3 matrix. (Exhibit III-1) It is our belief that management must understand and accept responsibility for both the technological and human sides of performance improvement because they are becoming inextricably integrated. In many cases this will require a major change in management mind-set, and this will be briefly described in Section VII of this report.

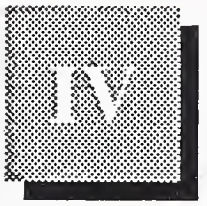
However, we are concerned primarily with downsizing, and downsizing is concerned primarily with network management and Performance Level I (PL/1). Therefore, without getting deeply involved, we will now briefly introduce the subject of network architectures.

EXHIBIT III-1

A Simple Management Framework

	Networks (PL/1)	D/I/K	Performance/ Productivity
NL/1	Mainframes	Data	Human/machine dyad (PL/2)
NL/2	Minicomputers	Information	Work unit (PL/3)
NL/3	IWSs	Knowledge	Institutional (PL/4)

NL = Network level
PL = Performance level



Downsizing and Architecture—A Framework

It is beyond the scope of this study to do a detailed analysis of network architectures, but INPUT considers such analysis so important to understanding the impacts and consequences of downsizing that it will devote a major report to the subject early in 1992.

However, it is necessary to set a general architectural framework for this study, and we will briefly outline some of the major architectural considerations that will determine the success of downsizing in the 1990s.

A

SNA to SAA to Rightsizing?

1. SNA

In the previous chapter, it was pointed out that Bertalanffy's four concepts of hierarchical order (integration, differentiation, mechanization and centralization) all progress in parallel. The primary target of downsizing is the highly centralized, host-oriented architecture that has resulted from IBM's Systems Network Architecture (SNA). For nearly 20 years, progressive centralization has been the dominant force in SNA networks. The mainframe "leading part" grew into complex, top-heavy architecture that nonetheless managed to withstand minicomputer downsizing assaults from DEC, HP, Data General and a host of other competitors during the 1970s.

It is not unfair to state that the primary purpose of SNA was to keep minicomputers from assuming their proper place in the processing hierarchy, and SNA was quite effective in doing this. This was accomplished by offloading minimal function and processing power from mainframes to a series of underpowered communications front ends (37XX) and cluster controllers (3790, 8100); and by announcing a minicomputer (Series/1) that was completely unsupported for commercial work and a series of small business systems (System/3X) that could be used as standalone systems or as departmental processors.

2. On the Road to SAA

The PC revolution of the 1980s destroyed any hope of the orderly distribution of processing from host mainframes, and exposed the considerable price/performance and usability gaps between mainframes and intelligent workstations. This, combined with IBM's hodgepodge of minicomputers, created a serious weakening of IBM account control, and the computer "slump" of the mid-1980s spurred IBM into action. In relatively short order, the following occurred:

- IBM began to talk with customers, consultants and industry analysts about cooperative processing and distributed data base management across mainframes, minicomputers and "programmable" workstations.

- Then, in early 1987, Dr. A. L. Scherr published a paper titled "Structures for Networks of Systems" in the *IBM Systems Journal* (Vol. 26, No. 1, 1987). After reviewing the fact that technological developments, and especially microprocessor technology had led many people to conclude that "one or more" of the processor levels would disappear, Dr. Scherr concluded:

  "In this paper, we have looked at a full spectrum of possibilities. It is difficult to escape the conclusion that each type of system has a significant role to play, and it is difficult to imagine technology changes that would eliminate any one of the types (mainframe, minicomputer or microprocessor). Each type of system represents unique advantages that argue strongly for its usage. Thus, we conclude that multiple-tier systems will be in general use, particularly in large corporations, for many years to come." [22]

This paper was published only a few weeks before IBM announced its Systems Applications Architecture in March of 1987. It was the first time IBM had acknowledged that minicomputers might have a significant continuing role to play in IBM's networking strategy.

3. SAA and Rightsizing

Rightsizing in an environment dominated by SNA for nearly two decades doesn't have anywhere to go but down. Therefore, since SAA is obviously designed to give IBM customers an opportunity to choose among mainframe, minicomputer, and microprocessor platforms according to their "unique advantages," it is IBM's preferred architecture for rightsizing and downsizing. INPUT's comments concerning SAA are as follows:

- The heart of SAA is distributed data base and network management in heterogeneous environments, and when IBM talks about distributed data in the 1990s, it specifically includes all data types: record, text, voice, graphics, images and "other" (programs, knowledge rules and meta data).

- The designated server for distributed data in SAA is the AS/400; a system that receives short shrift from competitors, consultants, the trade press, RISC advocates, and mainframe mavens both in and out of IBM—everyone except satisfied customers and the judges who gave it a Malcolm Baldridge award. The AS/400 brought in $14 billion in revenue in 1990, and IBM hasn't begun to sell it as a distributed data base server.

- The AS/400 is obviously the key to success for SAA and downsizing. The very nature of SAA means that the MVS/ESA systems have to be dragged along into places they were never intended to be, and OfficeVision and ImagePlus have failed precisely because they don't really belong on mainframes in the first place. The AS/400 remains a mystery and a threat to the Enterprise Systems types—downsizing, even to an IBM platform, remains anathema to IBM.

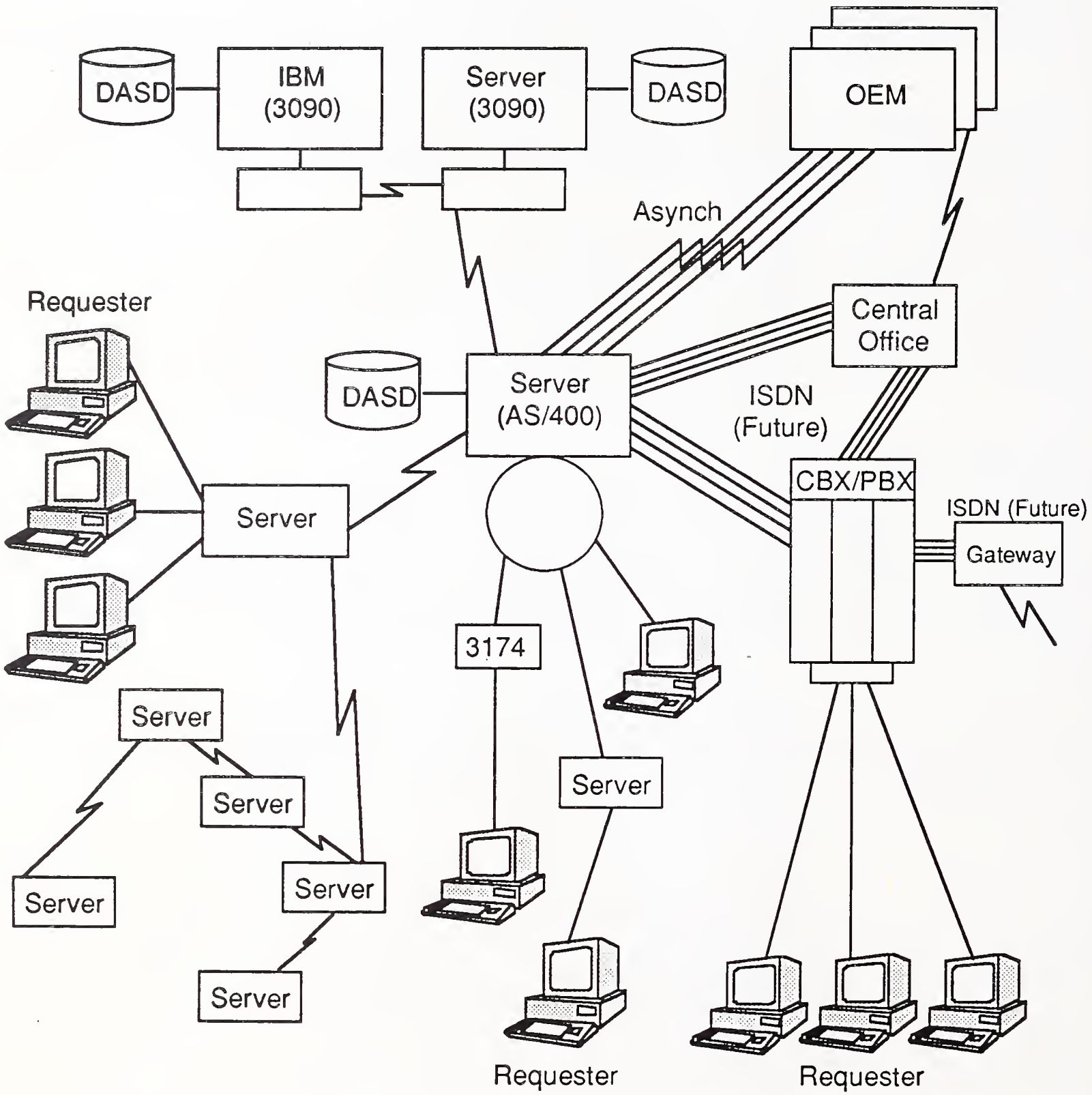
- It is a reality of the marketplace that the AS/400—the most proprietary of the proprietary—is by far the hottest product in the business systems marketplace. With conventional hardware becoming a commodity, the tight integration of systems software (including DBMS and communications software) under OS/400 represents real added value—and don't think IBM doesn't know it.

- As IBM restructuring continues, expect to see the AS/400 turned loose to compete for downsizing business; and, regardless of what anyone says about SAA (or what they call it), it will remain extant because the AS/400 is the very heart of SAA.

Exhibit IV-1 is a diagram prepared by IBM even before SAA was announced. It depicts the broad network architecture IBM anticipates in the 1990s. We have designated the "superserver" mainframes (3090) and distributed data base servers (AS/400) that will function in a cooperative processing environment. Other downsizing efforts must determine how and where they will interface with this architecture.

EXHIBIT IV-1

Servers, Servers, Everywhere and Who Controls the Data?



Source: IBM
( ): INPUT

B
The Client/Server Architecture

The difference between cooperative processing (SAA) and client/server architecture is primarily one of perspective. If you start with a mainframe application you distribute some processing (and data) to a more appropriate (cost effective) level in the processing hierarchy but essentially retain central control. If you start with a personal computer "application" that needs data you buy, beg, borrow or steal the data you need and retain control of "your application." This is a non-trivial difference of perspective that can lead to all sorts of technical and political difficulties because it is essentially a power struggle.

However, there is also the very important distinction that cooperative processing as defined in SAA promises to a level of distributed data base management that is not implicit in the more general term: client/server, where simple file transfer is the general rule even if it is accomplished with an SQL statement. The client assumes a certain amount of responsibility for data quality (local integrity, synchronization, and security) in the general client/server environment—especially when UNIX is involved.

The client/server architecture is nothing new. It was inevitable from the time direct-access storage devices were invented, and it is inherent in computer/communications networks, as indicated by IBM's view of the computer networking world of the 1990s (Exhibit IV-1). It was replete with servers and requesters. The subtle distinction between "client" and "requester" demonstrates the not-so-subtle difference in perspective. A "client" implies a customer who has certain rights even if he/she is not always right. A "requester" implies a hat-in-hand, subservient relationship with the "server" comparable to that of subject to ruler. But, perhaps we read too much into terminology. The fact remains that clients, requesters, users—whatever you want to call them—are going to be served from a variety of architecturally and/or geographically distributed sources on the network.

Here is the "vision" of the client/server environment presented in a newsletter distributed by a consulting consortium in the fall of 1991:

"We believe the preferred computing model for the 1990s and beyond is an architecture called "client/server computing" wherein a company's systems are run on a network of microcomputers and workstations instead of mainframes. The network is composed of "clients" such as PCs and workstations that are linked to "server" devices (often other microcomputers) that store and manipulate data. Other equipment such as printers, modems, and scanners can also be connected to the network.

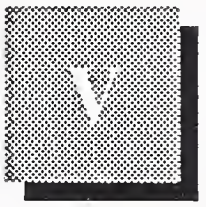
"The key feature of client/server computing is that both data and processing are distributed to the desktop, allowing a company to bring data out of the back room (usually on a mainframe), and put it, along with a tremendous amount of computing power, at the disposal of its employees.

"The key to a successful client/server network is the integration of the resources of the network. Rather than just an assemblage of connected workstations, the systems on the network should be linked so seamlessly that the network itself becomes the computer."

This description is quite simple, and it is nice to know that "server devices... store and manipulate data." That covers about 95% of what MVS/ESA, CICS, IMS and DB2 do in a mainframe data processing environment. Unfortunately, memory management, queue management, interrupt handling, scheduling, error handling, recovery management, and even such simple things as accounting for what is going on the system (so people can be billed for use) seem to get those large systems guys all tied up in knots. Then, of course, they also seem to be obsessed about data quality. There are many open questions concerning whether all of this complexity and concern for quality are really necessary or can be passed off lightly to a server that simply "stores and manipulates data."

Those who plan to implement major downsizing projects are going to find out whether or not the world is as simple as some would have us believe. We will have to leave more detailed analysis of these underlying architectural questions to the follow-on INPUT report.

It is now time to determine whether IS management is taking this downsizing thing seriously, and what they believe is really going to happen in the 1990s.



Current Architectural Thinking and Plans

Although this study focuses on downsizing, it is designed to elicit considerably more information concerning the current architectural thinking and plans of the IS executives making the critical decisions that will determine the shape of their information systems infrastructure in the 1990s.

A
Technologies and Concepts

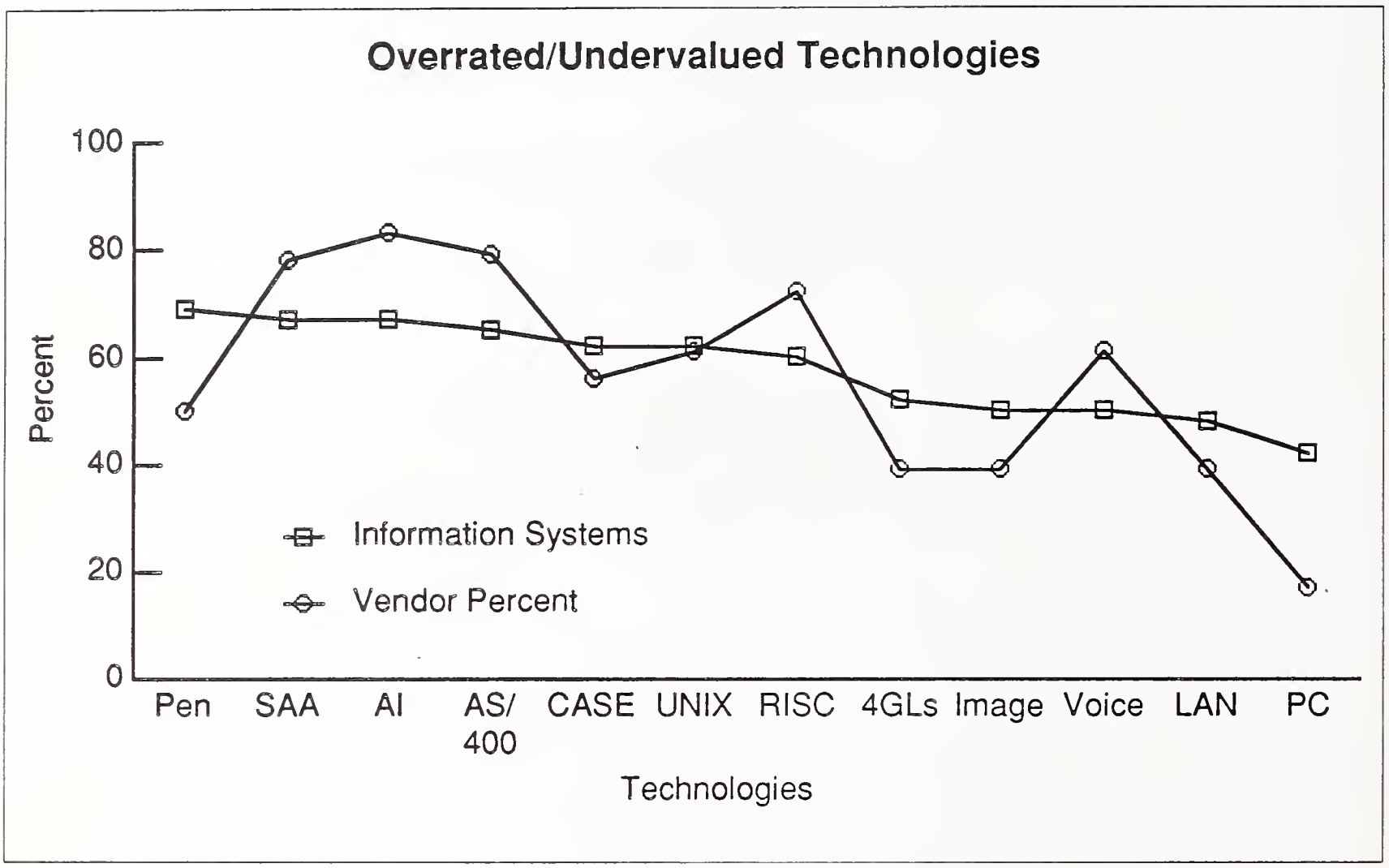
One of the most profound observations made about the computer industry was made at its inception, when it was stated that we are first inclined to overrate technological innovations and then, when they do not meet our expectations, we undervalue them. All new products and concepts in the information technology industry seem to go through overrating-undervaluing cycles.

INPUT asked vendor and IS respondents whether they felt certain technologies and concepts were "overrated" or "undervalued". (A copy of the questionnaire is included in Appendix B.) The significance of the answers to such questions occurs when there is consensus that something is overrated or undervalued, or when there is a significant difference of opinion between sets of respondents (such as IS and vendors). For example, if 50% of a population feels that a technology is overrated there is obviously no consensus since another 50% feel that it is undervalued. However, if 75% feel it is overrated that means that there are three people believing it is overrated for every one feeling it is undervalued. If only 25% feel is overrated, there are three people who feel it is undervalued for every one who feels it is overrated (undervaluing obviously being the inverse of overrating).

1. Overrated and Undervalued Technologies

Exhibit V-1 plots the percentage of IS and vendor management feeling that selected technologies are overrated. A number of general conclusions can be reached from the information in the chart.

EXHIBIT V-1



a. IS Management

- IS executives have more difficulty than vendors in reaching consensus about whether technologies are overrated or undervalued. However, more than half of the technologies (7 of 12) were considered overrated by 60% or more of the respondents. This means approximately twice as many feel that the technologies have been (or will be) disappointing in fulfilling expectations. These overrated technologies are:

  - Pen-based systems - 69%
  - SAA - 67%
  - Artificial intelligence (including expert systems) - 67%
  - AS/400 - 65%
  - CASE and re-engineering of applications - 62%
  - UNIX - 62%
  - Reduced instruction set computers (RISC) - 60%

  - This means that there is an attitude of skepticism concerning these particular technologies among a significant majority of customers.

- There is no consensus among IS management as to whether the following technologies are overrated or undervalued:

  - Fourth-generation languages - 52%
  - Image processing - 50%
  - Voice recognition systems - 50%
  - LAN-based relational data base management systems - 48%

- While IS management did not consider any technologies significantly undervalued, they did tend to feel that personal computers were the least overrated technology.

  - Personal computer productivity tools and solutions - 48%

b. Vendors

Vendors were better able to reach consensus as to which technologies were overrated or undervalued. This is perhaps to be expected since they would probably be inclined to rate competing technologies overrated and their own technologies as undervalued. The following general conclusions can be reached from the chart.

- Four technologies are considered to be were considered overrated by over 70% of the respondents. This means that the overrated-undervalued ratio was approximately 3 to 1. Those technologies were:

  - Artificial intelligence (including expert systems) - 88%
  - SAA - 78%
  - AS/400 - 78%
  - Reduced instruction set computers (RISC) - 72%

- In addition, two other technologies were considered overrated by a ratio of approximately 2 to 1.

  - UNIX - 61%
  - Voice recognition systems - 61%

- There were only two technologies upon which vendors did not reach consensus.

  - CASE and re-engineering of applications - 55%
  - Pen-based systems - 50%

- Three technologies were considered significantly undervalued since they had an overrated-undervalued ratio of approximately 1 - 2.

  - Fourth-generation languages - 38%
  - Image processing - 38%
  - LAN-based relational data base management systems - 38%

- Vendors were practically unanimous in feeling that personal computers were undervalued. Less than 1 in 5 rated them as being overrated.

  - Personal computer productivity tools and solutions - 17%

c. Conflicting Opinions

The reason we consider Lady Lovelace's overrating-undervaluing observation important is that it highlights conflicting opinions and communications problems. When IS executives state that something is overrated they are either saying that they have tried it and it did not meet their expectations or they don't believe what others (vendors) are saying about it. When vendors say that something is undervalued they are saying that customers are either not taking full advantage of the technology or they simply don't understand the value of it.

Exhibit V-1 isolates some major technological conflicts and/or communications problems.

- First of all, vendors and IS executives are obviously in conflict with IBM's opinion of the value of SAA. It would seem fair to say that experience to date has not demonstrated the value of SAA and that the value of IBM's major strategic initiative is not clearly understood—at least from the user's perspective.

- The same can be said for a key SAA component—the AS/400. Here is the best selling and highest rated product (in terms of overall quality) the computer industry has ever seen. Yet INPUT's research—which was admittedly among larger customers and vendors—indicates that the product is significantly overrated. This is an exceptionally important conflict of opinion—especially since the AS/400 would appear to have a significant role to play in the downsizing market.

- Another key IBM technology of the 1990s (AI/expert systems) is also among the most significantly overrated. AI had a overrated-undervalued ratio of over 4-1 among vendors. AI has gone through numerous overrated-undervalued cycles in the past, but now it appears that downsizing will permit economical knowledge capture and integration—provided this capability is built into the applications themselves. Either vendors (and IS) know from past experience that AI just doesn't work or they don't understand the potential of what the proponents of the Intelligent Systems School of Thought have been saying.

- Even image processing leaves IS management with no significant consensus as to its value. Hopefully this means that the value of reducing the paper burden is understood and is not being either overrated or undervalued, but it really depends upon whether you want to view the glass as being half full or half empty. The success or failure of current image processing efforts will determine how opinion will shift in the future.

- Also of importance for downsizing is the fact that UNIX and RISC architectures are considered to be significantly overrated by both IS management and vendors. It would certainly appear that there remains substantial skepticism that open systems can deliver on all of the promises being made.

- Finally, there is the significant discrepancy between the opinions of IS management and vendors about the value of personal computer productivity tools and solutions. Vendors seem to be saying that users are not taking advantage of all the wonderful personal computer hardware/software technology, and over 40% of IS executives are saying they are disappointed in the actual results they have achieved. It is probable that both sides are right, but the fact that over 80% of vendors feel that personal computer "solutions" (essentially, word processing, spreadsheets and data base systems) are undervalued demonstrates a considerable misunderstanding of the nature of real user application needs.

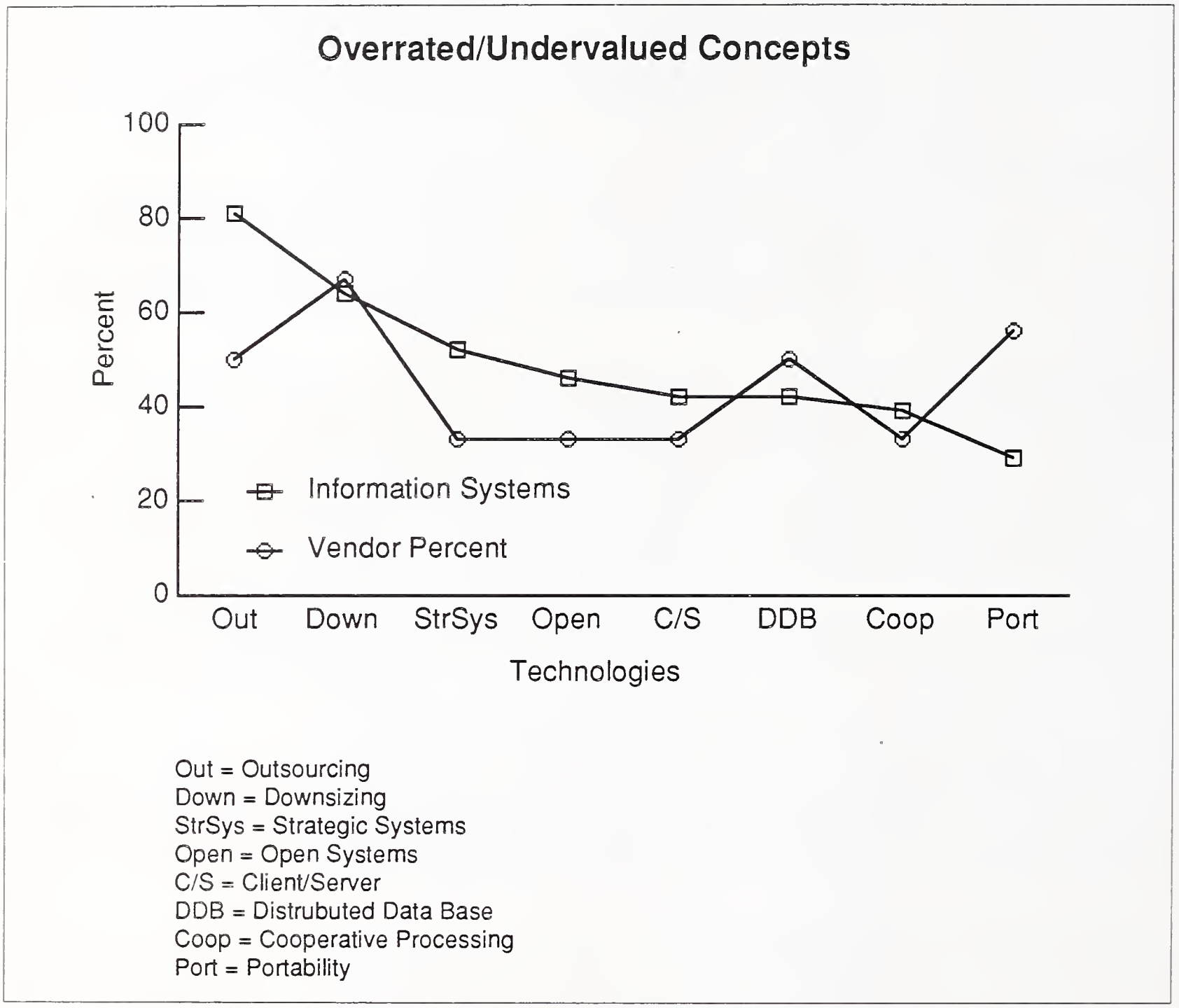
2. Overrated and Undervalued Concepts

Exhibit V-2 plots vendor and IS opinions on whether certain concepts are overrated or undervalued. Generally speaking, and not surprisingly, there is less tendency to consider concepts overrated than there was with technologies.

a. IS Management

Unlike their responses to technologies, IS executives demonstrated greater consensus on specific concepts than did vendors. The range was from 81% to 29% (of overrating) for IS, and 66% to 33% for vendors. (On technologies, IS ranged from 69% to 42% overrating and vendors from 83% to 17%.)

EXHIBIT V-2



- There was practically unanimous agreement among IS managers that outsourcing was overrated. The overrated-undervalued ratio was 4 to 1, and this is hardly surprising when the implication of outsourcing is that an outside vendor can do a better job than IS.

  - Outsourcing - 81%

- IS management reached significant consensus of overrating on only one other concept—downsizing! In that case, the ratio was approximately 2 to 1 that downsizing was overrated.

  - Downsizing - 64%

- IS management failed to reach significant consensus on whether the following concepts were overrated or undervalued:

  - Strategic systems - 52%
  - Open systems - 46%
  - Client/server architecture - 42%
  - Distributed data bases - 42%

- IS management did reach significant consensus that the following concepts were undervalued as indicated by the fact that there were approximately two respondents stating the concepts were undervalued for every one who stated they overrated.

  - Cooperative processing - 38%
  - Portability - 29%

b. Vendors

Vendors were more likely to reach consensus on the undervaluing of concepts than they were on technologies. This is understandable since technologies are more frequently viewed as competitive than are concepts.

- Vendors reached significant consensus of overrating on only one concept—downsizing!

  - Downsizing - 67%

- There was no consensus as to overrating-undervaluing on the following three concepts:

  - Portability - 56%
  - Outsourcing - 50%
  - Distributed data bases - 50%

- There was significant consensus that four concepts were undervalued (overrated-undervalued ratios of 1 to 2).

  - Strategic systems - 33%
  - Opens systems - 33%
  - Client/server architecture - 33%
  - Cooperative processing - 33%

c. Conflicting Opinions

By definition, concepts are less tangible than technologies. Also, due to "terminological inexactitude" it would probably be difficult to obtain consensus among either IS management or vendors as to the definitions of the concepts they were asked to rate. Therefore, the conflicts in opinion between IS management and vendors may be more concerned with definitions than with the actual concepts.

However, regardless of definition, Exhibit V-2 certainly highlights the current perceptions of certain marketing strategies.

- There is significant consensus among both vendors and IS that downsizing is overrated (64% of IS, and 67% of vendors). This is not surprising. All it really says is that downsizing is not a solution to all the world's problems. It supports the position that upsizing can be as appropriate as downsizing, and that both are necessary as we trudge the bumpy road to rightsizing.

- It is also significant that, while UNIX and RISC are considered overrated (Exhibit V-1), open systems and client/server are considered undervalued. It is our opinion that RISC workstation vendors, who are among the leading advocates of open systems and client/server, may have a communications problem with IS management and other vendors.

- In addition, while SAA is considered to be highly overrated (Exhibit V-1), cooperative processing is regarded as being undervalued by both IS and vendors. It appears that IBM has managed to sell a concept but has disappointed customers with the supporting technologies.

- According to IS executives the most undervalued concept is portability, and vendors are ambivalent about its value (with a slight tendency to view it as being overrated). Users have been asking for applications portability for 30 years, and they will probably never give up the quest. During that time, even upward compatibility has proven to be extremely elusive, and downward compatibility is much more difficult. This fact creates a major problem for downsizing without substantial, and expensive, re-engineering of applications.

B

Evaluation of Platform Attributes

IS and vendor management were asked to rank (from 1 to 4) the primary hardware/software platforms (mainframes, minicomputers, RISC workstations, and PCs) based on how well certain hardware/software and architectural attributes described them.

It should be pointed out that ranking is more difficult than rating—it makes one think and make choices. We were gratified that our respondents took the time to make these value judgments. It permitted us to establish relative evaluations of the platforms by attribute. These relative evaluations were computed as follows:

$$\text{Relative Evaluation} = \frac{\text{(Highest Possible Sum minus Individual Sum)}}{\text{(Highest Possible Sum minus Lowest Sum)}} \times 100$$

Obviously the platform having the lowest sum was ranked best by the respondents, since "1" is the highest ranking. The formula assigns an evaluation 100 to the platform with the lowest sum, and other values are computed relative to the highest ranked platform.

1. General Hardware/Software Attributes

The advantage of relative evaluations is that they distinguish the degree of superiority one platform has over another for each attribute. Plotting the relative evaluations on a single chart may at first seem confusing, but it presents a very clear picture of a very complex set of data.

a. IS Rankings

Exhibit V-3 plots the relative evaluations of the platforms based on their general hardware/software attributes. By merely glancing along the top line it is possible to see that mainframes and PCs received all but two of the highest evaluations.

- IS management evaluated mainframes as being better described by the following hardware/software attributes than any of the other platforms:

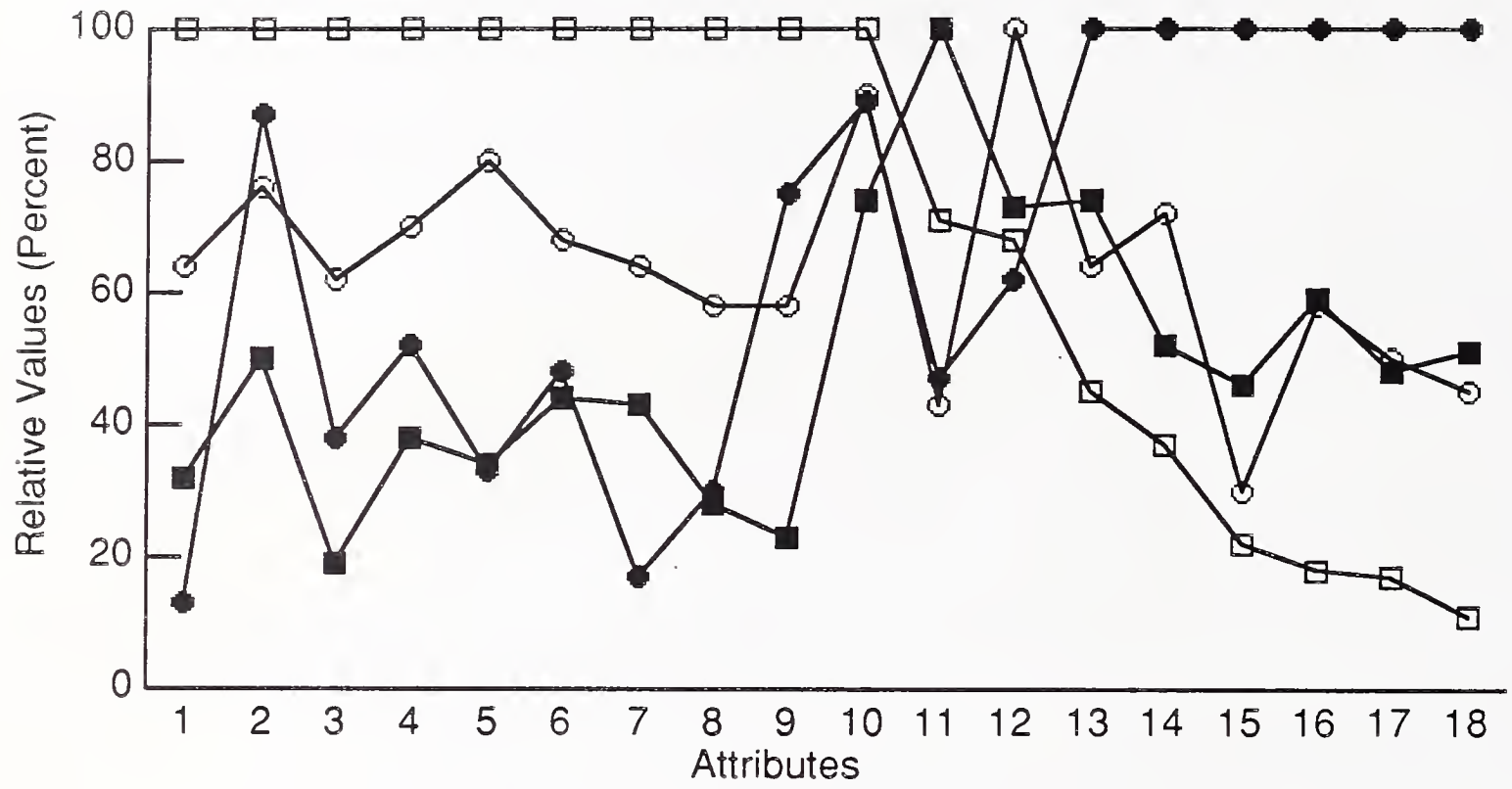
  - Very secure
  - Good connectivity
  - Good for commercial applications
  - Good reliability (hardware/software)
  - Good data management
  - Good network management
  - Complex (hardware/software)
  - Good vendor support
  - Good applications software (availability)
  - Good architecture (hardware/software)

- Personal computers were evaluated as being better described by the following general hardware/software attributes than any of the other platforms:

  - Cost effective
  - Easy to program
  - Open architecture
  - Good bargain
  - Easy to use
  - Easy to operate

EXHIBIT V-3

Platform Attribute Evaluations—by IS Management



Key	*Attribute*	*Mainframe*	*Mini*	*RISC*	*PC*
1	Security	100	64	32	13
2	Connectivity	100	76	50	87
3	Commercial Applications	100	62	19	38
4	Reliability (H/S)	100	70	38	52
5	Data Management	100	80	34	33
6	Network Management	100	68	44	48
7	Complex	100	64	43	17
8	Vendor Support	100	58	28	30
9	Applications SW	100	58	23	75
10	Architecture (H/S)	100	90	74	89
11	Scientific Applications	71	43	100	47
12	Distributed Data Server	68	100	73	62
13	Cost Effective	45	64	74	100
14	Easy to Program	37	72	52	100
15	Open Architecture	22	30	46	100
16	Good Bargain	18	58	59	100
17	Easy to Use	17	50	48	100
18	Easy to Operate	11	45	51	100

- Minicomputers were given the highest evaluation as "good data servers."

- RISC workstations were given the highest evaluation as being "good for scientific applications."

The strengths and weaknesses attributed to the platforms by IS management are not surprising, and they may be summarized as follows:

- Mainframes are best for commercial applications requiring high reliability, high quality data, and security. This is accomplished at the cost of having a very complex hardware/software platform, and being evaluated lowest for six attributes that make mainframes vulnerable for downsizing:

  - Cost effective
  - Easy to program
  - Open architecture
  - Good bargain
  - Easy to use
  - Easy to operate

- Personal computers are the least complex of all the platforms, and they are evaluated highest in precisely the attributes listed above as the weaknesses of mainframes (they are generally easy to use and give more bang for a buck). Offsetting these obvious advantages is the fact that PCs are evaluated lowest in the following three attributes:

  - Security
  - Good data management
  - Good distributed data server

- Minicomputers, rated first as a distributed data server, rank consistently second to mainframes in most of the important aspects of commercial data processing (security, data and network management, and vendor support). They received the lowest evaluation in only one category—scientific applications.

- RISC workstations were evaluated highest for scientific applications, and the fact that minicomputers were ranked lowest is significant. It confirms minicomputer vulnerability in its traditional interactive time-sharing market. (However, it should be noted that the price of RISC workstations in a client/server environment would place them in the minicomputer category by our definition.) Offsetting the advantage of RISC architecture in the scientific area is the fact that it ranks lowest in the following areas:

- Connectivity
- Good for commercial applications
- Reliability (hardware/software)
- Data management (a virtual tie with PCs in this category)
- Network management
- Vendor support
- Applications software availability
- Good architecture (hardware/software)

The relative IS evaluations, based on their rankings of the processing hierarchy, give a clear picture of their general perspective concerning the relative strengths and weaknesses across the processing hierarchy. Vendor rankings were evaluated and assigned relative values in the same manner.

b. Vendor Rankings

Vendor evaluations will be compared to IS rankings by platform in order to identify any significant differences of opinion. The IS evaluations will be sorted in descending order for purposes of comparison on the IS/vendor charts. Therefore, except for mainframes, the attributes will be listed in a different order from those in Exhibit V-3.

- Exhibit V-4 presents a comparison of mainframe IS/vendor evaluations of mainframes. Considering how the values were computed, there is remarkable agreement in the rankings. There are no deviations worth mentioning. The strengths and weaknesses of mainframes are viewed as being the same by IS and vendors.

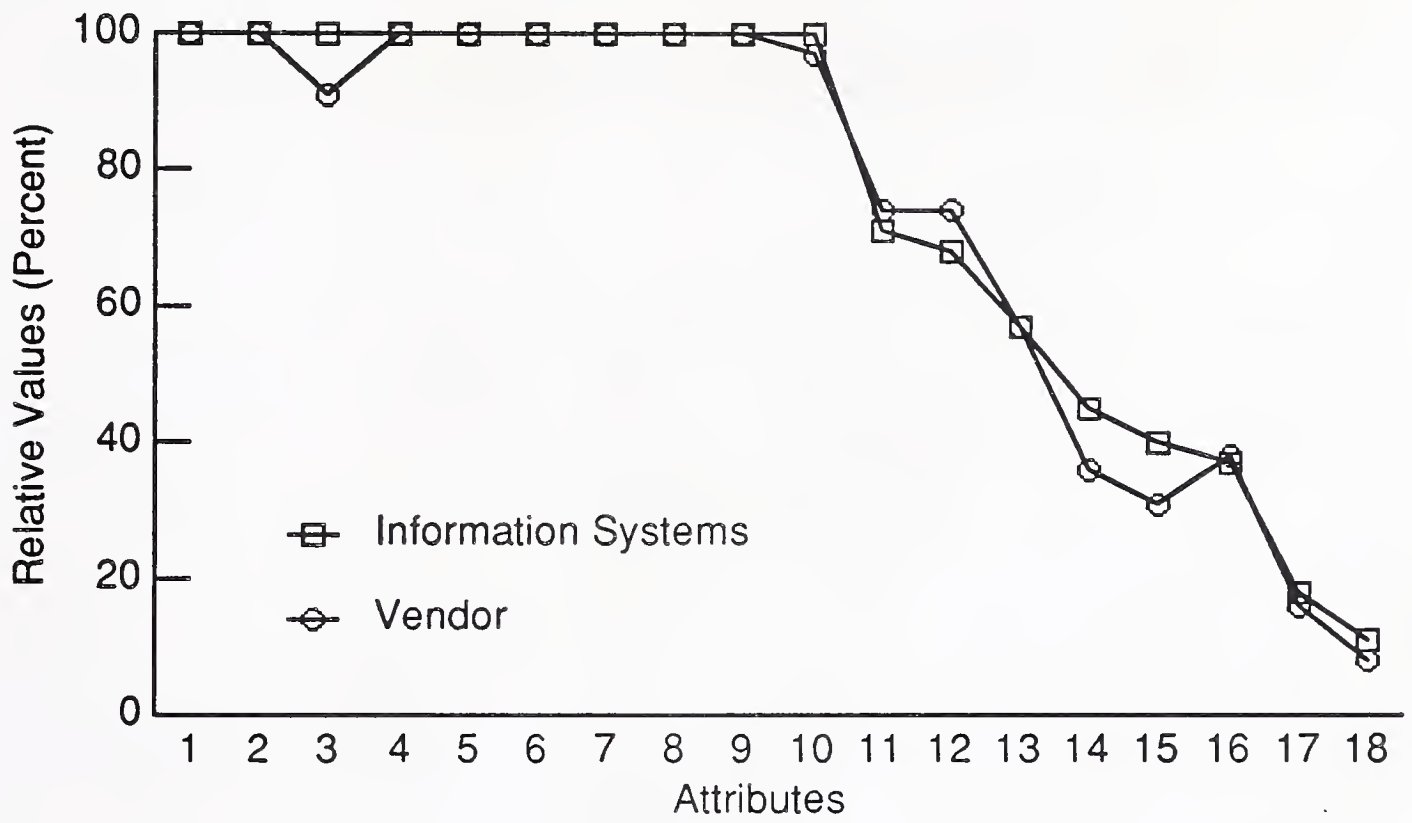
- Exhibit V-5 compares IS/vendor evaluations of minicomputers.

  There are some significant differences in perspective on the following attributes:

  - Good distributed data server - IS: 100, Vendor: 61
  - Good data management - IS: 80, Vendor: 62
  - Good network management - IS: 68, Vendor: 53
  - Good for commercial applications - IS: 62, Vendor: 88
  - Applications software (availability) - IS: 58, Vendor: 73
  - Good for scientific applications - IS: 43, Vendor: 67
  - These variations indicate that IS executives view the minicomputer as a distributed processor for offloading mainframe functions, and vendors view it more as a work unit applications engine. This could be taken to mean that vendors are more amenable to downsizing than are IS executives.

EXHIBIT V-4

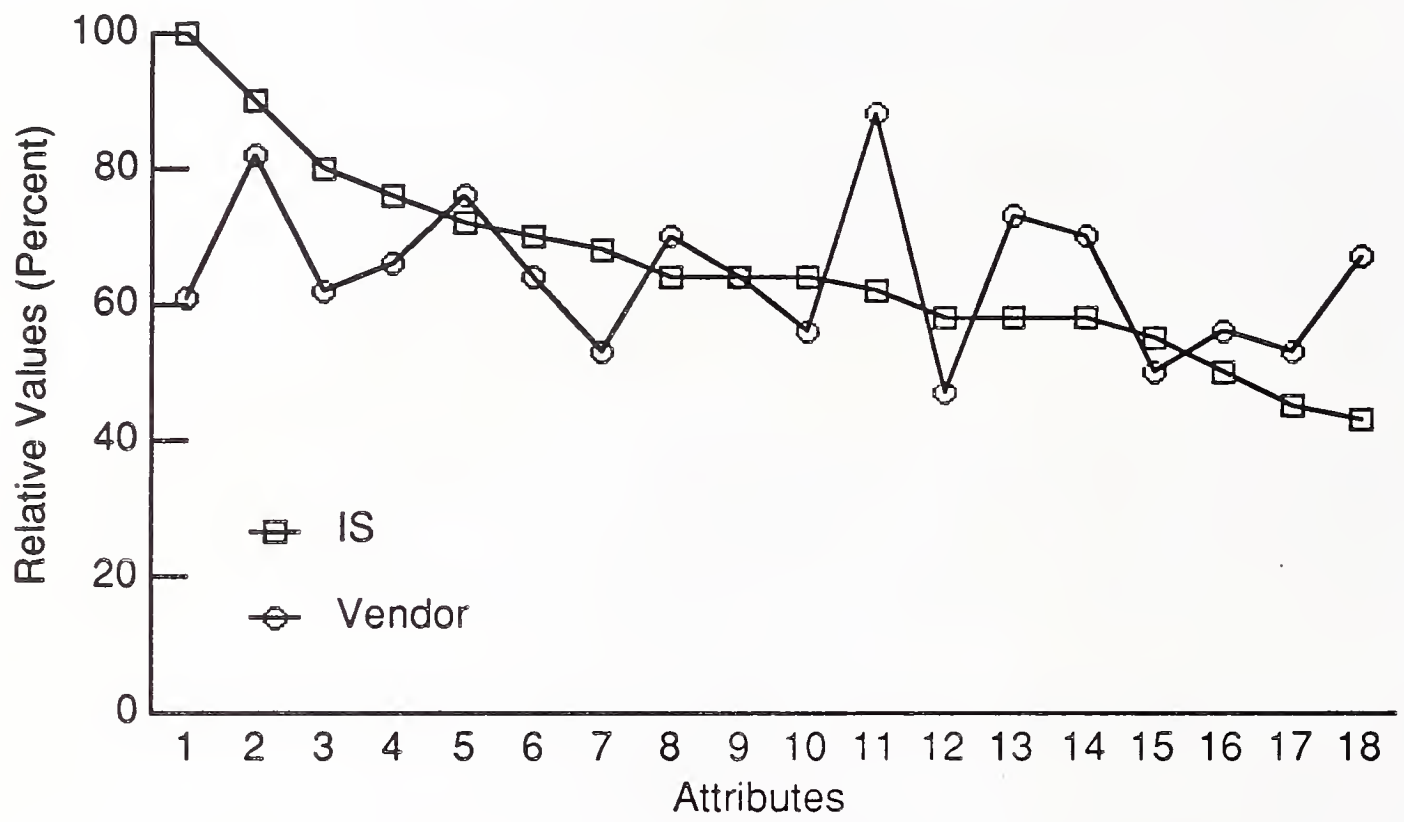
Mainframe Attribute Evaluations—by IS and Vendor Management



Key	*Attribute*	*IS*	*Vendor*
1	Security	100	100
2	Architecture (H/S)	100	100
3	Connectivity	100	91
4	Commercial Applications	100	100
5	Reliability (H/S)	100	100
6	Data Management	100	100
7	Network Management	100	100
8	Complex	100	100
9	Vendor Support	100	100
10	Applications SW	100	97
11	Scientific Applications	71	74
12	Distributed Data Server	68	74
13	Easy to Use	57	57
14	Cost Effective	45	36
15	Open Architecture	40	31
16	Easy to Program	37	38
17	Good Bargain	18	16
18	Easy to Operate	11	8

EXHIBIT V-5

Minicomputer Attribute Evaluations—by IS and Vendor Management

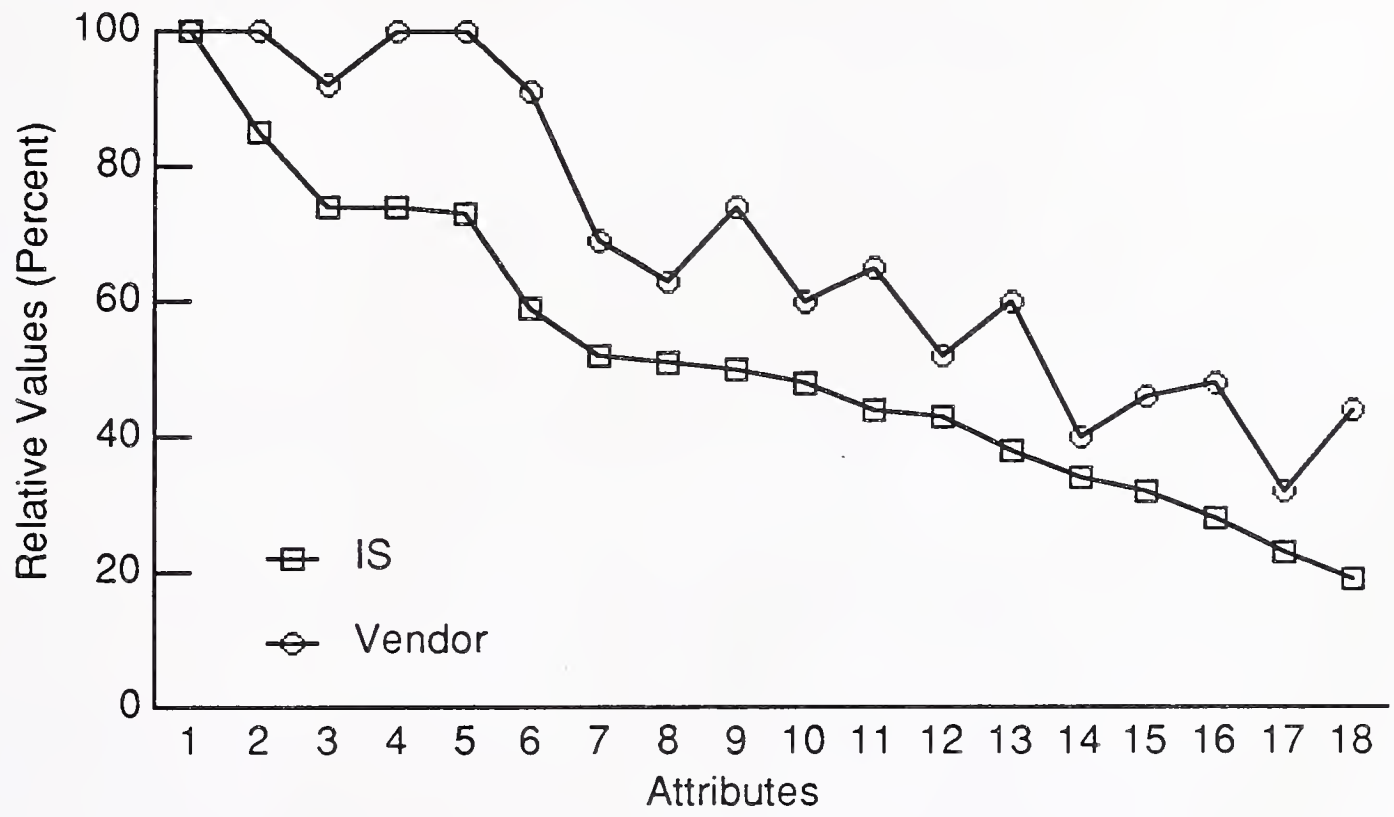


Key	*Attribute*	*IS*	*Vendor*
1	Distributed Data Server	100	61
2	Architecture (H/S)	90	82
3	Data Management	80	62
4	Connectivity	76	66
5	Easy to Program	72	76
6	Reliability (H/S)	70	64
7	Network Management	68	53
8	Complex	64	70
9	Security	64	64
10	Cost Effective	64	56
11	Commercial Applications	62	88
12	Good Bargain	58	47
13	Applications Software	58	73
14	Vendor Support	58	70
15	Open Architecture	55	50
16	Easy to Use	50	56
17	Easy to Operate	45	53
18	Scientific Application	43	67

- Exhibit V-6 compares vendor/IS evaluations of RISC workstations, and there is a clear pattern of vendors ranking RISC more highly than IS management.

EXHIBIT V-6

RISC Attribute Evaluations—by IS and Vendor Management



Key	*Attribute*	*IS*	*Vendor*
1	Scientific Applications	100	100
2	Open Architecture	85	100
3	Architecture (H/S)	74	92
4	Cost Effective	74	100
5	Distributed Data Server	73	100
6	Good Bargain	59	91
7	Easy to Program	52	69
8	Easy to Operate	51	63
9	Connectivity	50	74
10	Easy to Use	48	60
11	Network Management	44	65
12	Complex	43	52
13	Reliability (H/S)	38	60
14	Data Management	34	40
15	Security	32	46
16	Vendor Support	28	48
17	Applications Software	23	32
18	Commercial Applications	19	44

Among the more significant variances are the following:

- Open architecture - IS: 85, Vendor: 100
- Good architecture (hardware/software) - IS: 74, Vendor: 92
- Cost effective - IS: 74, Vendor: 100
- Good distributed data server - IS: 73, Vendor: 100
- Good bargain - IS: 59, Vendor: 91
- Easy to program - IS: 52, Vendor: 69
- Good connectivity - IS: 50, Vendor: 74
- Good network management - IS: 44, Vendor: 65
- Good reliability (hardware/software) - IS: 38, Vendor: 60
- Good vendor support - IS: 28, Vendor: 48
- Commercial application (availability) - IS: 19, Vendor: 44
- It is obvious that there is considerable difference of opinion between IS management and vendors as to the relative value of RISC-based systems. Is this vendor overrating or IS undervaluing? Probably a little of both, but the message is clear—downsizing to RISC workstations in the commercial market still faces significant resistance.

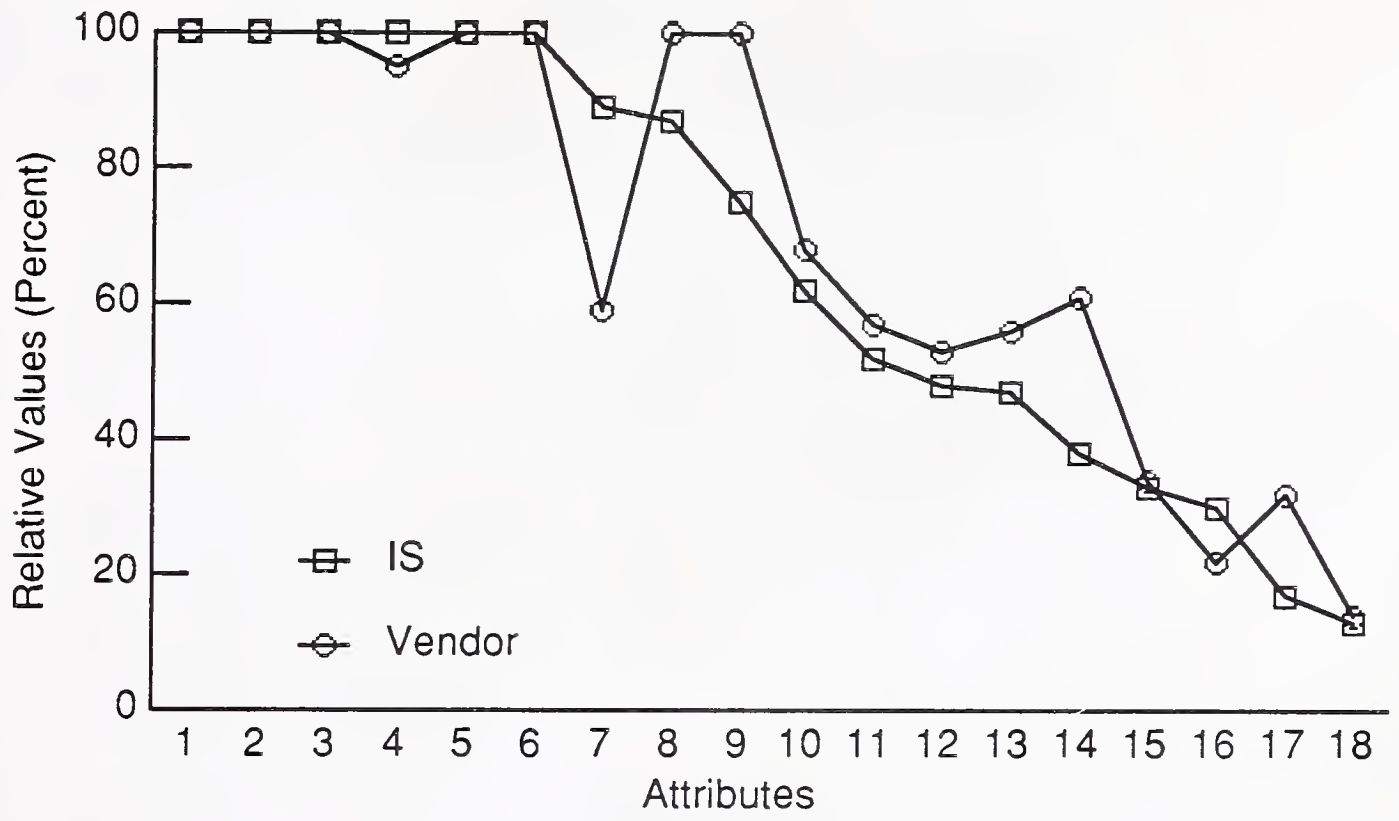
• Exhibit V-7 compares IS-vendor evaluations of personal computers. There is general agreement on most major PC strengths and weaknesses, but several notable variances on important attributes do occur.

- Good architecture (hardware/software) - IS: 89, Vendor: 59
- Good applications software (availability) -IS: 75, Vendor: 100
- Good for commercial applications - IS: 38, Vendor: 61
- These three discrepancies taken together have some serious ramifications for downsizing to PC LANs.

  · IS executives think that PC hardware/software architecture is quite good, but vendors are saying it isn't all that great—and vendors are the ones who have to implement tools and applications software to downsize serious business applications.

EXHIBIT V-7

PC Attribute Evaluations—by IS and Vendor Management



Key	*Attribute*	*IS*	*Vendor*
1	Cost Effective	100	100
2	Easy to Use	100	100
3	Good Bargain	100	100
4	Open Architecture	100	95
5	Easy to Program	100	100
6	Easy to Operate	100	100
7	Architecture (H/S)	89	59
8	Connectivity	87	100
9	Applications Software	75	100
10	Distributed Data Server	62	68
11	Reliability (H/S)	52	57
12	Network Management	48	53
13	Scientific Applications	47	56
14	Commercial Applications	38	61
15	Data Management	33	34
16	Vendor Support	30	22
17	Complex	17	32
18	Security	13	14

- Vendors say PCs have the best applications software availability already (this shows the danger of terminological inexactitude—vendors must be accepting the Microsoft definition of an application), and IS management isn't quite willing to go along with that evaluation.

- Vendors evaluate PCs significantly higher than do IS executives for commercial applications, but both are considerably lower than the rankings they gave for applications software availability. The target for downsizing is commercial applications; text processing and personal productivity tools have already been offloaded.

It all adds up to the fact that IS and vendor management can agree concerning which strengths and weaknesses of mainframes make them a target for downsizing, but it appears there will be considerable disagreement about what rightsizing means.

Fortunately, INPUT asked both IS executives and vendors where applications and data bases currently resided and where they thought they might be in 1995.

C

Predominant Hardware Platforms

Respondents were asked to indicate the predominant location of 12 applications and seven data bases, and then to indicate where they anticipated the predominant location would be in 1995. Bar charts are used to display the percentage of respondents designating each hardware platform for each application and data base now and in 1995.

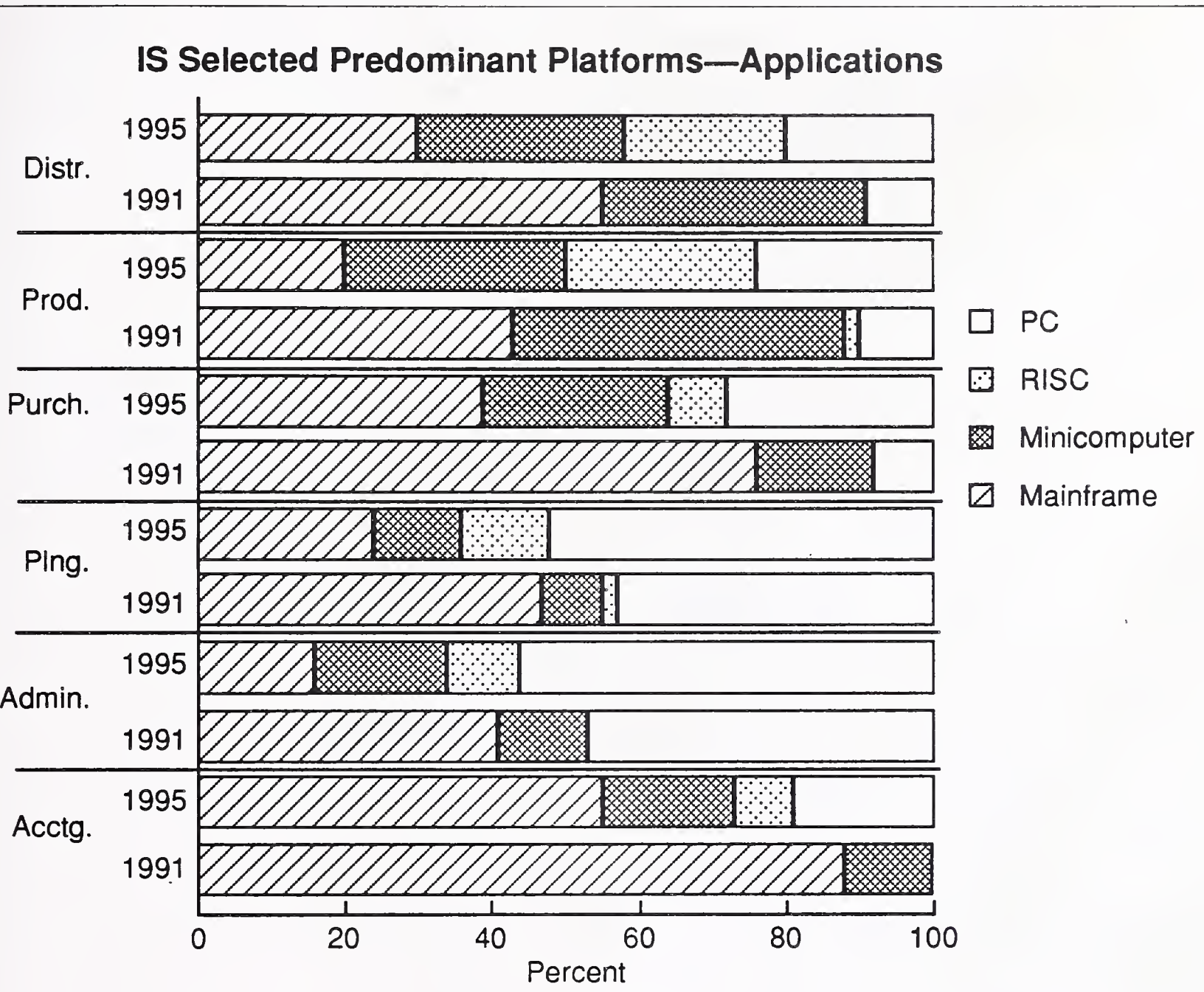
Since IS executives are responding from their own experience, and vendors are responding based on their estimates of their customers' applications and data distribution, it is not very meaningful to make comparisons of specific responses except when there appear to be gross discrepancies between the responses. However, the projections for 1995 do give insights into the preferred target platforms of downsizing efforts.

1. IS Responses

a. Applications

Exhibit V-8 presents the IS responses for applications. Several general observations can be made.

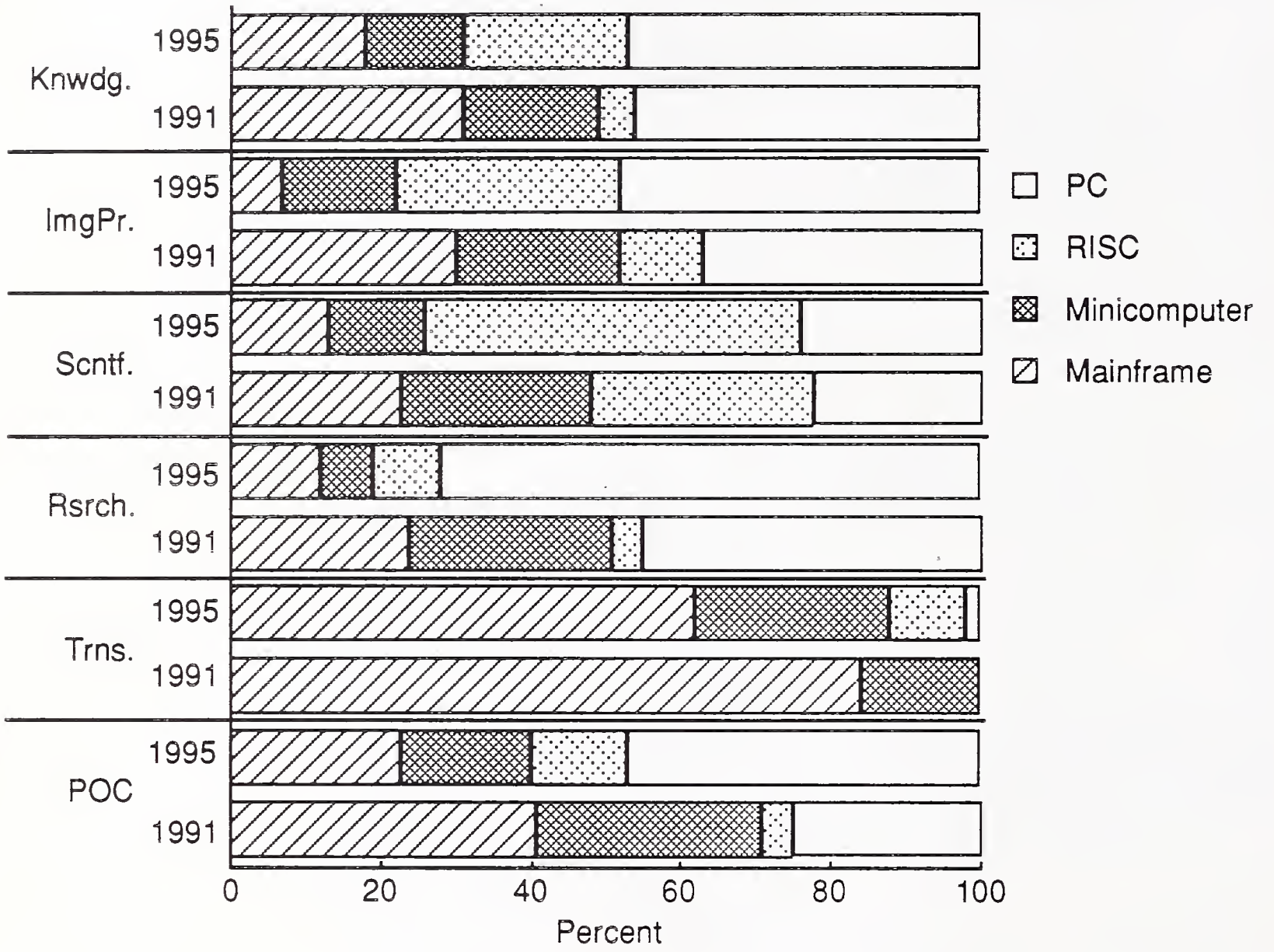
EXHIBIT V-8A



		Percent			
Application	*Year*	*MF*	*Mini*	*RISC*	*PC*
Accounting	1991	88	12	0	0
	1995	55	18	8	18
Administration	1991	41	12	0	47
	1995	16	18	10	56
Planning	1991	47	8	2	43
	1995	24	12	12	52
Purchasing	1991	76	16	0	8
	1995	39	25	8	29
Production	1991	43	45	2	11
	1995	20	30	26	24
Distribution	1991	55	36	0	9
	1995	30	28	22	20

EXHIBIT V-8B

IS Selected Predominant Platforms—Applications



		Percent			
Application	*Year*	*MF*	*Mini*	*RISC*	*PC*
Point of Contact	1991	41	30	4	24
	1995	23	17	13	47
Transaction System	1991	84	16	0	0
	1995	62	26	10	2
Research	1991	24	27	4	44
	1995	12	7	9	72
Scientific	1991	23	25	30	23
	1995	13	13	50	25
Image Processing	1991	30	22	11	38
	1995	7	15	30	48
Knowledge System	1991	31	18	5	46
	1995	18	13	22	47

- IS executives anticipate that mainframes will lose ground to other platforms in all applications areas.

- It is anticipated that personal computers will gain in all applications areas, although the gains appear to be negligible in several areas (transaction processing, scientific and engineering, and knowledge-based systems).

- Minicomputers will increase in some applications areas and decrease in others:

  - Increasing in:

    · Accounting
    · Administrative (office)
    · Planning/forecasting
    · Purchasing
    · Transaction processing

  - Decreasing in:

    · Production processes (factory and clerical)
    · Distribution (warehouse/inventory)
    · Point of contact (sales/customer)
    · Research, education, training (including libraries)
    · Scientific and engineering
    · Image processing
    · Knowledge-based (expert systems)

  - The primary cause for minicomputers being replaced as the predominant platforms in the applications areas listed is because of increased use of RISC-based systems (except in research, education and training, where PCs are the primary replacement technology).

- RISC-based systems are projected to have substantial growth in all applications areas, and will achieve rough parity with, or dominance of, other platforms (in terms of being a predominant platform) in the following areas by 1995:

  - Production processes (factory/clerical) - 26%

    · Mainframes - 20%
    · Minicomputers - 30%
    · PCs - 24%

- Distribution (warehouse/inventory) - 22%

  · Mainframes - 30%
  · Minicomputers - 28%
  · PCs - 20%

- Scientific and engineering - 50%

  · Mainframes - 13%
  · Minicomputers - 13%
  · PCs - 25%

- In addition, RISC-based systems are projected to be the second most predominant platform in image processing (30%) and knowledge-based/expert systems (22%) behind PCs, which are anticipated to be the predominant platforms by 48% and 47% of the users, respectively.

b. Data Bases

Exhibit V-9 presents the percent of IS-selected predominant locations of current data bases, and projects changes that will occur by 1995. Data base platforms are by definition "servers," so this should provide important insights into what may be downsized.

The same general observations that were made about applications apply to data bases: mainframes will lose ground, personal computers will gain a little (or hold their own), minicomputers will gain a little or lose a little (except in one case where they lose a lot), and RISC-based systems will show appreciable gains—primarily at the expense of mainframes.

Additional points of significance are as follows:

- While it is anticipated that mainframes will lose ground to other data base platforms by 1995, they are projected to remain the predominant platform in over 60% of IS installations for the following types of data bases:

  - Financial/accounting - 63%, down from 86%
  - Operational (transaction) - 64%, down from 78%
  - Archival - 65%, down from 80%

- RISC-based systems are projected to virtually wipe out minicomputers as data base servers in research and education.

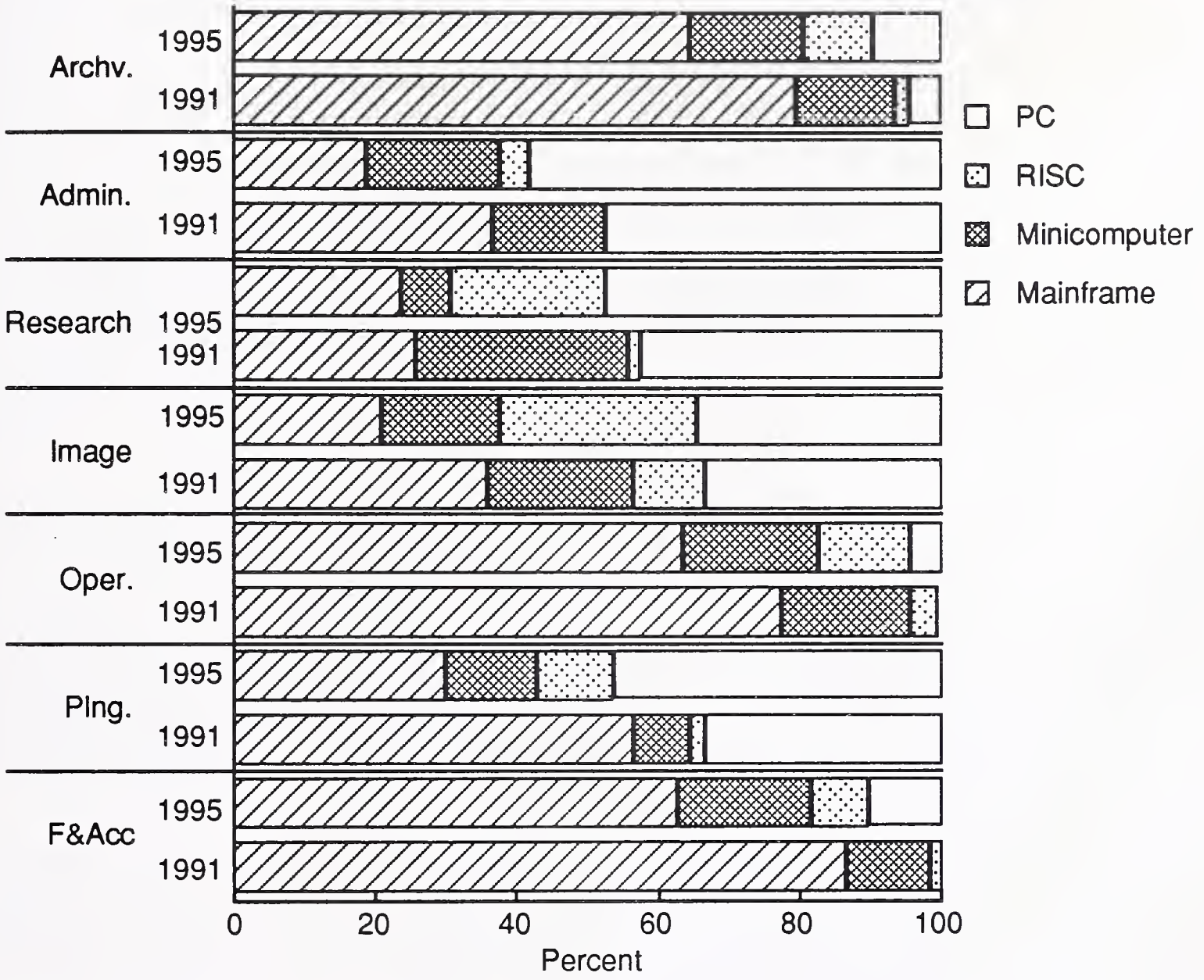
  - RISC will grow from 2% currently to 22% in 1995.

  - Minicomputers will shrink from 30% currently to 7% in 1995.

  - Personal computers will retain the lion's share—being 42% currently and projected to be 46% in 1995.

EXHIBIT V-9

IS Selected Predominant Platforms—Data Bases



		Percent			
Data Base	*Year*	*MF*	*Mini*	*RISC*	*PC*
Finance and Accounting	1991	87	12	2	0
	1995	63	19	8	10
Planning	1991	57	8	2	33
	1995	30	13	11	47
Operational	1991	78	18	4	0
	1995	64	19	13	4
Image	1991	36	21	10	33
	1995	21	17	28	34
Research	1991	26	30	2	42
	1995	24	7	22	46
Administrative	1991	37	16	0	47
	1995	19	19	4	58
Archive	1991	80	14	2	4
	1995	65	16	10	8

- Since minicomputers were rated as the best distributed data base servers by IS management, it is worthwhile to note where they will remain strong and/or grow.

  - Financial and accounting - 12% currently, to 19% in 1995
  - Planning - 8% currently, to 13% in 1995
  - Operational (transaction) - 18% currently, to 19% in 1995
  - Administrative (office) - 16% currently, to 19% in 1995
  - Archival - 14% currently, to 16% in 1995

Since these data base areas represent the bulk of the commercial application systems and an exceptionally high percentage of business data, it would appear that the minicomputer as a distributed data base server is alive and well in the eyes of IS management and will play a significant role in downsizing.

However, we must now look at what vendors are saying.

2. Vendor Responses

a. Applications

Vendors responded for their customers when indicating what they felt to be the predominant applications platforms, and a vendor's customer base depends on what it being sold. Therefore, vendor responses will tend to be heavily skewed toward their markets (or potential markets). This becomes readily apparent in their responses.

At the risk of having some very busy charts, we have plotted the vendor responses next to the IS responses (Exhibit V-10) presented earlier. Bearing in mind the natural skewing of vendor responses on current application residence, it will become apparent that vendors are exceptionally bullish on downsizing.

The application data are presented in the following order:

- Current IS data
- Current vendor data
- 1995 IS data
- 1995 vendor data

EXHIBIT V-10A

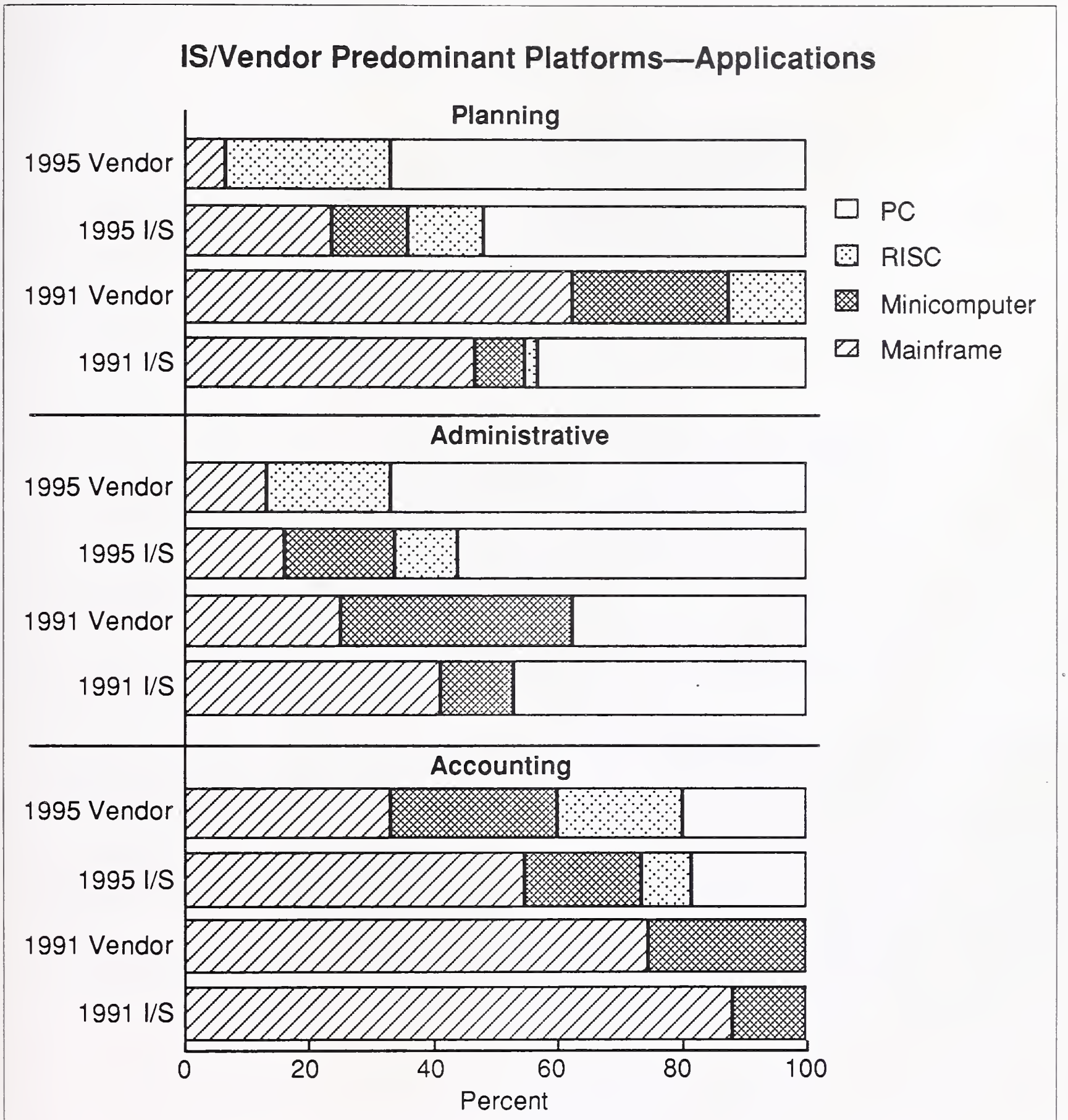


EXHIBIT V-10B

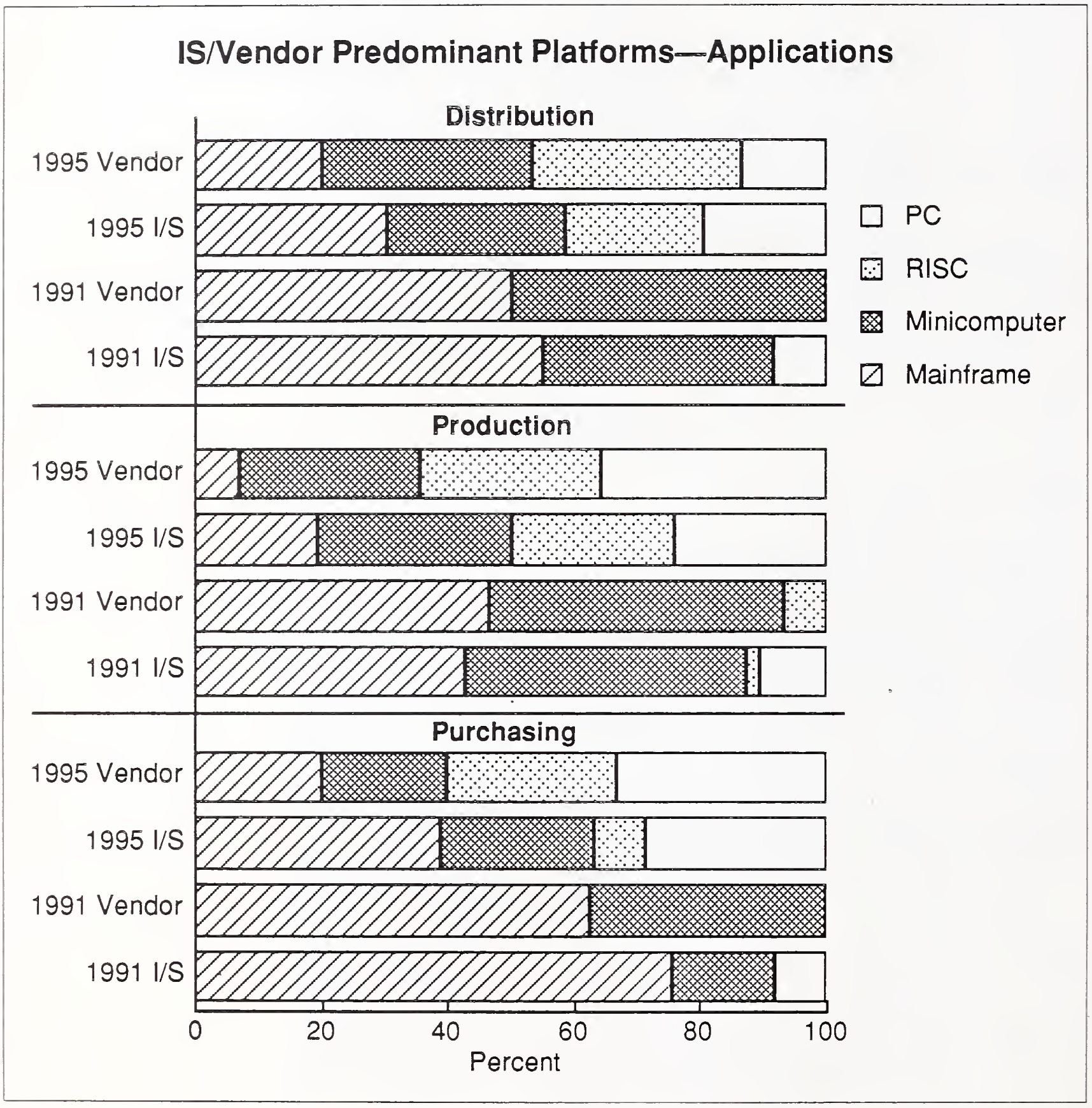


EXHIBIT V-10C

IS/Vendor Predominant Platforms—Applications

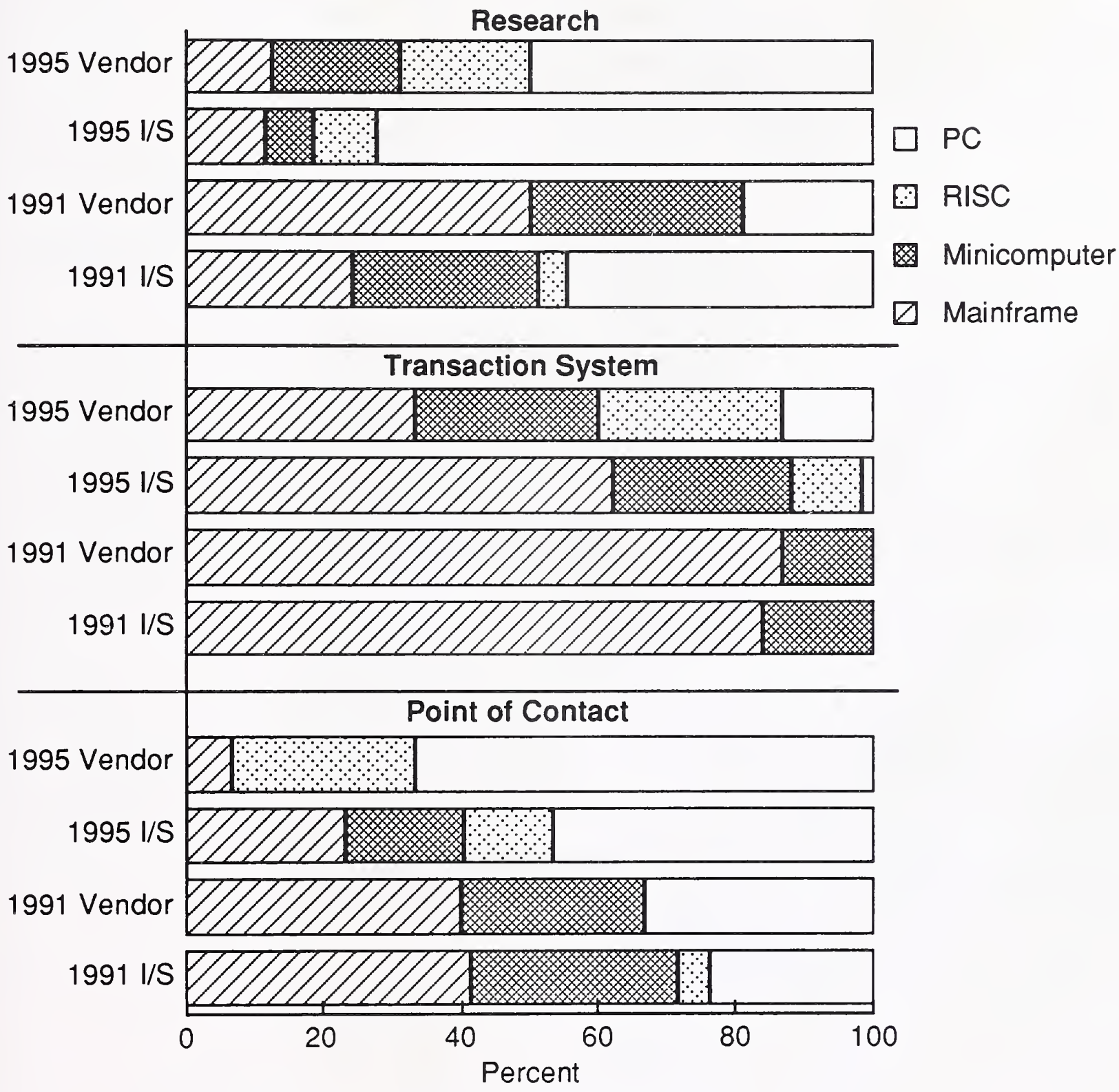
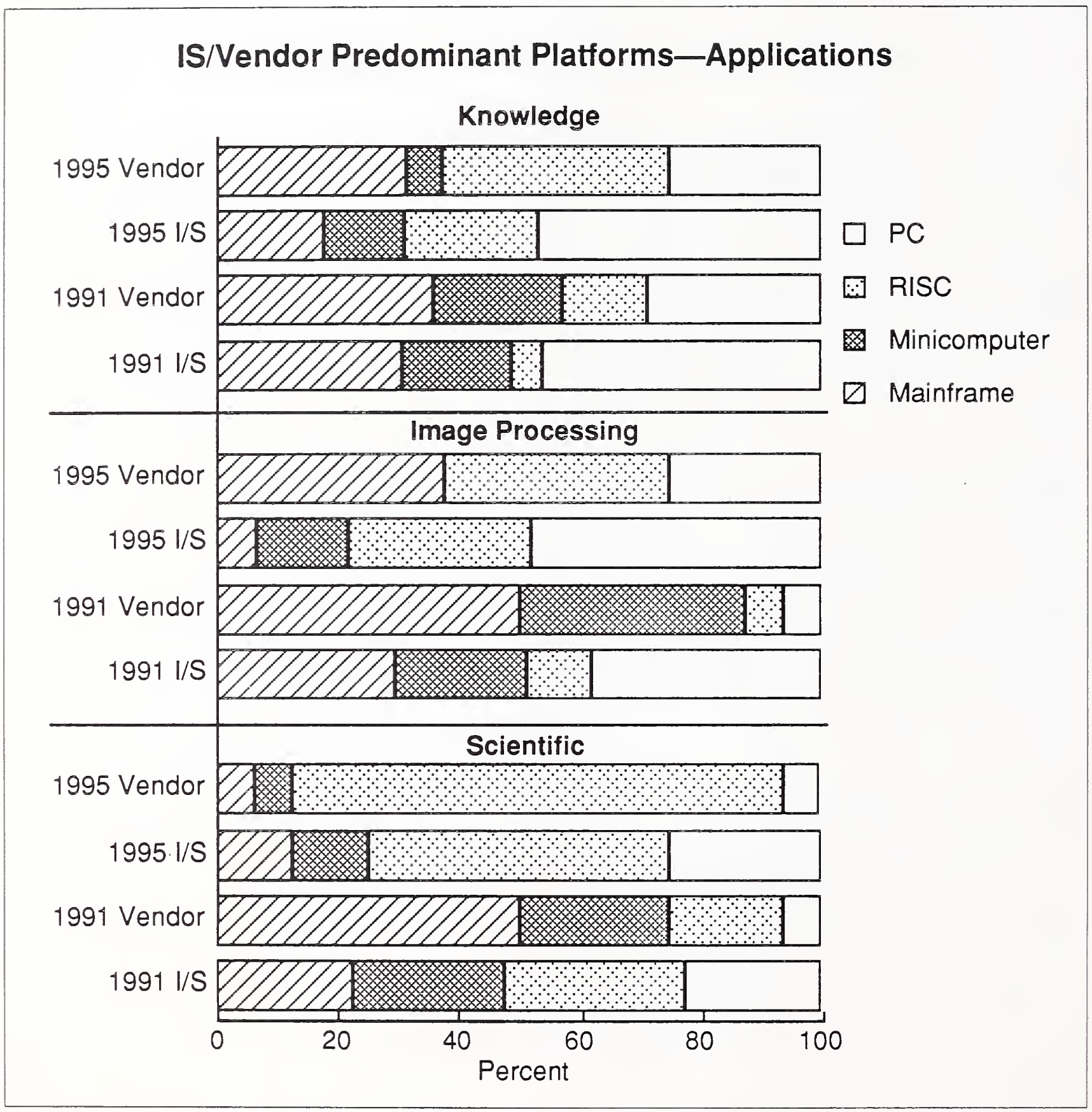


EXHIBIT V-10D



We will analyze these data by application.

- IS management and vendors agree that accounting applications are on mainframes and minicomputers at present, but vendors feel that mainframes are less dominant than do IS executives (89% mainframe for IS, and 75% for vendors). By 1995, vendors predict dramatic downsizing of accounting applications resulting in the following predominant platforms:

- Mainframes - 33%
- Minicomputers - 27%
- RISC - 20%
- PCs - 20%

- Vendors believe that minicomputers represent a substantially higher percentage of administrative applications than do IS executives (38% for vendors and only 11% for IS). Then vendors see minicomputers get completely wiped out as a predominant platform by RISC-based machines and PCs by 1995, whereas IS executives see them increasing (from 11% currently to 20% in 1995).

- Vendors believe that mainframes and minicomputers currently provide 87% of the predominant platforms for planning/forecasting applications (63% for mainframes and 25% for minicomputers). They anticipate that mainframes will drop to 7% by 1995 and minicomputers will be wiped out by RISCs and PCs (PCs having come from nowhere to become the predominant platform in 67% of the installations by 1995). Though this may at first seem astounding, consider the following:

  - IS management projects that mainframes and minicomputers will be the predominant platforms for planning/forecasting applications in 34% of installations in 1995.

  - Vendors believe that mainframes and RISCs will be the predominant platforms in 33% of installations in 1995 and that minicomputers will be eliminated as a predominant platform.

  - Under any circumstances, major downsizing of planning/forecasting applications is anticipated by 1995.

- Vendors predict that purchasing applications will go from a base of mainframes and minicomputers (63% and 37% respectively) to the following distribution in 1995:

  - Mainframes - 20%
  - Minicomputers -20%
  - RISC - 27%
  - PCs - 33%

- Production process applications will go from a 93% mainframe and minicomputer orientation to:

  - Mainframes - 7%
  - Minicomputers - 29%
  - RISC - 29%
  - PCs - 36%

- Distribution applications projected by vendors and IS management in 1995 are reasonably close, the discrepancy being that vendor bias in favor of RISC systems is still evident.

  - Mainframes - Vendor-21%, IS-31%
  - Minicomputers - Vendor-33%, IS-31%
  - RISC - Vendor-33%, IS-25%
  - PCs - Vendor-13%, IS-13%

- Point-of-contact applications return to a familiar vendor pattern—mainframes and minicomputers currently provide 67% of the predominant platforms, but it is predicted that by 1995 mainframes will represent only 7%, and minicomputers will have been replaced by RISCs (minicomputers currently predominate in 27% of the organizations, and RISCs are projected to predominate in 27% in 1995).

- Vendors state that transaction processing applications, predominantly on mainframes and minicomputers (87% mainframes and 13% minis), will decline to 60% in 1995 (33% mainframes and 27% minicomputers). This compares with IS estimates that 85% of transaction processing applications will remain on mainframes and minicomputers (54% mainframes and 31% minis).

- Research, education and training applications are the first exception to the rule that vendors are more bullish on downsizing from mainframes and minicomputers than are IS executives.

  - Vendors project that 32% of such applications will remain on mainframes and minicomputers (13% on mainframes and 19% on minicomputers).

  - IS executives, on the other hand, only project 20% (13% mainframes and 7% minicomputers).

- Scientific applications are a complete downsizing victory for RISC-based systems. Vendors state that, from an environment where mainframes and minicomputers currently predominate in 75% of the installations (50% mainframes and 25% minicomputers), in 1995 predominant platforms will be distributed as follows:

  - Mainframes - 6%
  - Minicomputers - 6%
  - RISC - 82%
  - PCs - 6%

- Image processing applications become the second case where vendors actually project a higher mainframe-minicomputer percentage for 1995 than do IS executives. However, the vendor pattern of RISCs replacing minicomputers continues.

- Vendor responses go from 88% mainframe and minicomputers currently to 38% mainframes in 1995 (with all minicomputers being replaced with RISCs).

- IS management responses, on the other hand, go from 54% mainframes and minicomputers currently to only 25% in 1995 (9% mainframes and 16% minicomputers).

- Since image processing is a major strategic area for IBM, it would appear that IBM's ImagePlus (mainframe- and minicomputer-oriented) has not been favorably received by IS management.

• Knowledge-based applications (expert systems) present similar patterns for vendors and IS management in 1995 except for the ever present vendor bias toward RISC systems. The distribution is as follows:

- Mainframes - Vendors-31%, IS-33%
- Minicomputers - Vendors-6%, IS-14%
- RISC - Vendors-38%, IS-29%
- PCs - Vendors-25%, IS-24%

b. Data Bases

Vendor-projected data base platforms for 1995 reflect the pro-RISC and anti-minicomputer bias that became apparent when IS management rated minicomputers as best (100) for distributed data base servers and vendors gave them a relative ranking of 60 (Exhibit V-5). However, vendors seem more conservative in distributing data bases from mainframes and minicomputers than they were with applications (Exhibit V-11). Consider the following:

• Vendors projected slightly higher combined mainframe-minicomputer percentages for data bases than did IS management:

- Archival - Vendors - 81% (69% mainframe, 12% minicomputers) IS - 80% (59% mainframe, 21% minicomputers)

- Administrative - Vendors - 40% (33% mainframe, 7% minicomputers) IS - 38% (15% mainframe, 23% minicomputers)

- Research and education - Vendors - 38% (25% mainframes, 13% minis) IS - 28% (21% mainframes, 7% minis)

• In addition, vendors projected a higher percentage of mainframe image data bases—vendors - 33%, IS - 25%. However, just as with image applications, vendors eliminated minicomputers for image data bases and replaced them with RISCs.

EXHIBIT V-11A

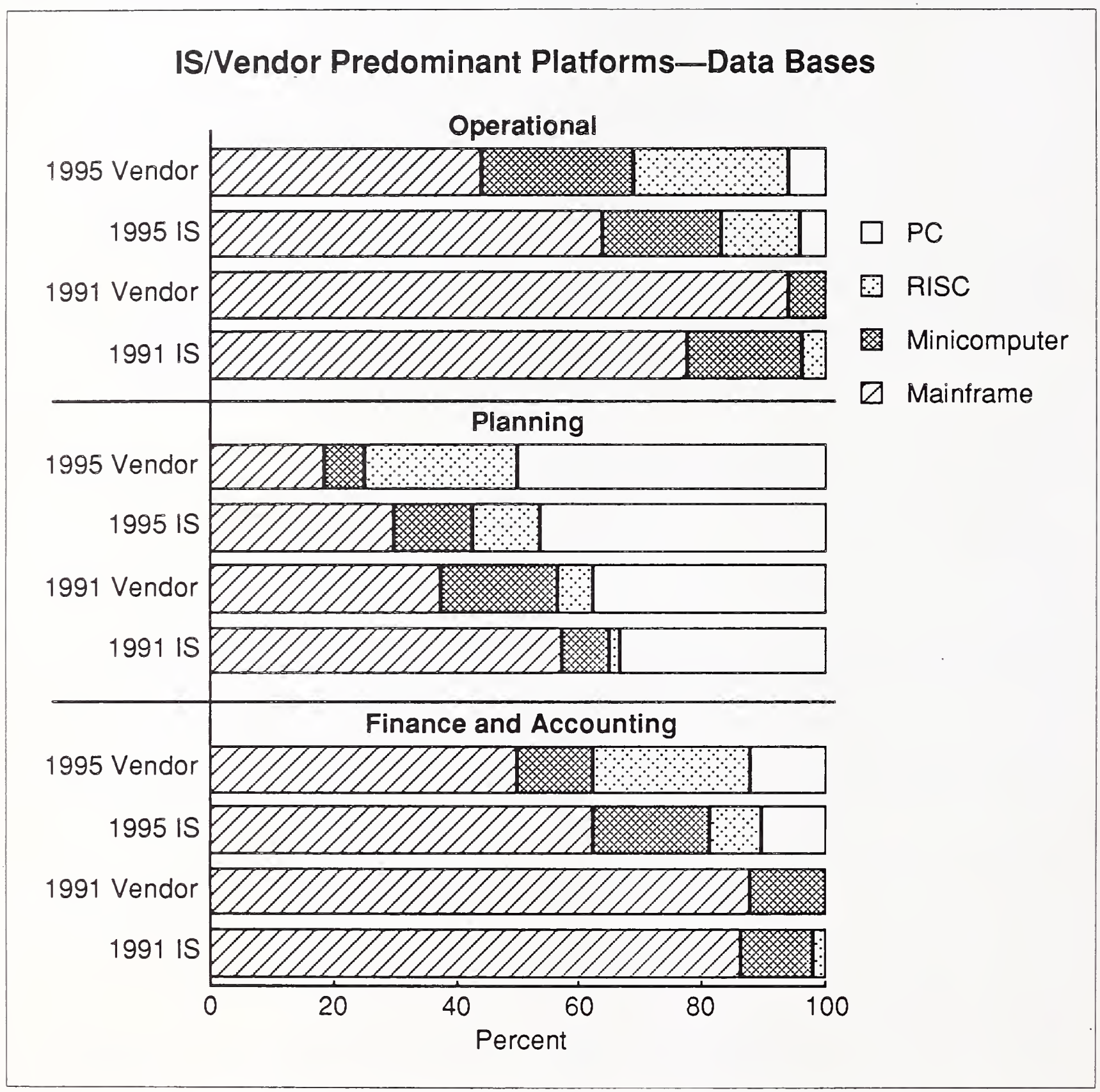
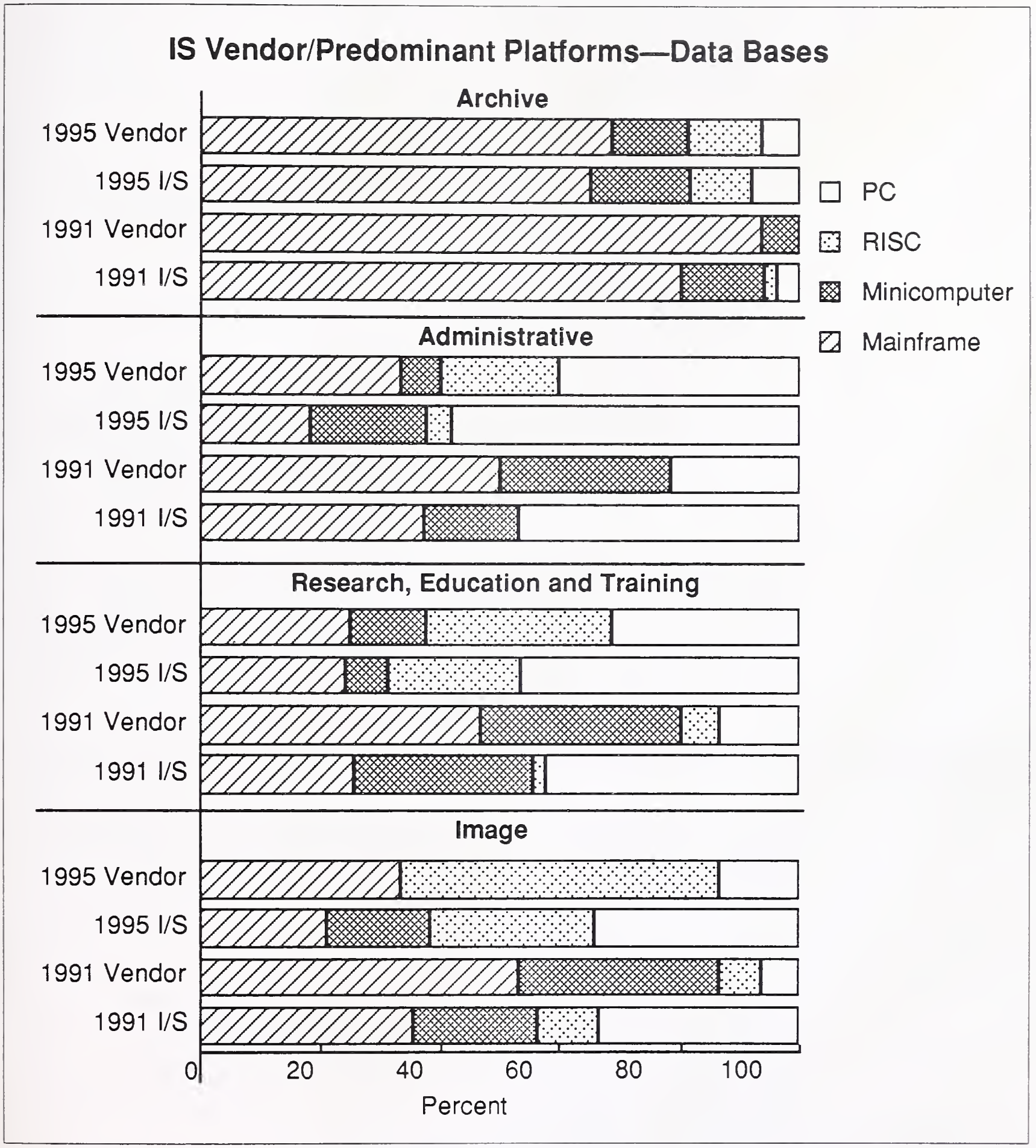


EXHIBIT V-11B



- Vendors predicted less mainframe predominance than did IS executives for the remaining data bases in 1995:
  - Operations (transaction) - Vendors-44%, IS-64%
  - Planning - Vendors-19%, IS-30%
  - Financial/Accounting - Vendors-50%, IS-62%
  - However, in all of the above cases, vendors predicted a substantial reduction from current estimates.
    - Operations from 94% to 44%
    - Planning from 38% to 19%
    - Financial/Accounting from 88% to 50%

Vendors are obviously dedicated to downsizing and are projecting that mainframes and minicomputers are going to lose control of a considerable portion of their data resources between now and 1995. This despite the fact that RISCs and PCs were rated quite low on all of the important elements of distributed data base management.

If these changes do in fact occur, it would appear there will be a considerable risk of adverse consequences. These general projections will be analyzed against the market analysis framework that will be presented in a later section, but first it is necessary to take a look at the factors prompting and inhibiting downsizing.

D

Factors Prompting and Inhibiting Downsizing

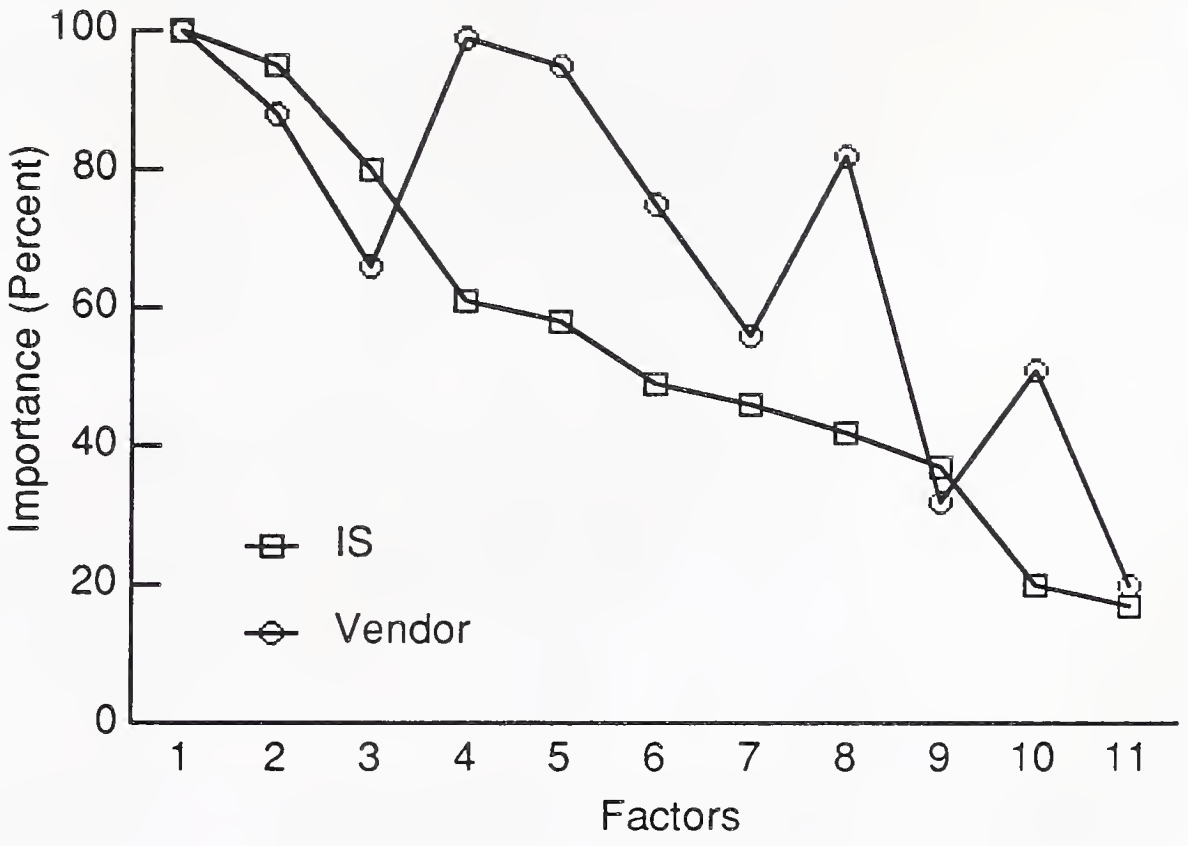
It appears obvious that both IS and vendor management anticipate major changes in the existing information systems infrastructure by 1995. INPUT asked them to rank the factors prompting and inhibiting this shift.

1. Factors Prompting Downsizing

Exhibit V-12 shows the relative importance of the factors prompting downsizing. This is an extremely important chart. It clearly shows that IS management views downsizing as primarily a means of reducing (or controlling) costs, and that vendors feel there are equally important management factors involved.

EXHIBIT V-12

Factors Prompting Downsizing
Relative Importance



Key	*Factor*	*IS*	*Vendor*
1	Lower IS Costs	100	100
2	Hdwr. Price/Perf.	95	88
3	Reduced Development Cost	80	66
4	Improved User Service	61	99
5	User Control	58	95
6	Organizational Flexibility	49	75
7	Need to Re-engineer	46	56
8	Improve Mgmt. Info. Quality	42	82
9	Decentralize (Mgmt. Desire)	37	32
10	Open Systems	20	51
11	Specification SW	17	20

- Both IS and vendor management agree that lower information systems cost is the most important factor prompting downsizing.

- IS management confirms this by ranking better hardware price/performance as the second most important factor, followed by reduced development costs. Then there is a sharp drop in the relative importance of other factors. All three of the most important factors are related to cost reduction.

- On the other hand, vendors rank improved user service and users' desire to control information systems second and third respectively, followed by better hardware price/performance. In addition, improved management information quality and organizational flexibility are deemed to be relatively important factors prompting downsizing.

- Both IS and vendor management considered the following factors relatively unimportant in prompting downsizing.

  - The need to re-engineer (improve) existing applications systems
  - Management's desire to decentralize
  - The desire to go to an open systems environment
  - The availability of specification software

Essentially, vendors are saying that downsizing is being promoted as much by user dissatisfaction with the central IS function as it is with the cost savings that may be possible, and IS management is saying downsizing is first and foremost a question of cost savings. This major difference in perception is not surprising, but it does highlight the continuing controversy concerning the proper role of the central IS function and information technology.

IS management firmly adheres to the Management Theory School of Thought that emphasizes centralized efficiency and cost control. Vendors express the opinion that end users are dissatisfied with centralized control, and that downsizing is being prompted by the "Living System" School of Thought that emphasizes the empowerment of operating work units with information technology and data.

It is our opinion that understanding the nature of this shift in management thinking and the implied tug-of-war over "corporate data" is absolutely necessary in order to assess the significance of downsizing.

2. Factors Inhibiting Downsizing

Exhibit V-13 shows the relative importance of the factors inhibiting downsizing. There is significantly more consensus between IS and vendor management on the factors inhibiting downsizing than there was on the factors prompting downsizing.

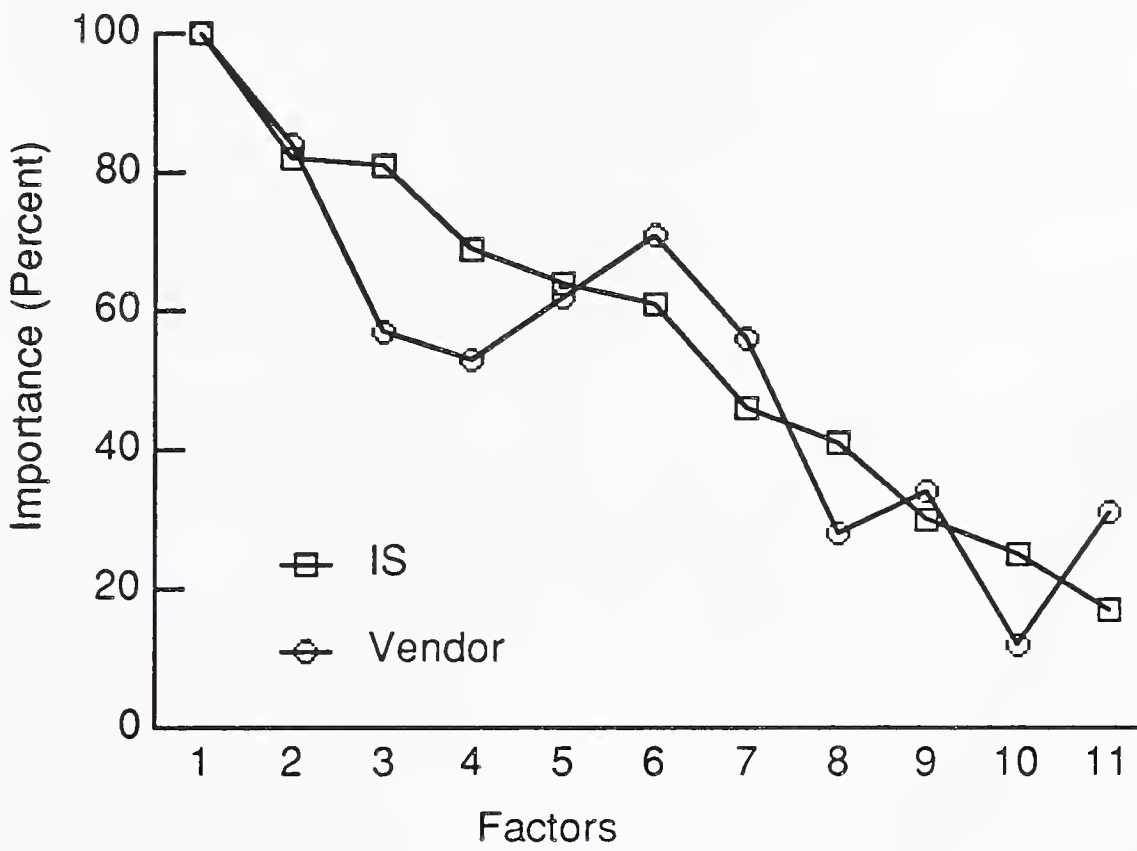
- There is specific agreement on the two most important factors:

  - Problems of data quality in terms of data base integrity, synchronization and security are deemed the most important inhibiting factor. (This supports the earlier findings in Exhibits V-3 and V-4, where both IS management and vendors evaluated mainframes to be vastly superior to RISC and PC-based systems in these attributes.)

- The cost of reprogramming existing applications for the downsized environment. This supports the relatively low ratings given RISC and PC-based systems for commercial applications (Exhibits V-3 and V-4) and the fact that both IS management and vendors tend to feel CASE tools are somewhat overrated (Exhibit V-1).

EXHIBIT V-13

Factors Inhibiting Downsizing
Relative Importance



Key	*Factor*	*IS*	*Vendor*
1	Data Quality Problems (ISS)	100	100
2	Cost of Reprograming	82	84
3	Increased Network Complexity	81	57
4	Appl. SW Not Available	69	53
5	Cost of DB Conversion	64	62
6	Inadequate Sys. SW	61	71
7	Centralized Control	46	56
8	Increased DBM Costs	41	28
9	Vendor Reliability	30	34
10	Increased SW Expense	25	12
11	Loss of Vendor Support	17	31

- The only significant disagreement between IS management and vendors occurred on the third and fourth most important factors as ranked by IS management:

- IS management felt that increased network complexity was an important factor in inhibiting downsizing, but vendors did not view this as being nearly as much of a problem. (It is probable that IS management is more sensitive to the "view from the top" where mainframes attempt to remain the master of all they survey in terms of both data base and network management, whereas most vendors focus on their piece of the action without regard for the impacts of distributed data bases on network management.)

- IS management also feels that the availability of applications software (or lack thereof) will inhibit downsizing more than do vendors. This merely substantiates the fact that vendors have very positive feelings about the availability of applications software on the PC (Exhibit V-4).

• While there is general agreement between IS and vendor management on the remaining factors, they are still of considerable importance in terms of their relative positioning; and some of the responses raise questions in their own right.

- Management's desire for centralized control is not viewed as being as much of an inhibiting factor as we would have anticipated—especially among IS management. This raises a question as to whether IS management merely doesn't consider retention of control a problem, or whether it represents a significant shift in management philosophy.

- Increased data base management costs are viewed as being a relatively unimportant factor. This raises a whole series of questions:

  · Is this because a problem doesn't actually exist or because it isn't recognized?

  · Is the potential problem just being ignored?

  · If it is being ignored, is it because IS management feels any additional data management effort should properly be the responsibility of end users, or is it merely because the additional expense can be hidden in departmental budgets?

  · Is the downplaying of the potential problem merely a way for IS to unload a lot of thankless work on unsuspecting users?

• Both IS and vendor management agree that reliability of hardware/software vendors and loss of vendor support are of relatively minor importance in inhibiting downsizing. This represents a significant change in attitude on the part of the IS department, that traditionally has maintained that the higher prices of established vendors (and especially IBM) can be justified based on those factors. It seems apparent that the

experience with personal computers has convinced IS management that the differences in support among vendors is no longer of paramount importance. Among the open questions raised by this seeming shift in attitude are the following:

- Is this shift based on the fact that customers have become disenchanted with all vendors because promised benefits have failed to materialize?

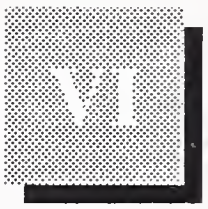
- Is the IS department merely being "politically correct" in not questioning the viability and quality of service of smaller and/or newer vendors?

- Has information technology literally become a commodity, with cost being all important?

- Will these attitudes on the part of IS management hold up when it comes time to downsize critical applications?

It seems obvious that both IS and vendor management feel the information systems infrastructure is going to change drastically during the 1990s, and that the trend is away from highly centralized host systems to a more distributed environment.

It is now time to examine this architectural trend in more detail.



Analysis of Architectural Trends

The questionnaire was constructed to ask first for the general information that was analyzed in the previous section, and then to "peel back the layers of the onion" to obtain more detailed information about specific downsizing plans, impacts and expectations. Once again, IS managers answered for their organizations, and vendors answered based on knowledge of their customer base.

A

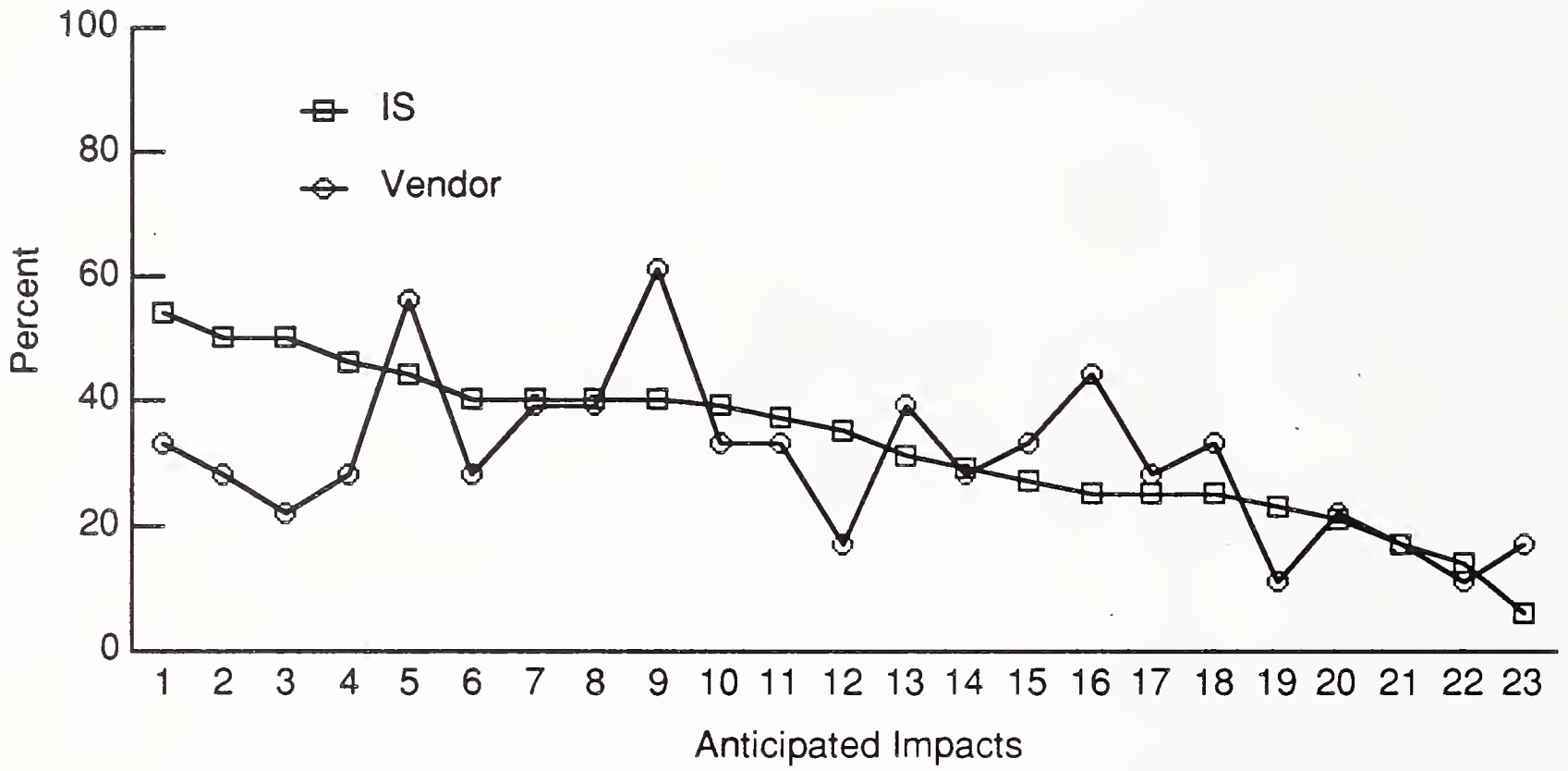
Impacts on Hardware/Software Platforms

INPUT asked respondents to indicate their current plans (or thinking) about downsizing by listing various architectural alternatives for implemention. They were asked to check all that applied in their particular organization; or, in the case of vendors, in their customers' organizations. Due to the "open" nature of the question, and trade-offs among various alternatives, responses of more than 50% or under 20% are considered to be highly significant.

Exhibit VI-1 plots (in descending order) the percentage of IS management repondents checking specific descriptive items concerning their plans (or thinking) about downsizing. Vendor responses are overlaid for purposes of comparison.

EXHIBIT VI-1

Hardware/Software Impacts of Downsizing



Key	*Anticipated Impacts*	*IS*	*Vendor*
1	Functions "Cooperatively" Processed with C/S LANs	54	33
2	None - No Specific Downsizing Plan	50	28
3	Transfer of Responsibility for Data Quality	50	22
4	Functions "Cooperatively" Processed with Minis	46	28
5	Emphasis on UNIX and Open Systems	44	56
6	Entire Applications and Data to C/S LANs	40	28
7	Applications Distributed - Data Remains on Mainframe	40	39
8	Data Distributed to Servers by File Transfer	40	39
9	Functions "Cooperatively" Processed with RISC or PCs	40	61
10	Working Closely with Users to Downsize	39	33
11	Downsizing a Major Objective of IS Plan	37	33
12	Data Bases Distributed to Micro-based Servers	35	17
13	New Development Will Be on C/S LANs	31	39
14	Functions "Cooperatively" between Minis and LANs	29	28
15	Downsizing Dangerous - IS Trying to Control	27	33
16	Minis Replaced by C/S LANs	25	44
17	New Development Will Be on RISC Open Systems	25	28
18	Downsizing to Windows/DOS Platforms	25	33
19	Downsizing under SAA	23	11
20	Data Bases Distributed to Minicomputer Servers	21	22
21	Data Bases Distributed to Micro-based Workstations	17	17
22	Downsizing is "Meaningless"	14	11
23	Entire Mainframes Replaced by C/S LANs	6	17

1. Highly Significant Items

a. IS Management

Fifty percent or more of IS management respondents indicated that the following questionnaire statements applied to the current status of their downsizing plans (or thinking):

- Some application functions (as opposed to entire applications) will be distributed and "cooperatively processed" between mainframes and client/server LANs (54%).

- There is no specific plan to downsize, as such; but we do plan to re-engineer applications to take advantage of new hardware/software technologies (50%).

- Downsizing frequently requires a transfer of responsibility for data and/or management information quality. Many advocates of downsizing (both users and vendors) either don't understand this, or prefer to ignore it (50%).

Vendor respondents did not concur with IS management on these items and indicated that the statements applied to substantially lower percentages of their customers (33%, 28%, & 22% respectively).

Less than 20% of IS management respondents indicated that the following questionnaire statements applied to their downsizing plans (or thinking):

- Data bases will be distributed from mainframes to multiple micro-based workstations. (17%)

- Downsizing is a meaningless term and should be permanently banned from use. (14%)

- Entire mainframes will be replaced with client/server LANs. (6%)

Vendor respondents supported the negative IS management responses to these statements with correspondingly low percentages (17%, 11% and 17% respectively).

These findings give considerable insight into the attitude of IS management concerning downsizing and how they are approaching it.

- First of all, they do take downsizing seriously, as evidenced by their rejection of the possibility that it is a "meaningless term;" and, though many of them do not have a specific plan for addressing downsizing, they do plan to re-engineer existing applications to take advantage of advances in hardware/software technologies.

- IS management rejects the possibility that mainframes will be replaced with client/server LANs, and indicates that the preferred architecture will be one of cooperative processing between mainframes and client/server LANs. In addition, they reject the possibility of distributing data bases from mainframes directly to multiple micro-based workstations. Essentially, these responses support a three-tiered processing (and data base) architecture consisting of mainframes, local data servers, and programmable workstations.

- IS management also feels that downsizing will inevitably result in the transfer of some responsibility for data and information quality from the central IS department to end users; and that this fact is being ignored by many vendors and end users. This response begins to clarify some of the questions raised in the previous section about data and information quality.

  - IS management is aware that downsizing presents potential problems of data and information quality, and it appears that they do not intend to accept responsibility for the quality of data not under their direct control.

  - In the tug-of-war over corporate data, this is a powerful argument on the IS management side. The IS department is saying that as data are distributed they cannot accept responsibility for what happens to those data or the information that is generated from them.

  - To the degree that end users and vendors are basing downsizing "solutions" on the ready availability of data from the central IS department, they are confronted with either leaving a substantial amount of control with the central IS organization or accepting responsibility for any data problems that result from the downsizing process.

  - In fact, it is probable that some IS departments will attempt to unload some of their more burdensome data base administration and management problems when they downsize.

b. Vendors

More than 50% of vendors agreed with the following questionnaire statements:

- Some application functions will be distributed, and applications will be "cooperatively processed" between mainframes and workstations (RISC or PC). (61%)

- Downsizing will emphasize "open systems" and UNIX. (56%)

Although a smaller percentage of IS management agreed with these statements, their responses were still significant (40% and 44% respectively).

In addition to the three statements that were cited above as receiving negative responses from both vendors and IS, vendors also tended to reject the following statements with less than 20% agreement.

- Data bases will be distributed from mainframes to multiple micro-based servers. (17%)

- Downsizing will be accomplished primarily under IBM's SAA. (11%)

A significantly higher percentage of IS management responses supported data base distribution to micro-based servers (34%), but their response to IBM's SAA (while higher) still amounted to substantial rejection of SAA as an architecture for downsizing (23%).

Vendor responses tend to indicate the following view of downsizing.

- Downsizing provides focus for the open versus proprietary systems controversy and is therefore heavily dependent upon UNIX and RISC architectures.

- The general architecture is two-tiered—mainframe to workstation—with mainframes being viewed as data base machines. The need for, and problems of, "industrial-strength" distributed data base management are rejected as unnecessary. Data bases can be "distributed" on an as-needed basis through query and file transfer.

- Vendors see downsizing as the ultimate alternative to SAA (SNA) with its emphasis upon centralization of data base and network management, and its evolutionary distribution of data and responsibility to end users. The revolution goes on, and there isn't any question about the primary target.

Responses to other statements concerning downsizing plans confirm that there is a signicant difference between vendors and IS management on how downsizing will be implemented.

2. Contrasting IS and Vendor Management Views of Downsizing

There are two noticeable architectural differences between IS and vendor management views of downsizing: 1) the need for distributed data base management and 2) the need for minicomputers between mainframes and workstations. These two differences are obviously interconnected.

Responses to the following statements highlight these differences of opinion.

- Entire applications (including data bases) will be offloaded from host systems to client/server LANs. Forty percent of IS management and only 28% of vendor management agreed with this statement.

- Data bases will be distributed from mainframes to micro-based servers. Thirty-five percent of IS management and only 17% of vendor management agreed with this statement.

- Some applications functions will be distributed, and applications will be "cooperatively processed" between mainframes and minicomputers. Forty-six percent of IS management and only 28% of vendor management agreed with this statement.

- Entire minicomputers will be replaced with client/server LANs. Only 25% of IS management agreed with this statement, but 44% of vendor management agreed.

However, despite these differences of opinion about minicomputers and distributed data bases, IS and vendor management are in agreement that "data will be distributed from mainframes (and among servers) by file transfer" (IS management 40% and vendors 39%).

This point is important because SAA is attempting to manage distributed data bases across heterogenous environments, and many of the formidable technical problems associated with this effort can be avoided if relatively simple file transfer will suffice. Perhaps that is the reason that neither IS nor vendor management strongly support SAA as an architecture for downsizing.

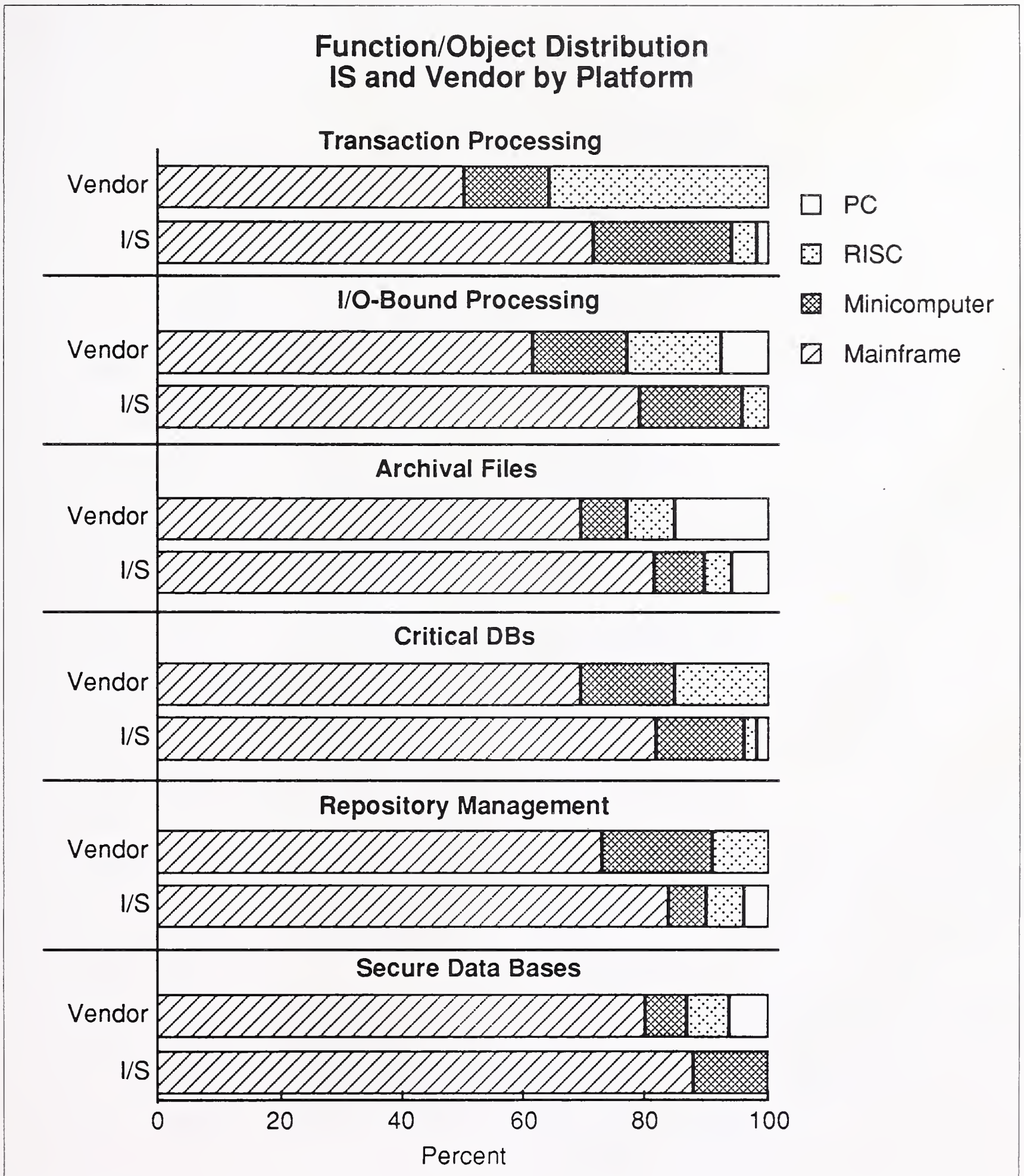
The responses to this question indicate that downsizing will be accomplished by both the distribution of function and the offloading of entire applications from mainframe computers. We later asked a question about functional and object distribution from mainframes.

B

Functional and Object Distribution

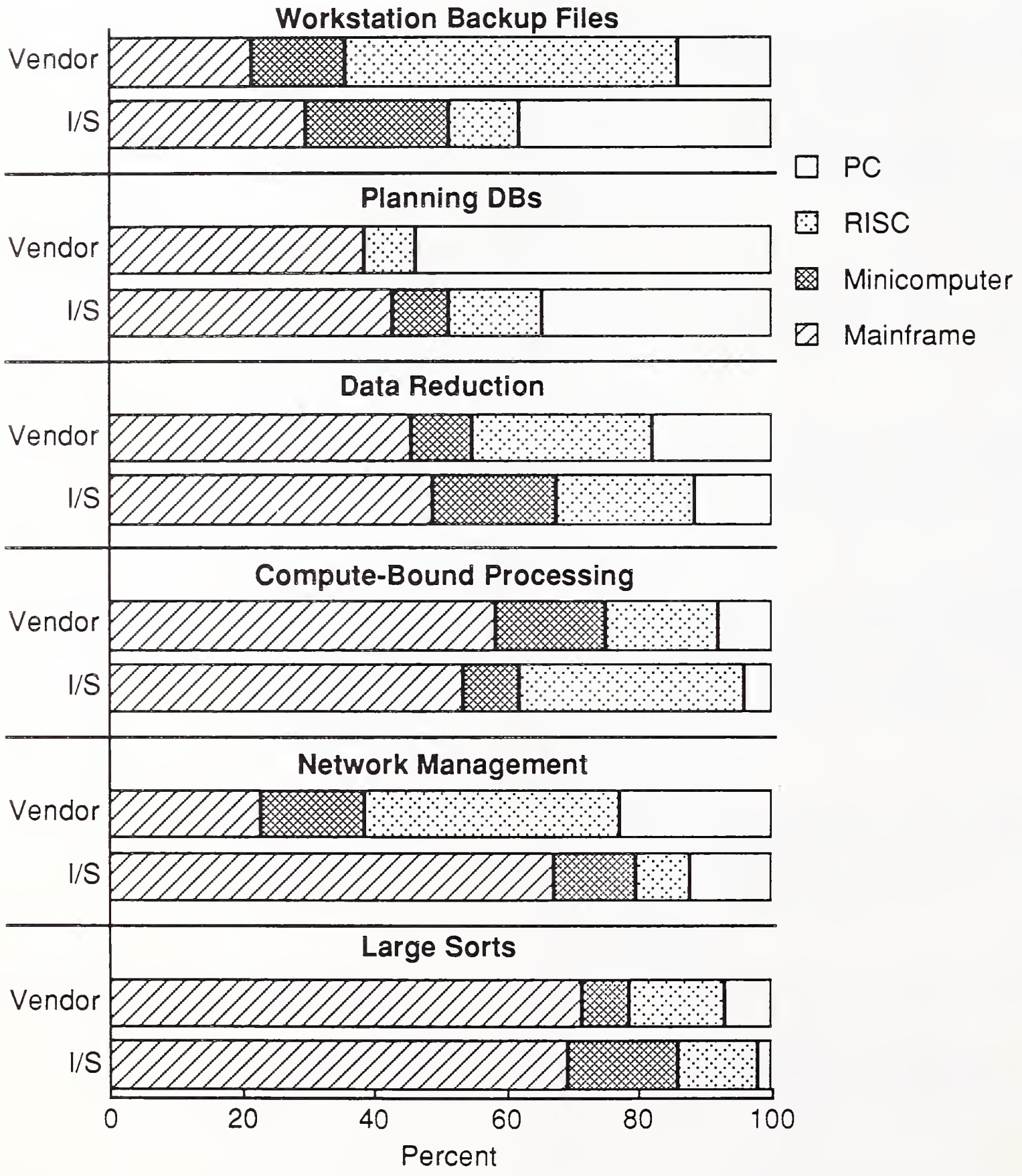
We asked which platforms were most appropriate for various application functions and data bases (objects). IS and vendor management results are presented in Exhibits VI-2a, b and c. The responses have been positioned next to each other for purposes of comparison, and are arranged in descending order based on percent of user mainframe responses. Therefore, the opportunities for downsizing will tend to increase as the preference for mainframes diminishes.

EXHIBIT VI-2A

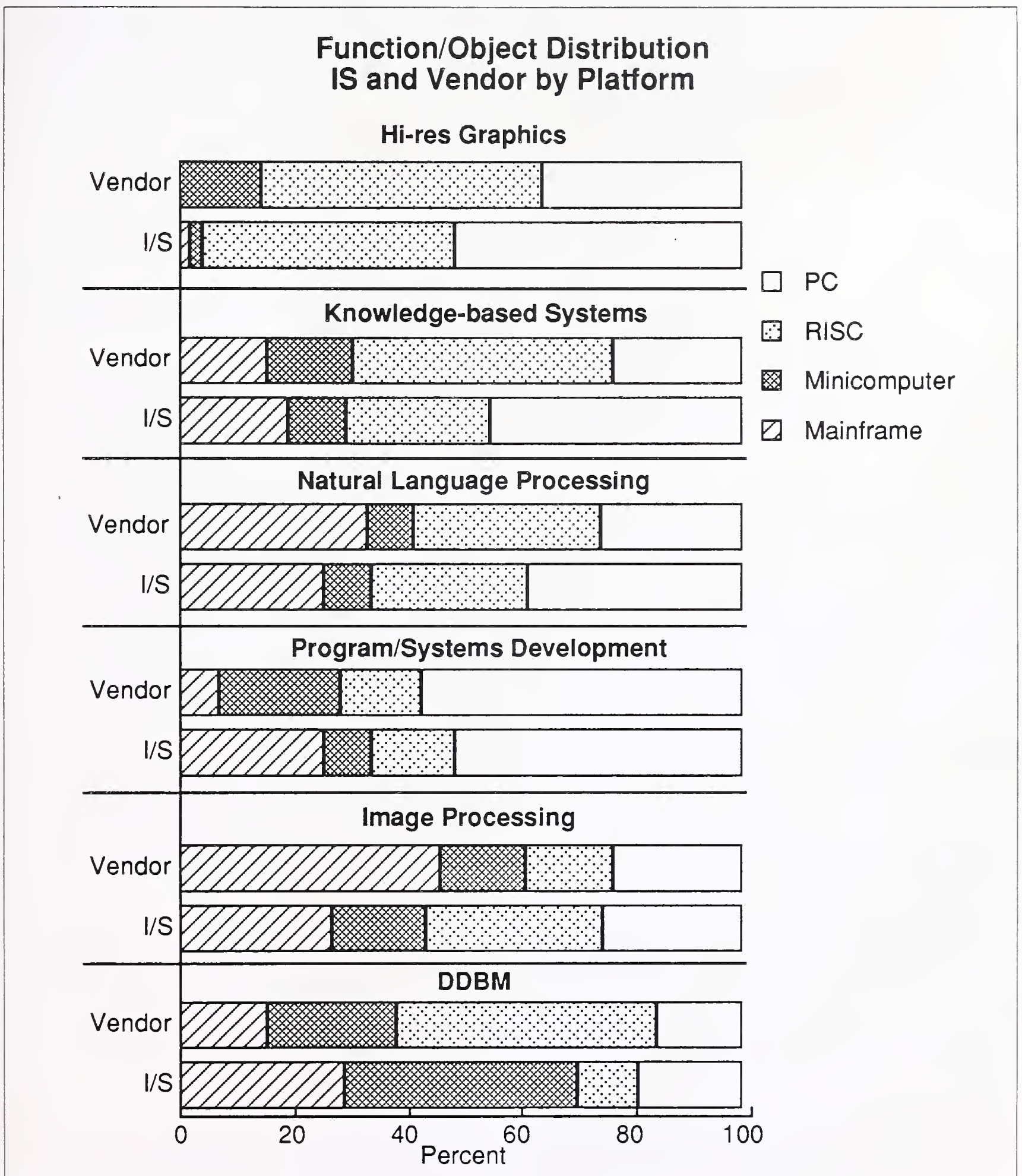


EXHIBITS VI-2B

Function/Object Distribution IS and Vendor by Platform



EXHIBITS VI-2C



Based on these results, one can reach the following conclusions:

- Secure Data Bases - Applications that require security are not considered good candidates for downsizing by either IS managers or vendors, with at least 80% of them stating that mainframes are the proper platform for secure data bases.
  - IS management doesn't feel that any secure data bases should be downsized to either RISC or PC workstations.
  - Only about 10% of vendors feel that secure data bases should be installed on either RISC or PC workstations.
  - The question now becomes: which applications require secure data bases?
  - The answer will depend on whom you ask and when. Look for increased security awareness among IS management when, and if, they feel threatened by downsizing.
- Repository Management - IS and vendor management are also in agreement that repository management should reside on mainframes (IS over 80% and vendors over 70%). And only 10% of IS managers and vendors indicate that repository management could be downsized to either RISC or PC workstations. This has some profound ramifications.
  - By definition, repositories are tools of centralization and integration, and both IS and vendors recognize that this function will remain on either mainframes or minicomputers.
  - It also means that if you start with RISC and PC applications, they will eventually require integration and centralization, and there will be a minicomputer or mainframe in your future. These are the facts of life in General Systems Theory, which dictates not only downsizing but upsizing.
- Mission-Critical Data Bases - IS and vendor management responses for mission-critical data bases closely parallel those for repository management in which 80% of IS and 70% of vendors selected mainframes as the "proper" platform. In addition, 15% agreed that critical data bases can be assigned to minicomputers. However, the results also confirm that vendors support RISC technology more than do users.
  - While less than 5% of users believe that critical data bases can be distributed to RISC or PC workstations (or servers), 15% of vendors feel that critical data bases can be distributed to RISC workstation/servers.

- However, this is cutting the pie a little fine—the fact remains that mission-critical data will normally remain on mainframes even if application functions are downsized.

- Archival Files - The results for archival files are practically identical to those for critical data bases. This is understandable, since archival files are probably considered mission critical in many instances. However, 15% of vendors prefer to see archival files on PCs. Although this puts them out of step with both IS management and other vendors, it does raise several important questions.

  - Are these particular vendors simply misguided or are they actually on the leading edge in downsizing architecture?

  - If they are misguided, one can picture an endless morass of floppy disks in different formats and requiring different software that would prove daunting to any auditor or any IS department. What is the good of archiving if you can never access anything in the archival files?

  - On the other hand, if these vendors are imaginative, they may be thinking of truncating information of all kinds as close to the source as possible, and this could have some interesting possibilities, especially if optical media are employed. For example:

    · One can imagine documents (including transactions) being scanned in the mailroom (or any point of entry, including a doctor's office) and stored sequentially on optical disk as an archival log of activity or for required professional records.

    · It is also probable that archival records of critical phone conversations (or orders) may be captured and archived at the time (and place) of sale or transaction.

  - It is difficult to make a case for moving most data and information to centralized archival storage facilities if it can be captured and economically stored close to its origin. Image processing will permit any PC with optical storage to replace a central warehouse with paper documents or central microfilming facilities at any desktop in the office.

  - It would appear that some large mainframe-based archival storage systems may be good candidates for downsizing.

- I/O-Bound Processing - It is also felt that I/O-bound processing belongs on either mainframes or minicomputers. (IS management 95%, vendors 75%.) By definition, more MIPS do little good in this environment. Mainframe channels are really fast RISC processors, operating in parallel. Their only purpose is to move data around, and they are good at it.

Integrate multiple micros or RISCs together as parallel processors, and you soon find yourself with a mainframe without an effective operating system. String them together on a fiberoptics network and you create intriguing network management and systems software problems. Applications that are I/O-bound will probably remain on mainframes and/or minicomputers for some time.

- Transaction Processing - IS and vendor management differ significantly on the proper platform for transaction processing.

  - Over 90% of IS executives feel that transaction processing should be done on mainframes or minicomputers.

    - 71% mainframes
    - 22% minicomputers

  - Less than 65% of the vendor respondents feel that transaction processing should be done on mainframes or minicomputers.

    - 50% mainframes
    - 14% minicomputers

  - This difference is accounted for by the 36% of vendors who feel that transaction processing should be done on RISC workstations/servers—presumably operating under UNIX. (This is a key finding and will be discussed later.)

- Large Sorts - Approximately 70% of IS and vendor respondents are in agreement that large sorts should be done on mainframes. Since large commercial installations continue to spend between 15% and 30% of all their CPU cycles and I/O activity on sorting [17], sorting is an important factor when considering downsizing. This is especially so in light of the fact that:

  - The definition of relational model, which is so important to the distribution of data bases over the processing hierarchy, excludes the recognition of sorted data.

  - Advanced applications—such as those of artificial intelligence—are finding that sorting is a critical factor in performance. (The Japanese "Fifth Generation" project labored long and hard, and its most significant hardware finding was that a separate sort "box" was highly desirable.)

  - The architecture of IBM mainframes has never been especially well suited for sorting—a point of contention that goes back to IBM's early architectural decision to exclude indirect addressing from the System/360 architecture.

- Microprocessor technology should encourage new architectures that would facilitate the "downsizing" of many current mainframe functions such as sorting and data base management.

- Network Management - The responses to this question clearly demonstrate that the road to "rightsizing" depends on where you are coming from. Approximately 80% of IS respondents felt network management should be exercised from mainframes or minicomputers, and over 60% of vendor respondents view network management as a function for RISCs or PCs. This is an importance difference of opinion as it relates to downsizing.

  - It appears that IS management prefers to use a telescope to view the WAN world, and vendors are more concerned with viewing the LAN world with a microscope. It is possible that neither view is suitable for the real world.

  - Since it is our opinion that network management and data base management are merely different perspectives on the same problem, we sense a power struggle in these answers. Therefore, the answers probably reflect political correctness more than they do technical correctness.

- Compute-bound Processing - The answers to this question are fascinating.

  - Approximately 50% of IS managers and vendors state that mainframes are best suited for compute-bound processing (53% and 58% respectively).

  - IS and vendor management then reverse their normal positions on minicomputers and RISC workstations.

    · A higher percentage of vendors favor minicomputers than do IS respondents (17% for vendors and 9% for IS).

    · A higher percent of IS respondents favor RISC than do vendors (34% for IS and 17% for vendors).

  - Perhaps this is because some of those in IS do not understand that high MIPS ratings do not mean high ratings for megaflops and that RISC workstations need assistance when it comes to floating point operations. Under any circumstances, vendor respondents seem to acknowledge that MIPS do not have as much to do with performance as some would have us believe.

- Data Reduction - Over 45% of IS and vendor respondents agree that data reduction should be done on mainframes, and there are no significant differences of opinion on the other platforms. It is our belief that this question provides a good example of the need to be more exact in terminology. For example:

  - It is doubtful that these responses would have favored mainframes, even to the degree that they do, if respondents considered data to be "anything stored in a computer."

  - It would then be obvious that compression and consolidation of raw data—including text, images and voice—should occur as close to the point of capture as possible.

  - In addition, the current propensity to refer to even scientific data as "information" further clouds the issue inferring that raw data can "tell" us something, and perhaps should not be reduced at all.

  - The generation of information from data may be considered data reduction, if we eliminate the current "terminological inexactitude" that permits the two terms to be used interchangeably.

- Planning Data Bases - IS and vendor respondents agree that planning data bases should reside on either mainframes or on PCs (IS management with a total percentage of 78% and vendors with 92%). However, a significantly higher percentage of vendors favor PCs (54% for vendors and 35% for IS managers).

- Workstation Backup Files - There are major differences of opinion on where workstation backup files should reside. This is probably so because when vendors think of workstations they think of RISC-based technology, whereas IS tends to think of microprocessor-based PCs. This results in the following:

  - A higher percentage of IS respondents favor uploading backup file to mainframes or minicomputers (51% versus 36%).

  - As might be expected, a much higher percentage of vendors favor RISC backup for workstation files (50% versus 11%).

  - Then, of course, IS is significantly higher than vendors in designating PCs for workstation backup files (38% versus 14%).

- Distributed Data Base Management - As might be expected, after the results for network management, IS and vendors have a significant difference of opinion about the proper platforms for distributed data base management.

- More IS respondents favor mainframes (29% versus 15%).

- More IS respondents favor minicomputers (42% versus 23%).

- A much higher percentage of vendors favor RISC for distributed data base management (46% versus 10%).

- An IBM executive, in a moment of frustration, once said: "They (IBM customers) just don't understand the sanctity of data." However, for whatever reason, it does not appear that many IS executives are willing to entrust their sacred data to RISC workstations/servers.

• Image Processing - The responses on image processing present us with another anomaly. IS and vendor management responses are in agreement on minicomputers and PCs, but they reverse their usual support for mainframes and RISC.

- A higher percentage of vendors favor mainframes for image processing than do IS respondents (46% versus 27%).

- And, a higher percentage of IS respondents favor RISCs for image processing than do vendors (31% versus 15%).

- We believe that this has been caused by IBM directing its customers toward pilot image processing projects on the RS/6000 prior to attempting ImagePlus on mainframes. (Or by users deciding for themselves that pilot projects are required.)

- It is important for both vendors and users to be technically correct on this important issue, and we shall return to the subject later.

• Program and Systems Development - More than 50% of both IS and vendor respondents favor doing program and systems development on PCs (51% and 57% respectively). The rest of the results are not surprising, except that vendors aren't jumping on the RISC bandwagon. Only 14% favor that platform—virtually the same as IS departments, with 15%. The remainder of the IS respondents favor mainframes over minicomputers (26% to 9%); and the vendor respondents favor minicomputers over mainframes (21% to 7%).

- Since program and systems development activities require both word processing and graphics, it is only natural that personal computers are generally the favored platform.

- However, while excellent tool kits are available on PCs for "applications" development, we run into definitional problems again. What the PC vendors mean by applications are really tools such as spreadsheets and DBMSs.

- This, in turn, leads to considerable misunderstanding and "remarkable" discoveries. For example, in a recent issue of *Computerworld* there was an article entitled "Applications as Tool Kits" [31] in which it was discovered that personal computer "applications" such as word processors, spreadsheets and DBMSs—combined with macro capability—could be "powerful applications development tools." Thus goes the circuitous and pained reasoning of terminological inexactitude.

- Natural Language Processing - The pattern of responses for natural language processing (an AI component) reflects 66% of IS respondents and 58% of vendor respondents favoring either RISC or PC platforms. However, vendors do tend to favor mainframes more than IS, and IS tends to favor PCs more than vendors. It is difficult to read very much into this except to say that text is the most prevalent form of natural language currently being processed, and we don't see mainframes having very much of a role to play in "reading" that for us—whether it consists of encoded data or image.

- Knowledge-Based Systems - The shift away from mainframes and minicomputers continues with another AI component—knowledge-based systems. Approximately 70% of IS and vendor respondents feel that RISC or PC platforms are appropriate for such systems. Following a familiar pattern, IS seems to prefer PCs over RISC (45% versus 26%), and vendors prefer RISC over PCs (46% to 23%). It is hard to argue with these preferences except to say that:

  - Expert systems in narrow domains are appropriately assigned to workstations, and any that have been implemented on mainframes are fair game for downsizing unless they require large data bases.

  - However, there are some emerging knowledge-based systems that are tightly integrated with larger application systems. These will be more difficult to downsize.

  - Remembering that knowledge becomes data when it is integrated, it should be pointed out that data bases with a heavy knowledge component require management with special attention to integrity, synchronization and security—all of which are currently problem areas with RISC and PC systems.

- High-Resolution Graphics - Finally we arrive at the point where RISCs and PCs reign supreme—high-resolution graphics applications—with 96% of IS respondents and 86% of vendors designating those platforms as most appropriate. In fact, RISCs and microprocessors are not only desirable but necessary for most high-resolution graphics applications. They have simply been too expensive for most customers to implement on mainframes or minicomputers. Therefore, there just aren't many high-resolution graphics applications running on those platforms to downsize.

Although IS and vendor management do not necessarily agree on what the specific platforms that will be employed, it seems apparent that downsizing will significantly change the information systems infrastructure during the 1990s.

C
Implementation Schedule

In order to determine the timing of these infrastructure changes, INPUT asked respondents whether certain changes had already occurred, or would occur by 1992, 1993, 1995, 1999 or never. Exhibit VI-3 (a through k) compares the percentages of IS and vendor management responses. Data points for 1994, and between 1995 and 1999 have been inserted by linear projections. (The percentage stating "never" is 100% less the plotted percentage. For example, in VI-3a, 27% (100% - 72%) of the IS executives said there would never be significant reduction in mainframe use.)

EXHIBIT VI-3A

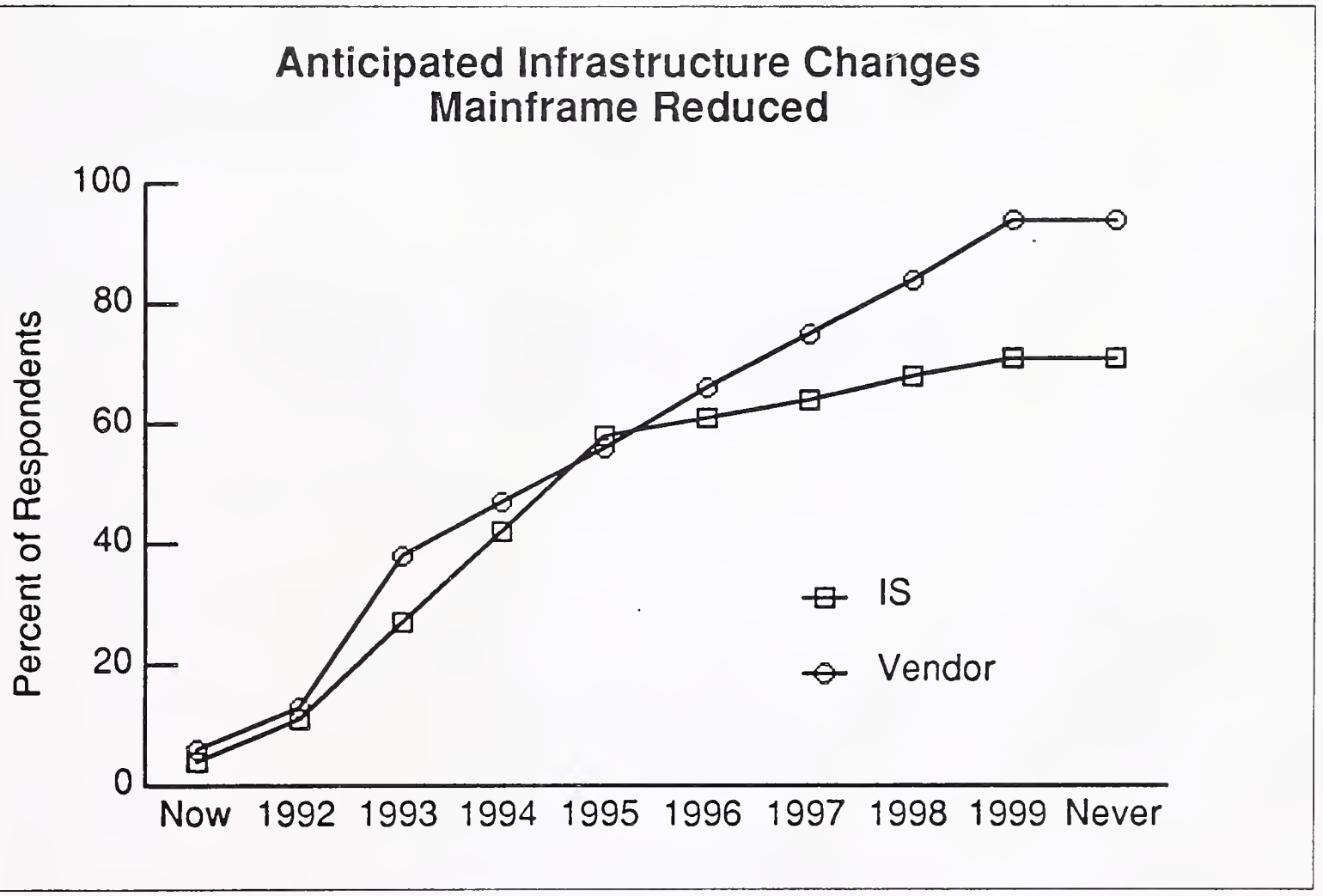


EXHIBIT VI-3B

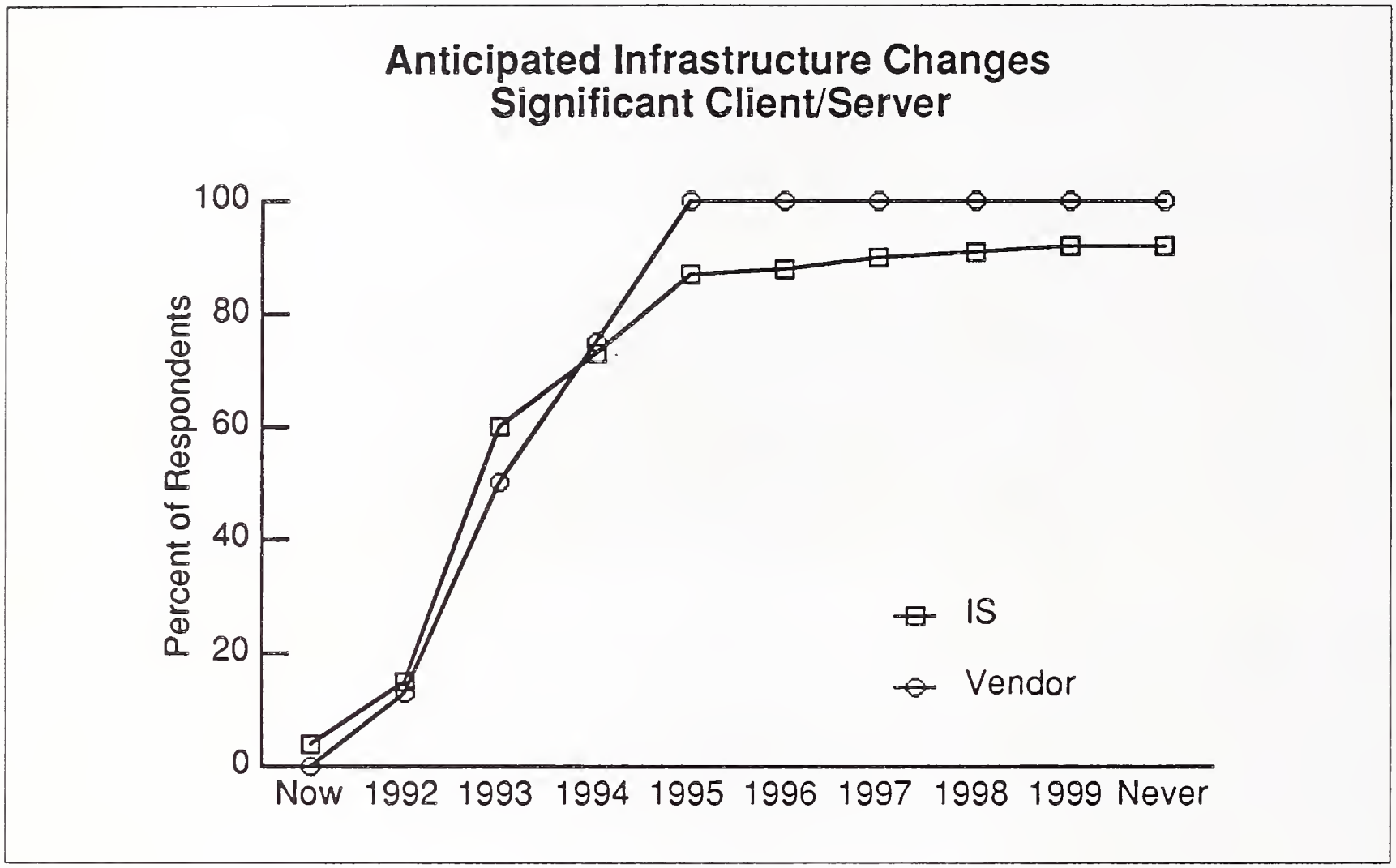
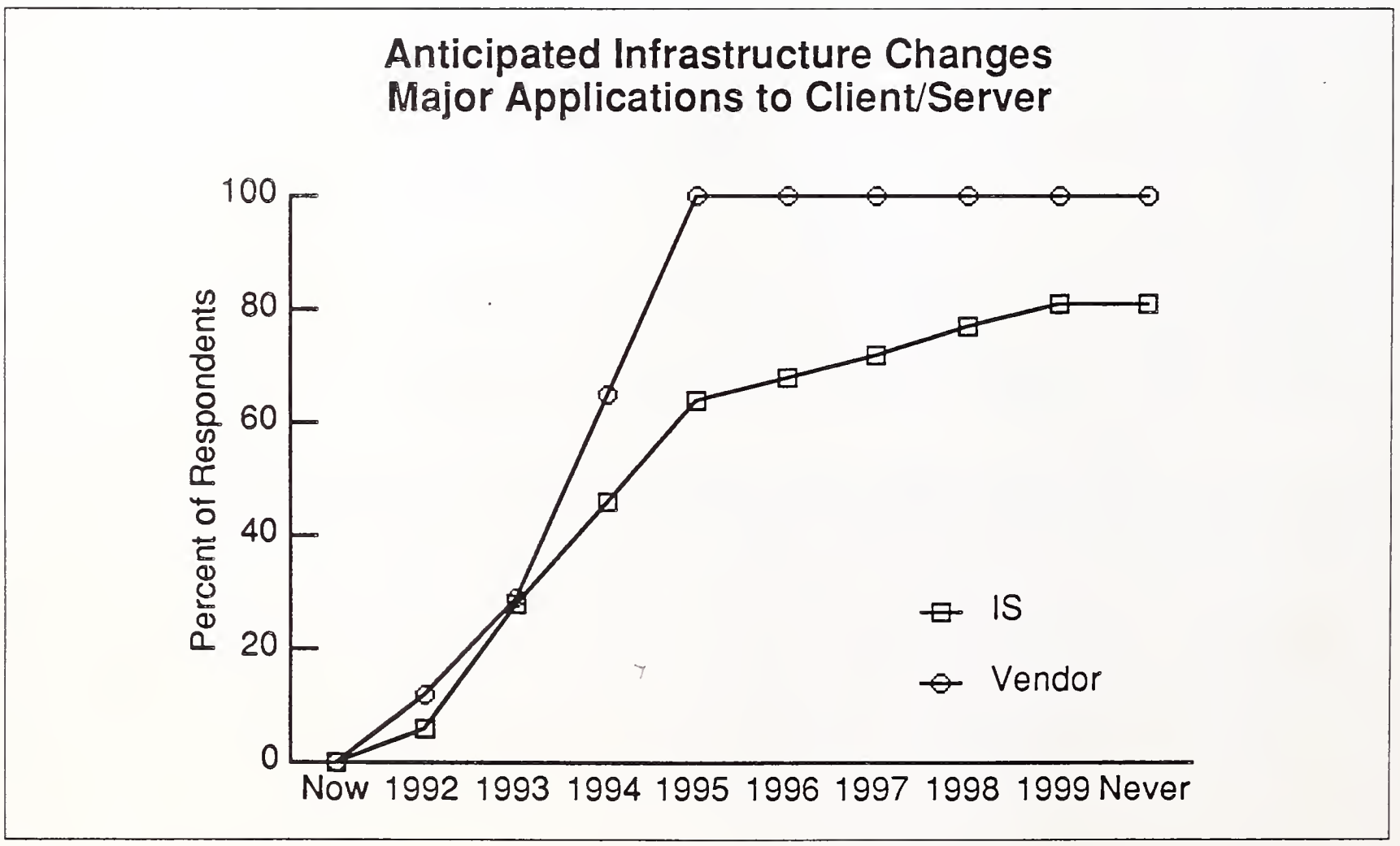


EXHIBIT VI-3C



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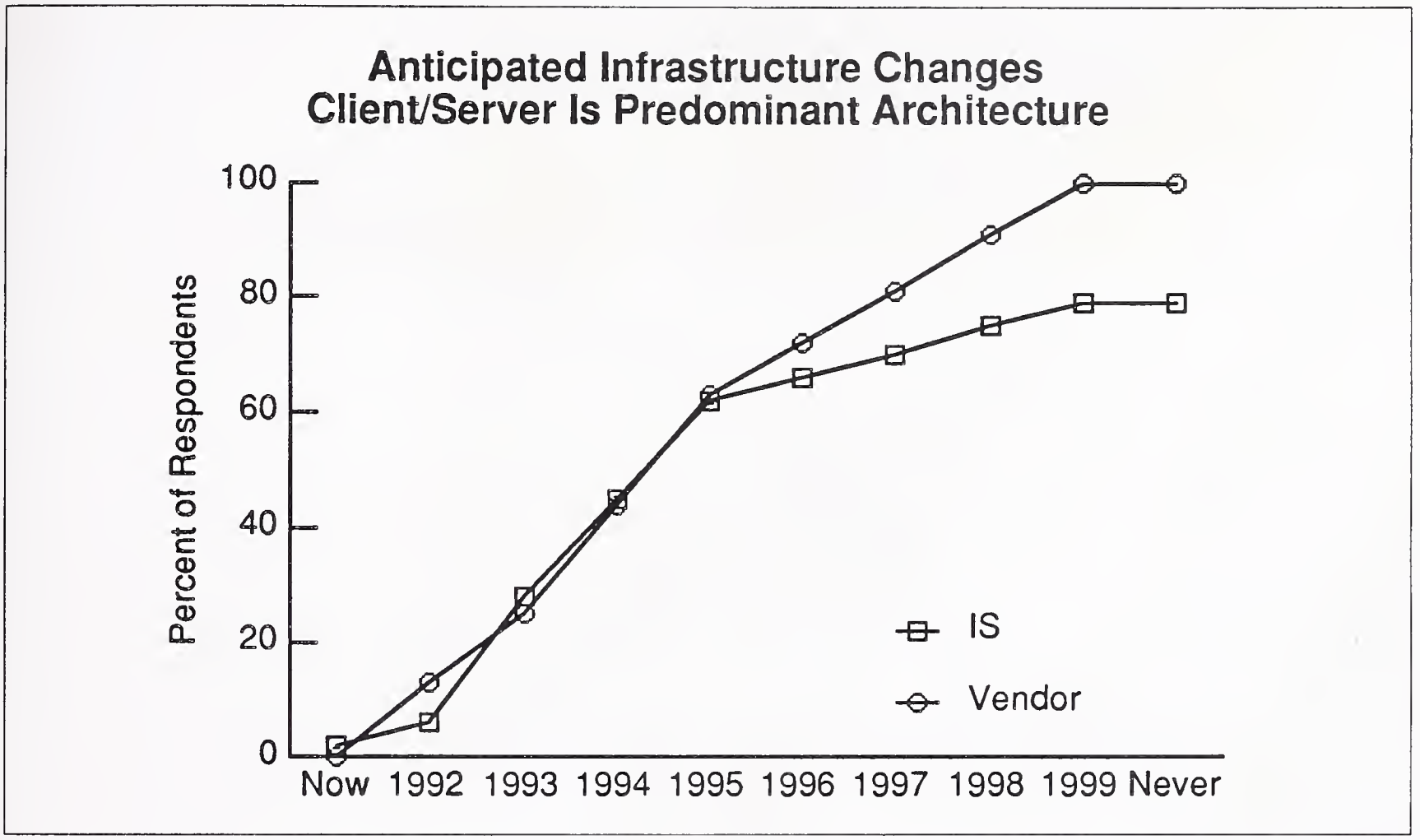

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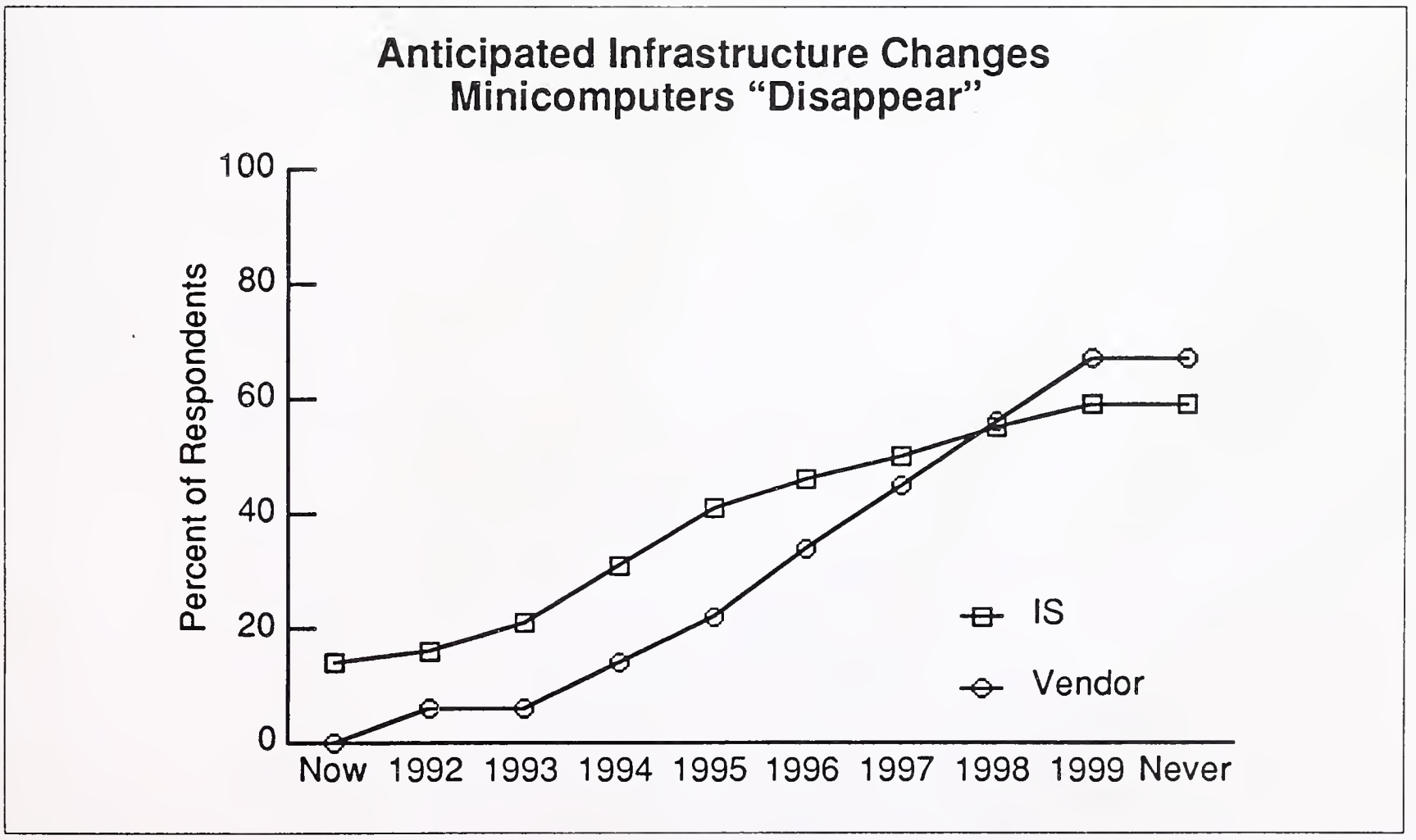

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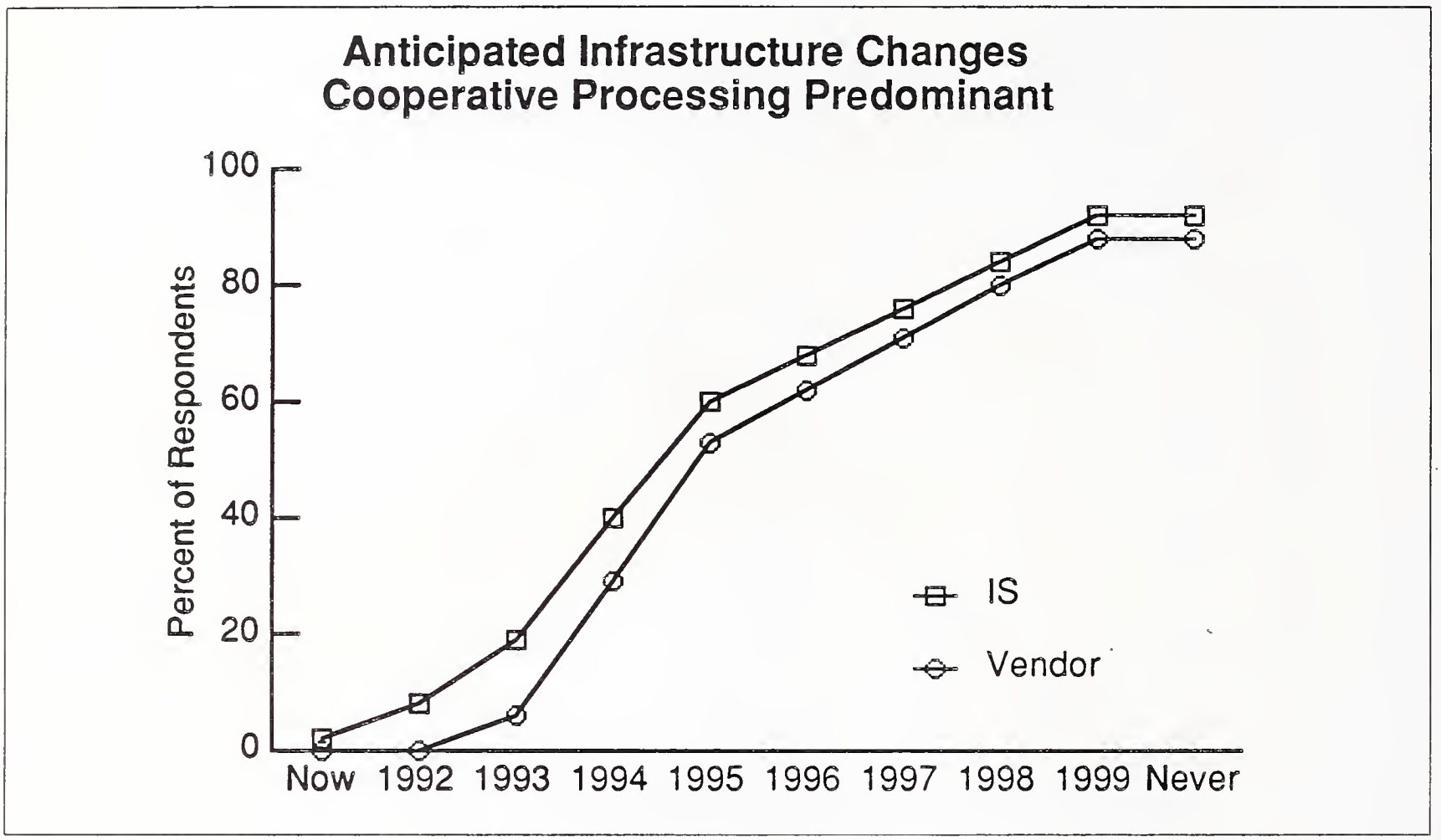

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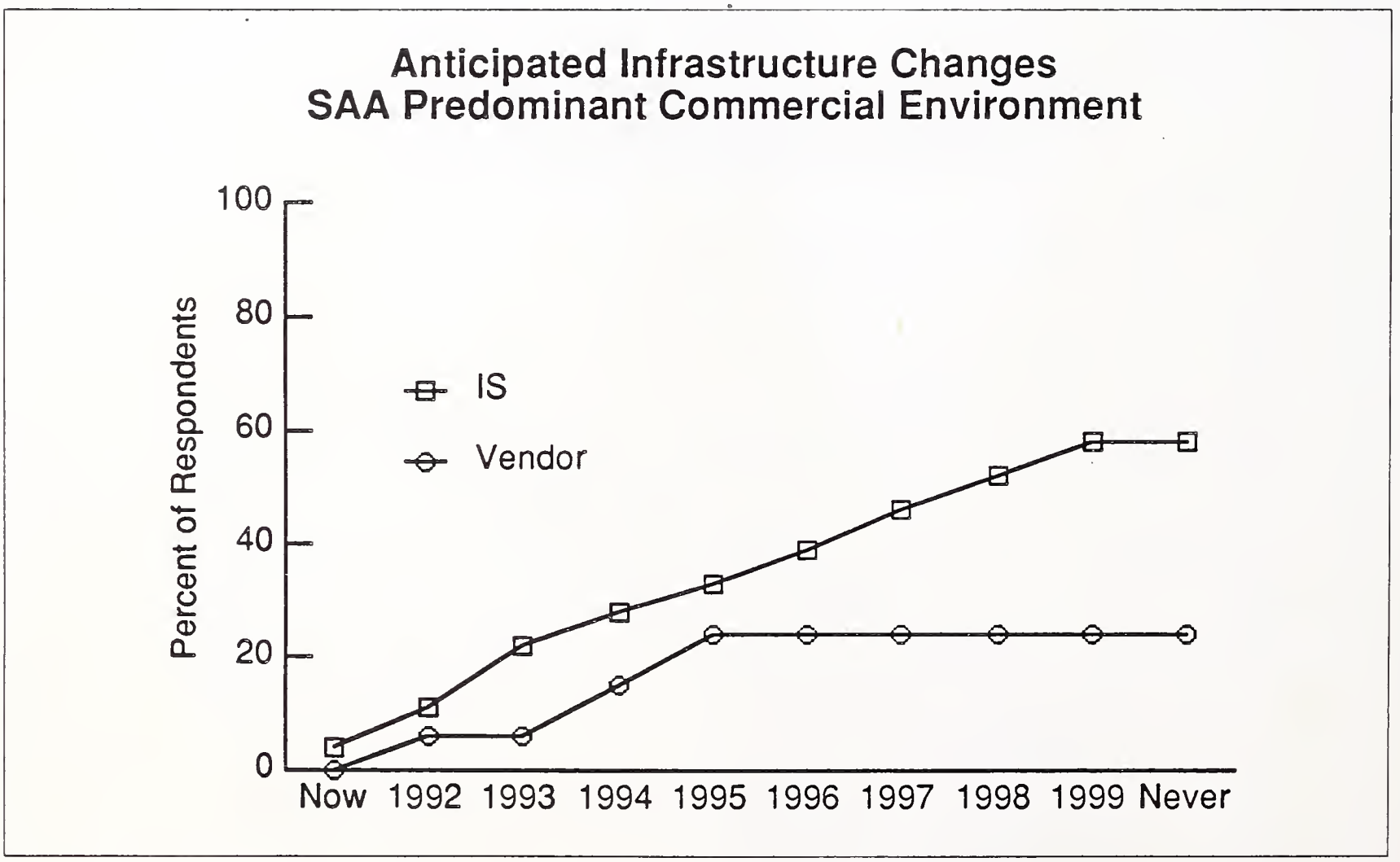


EXHIBIT VI-3H

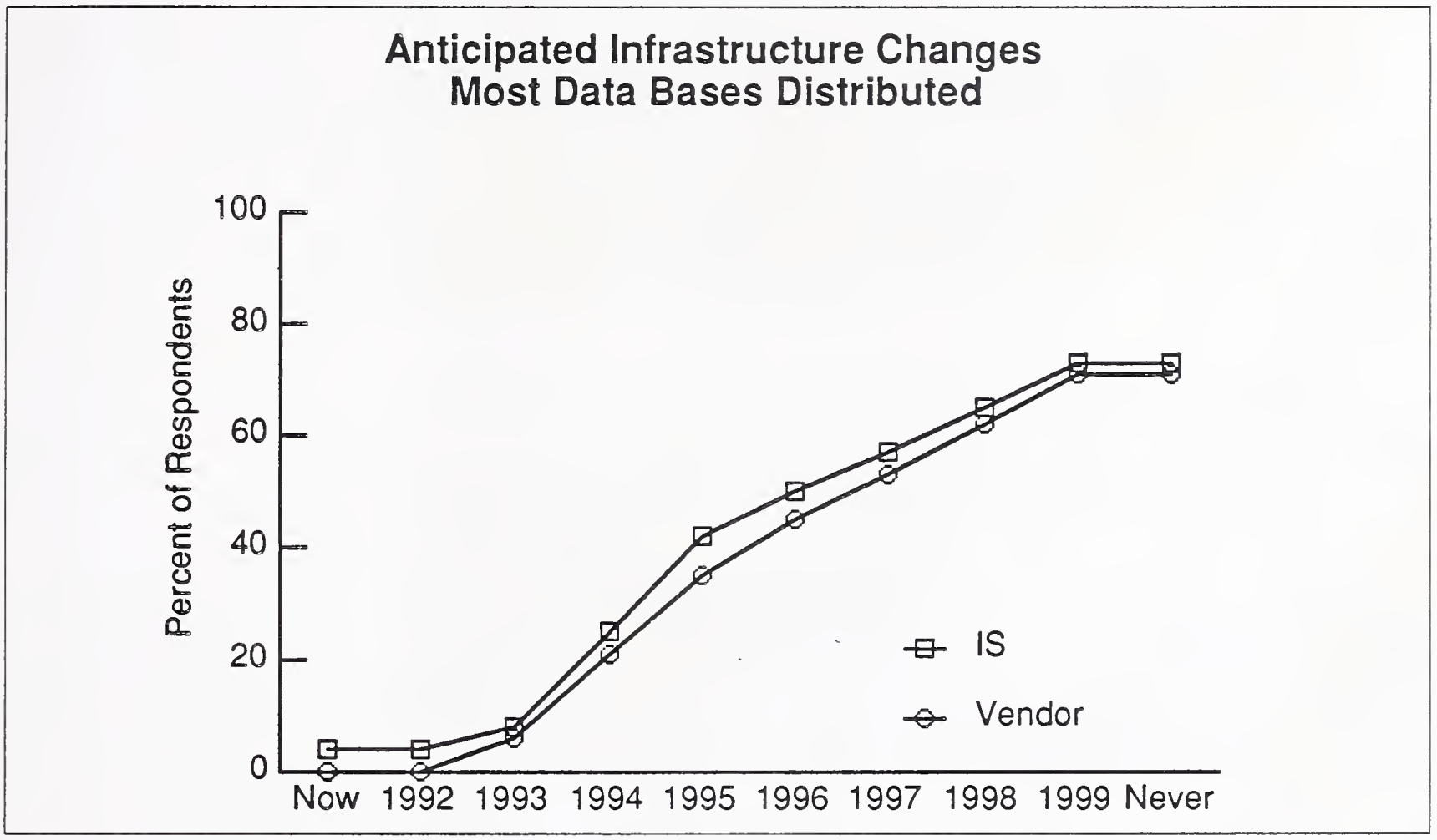
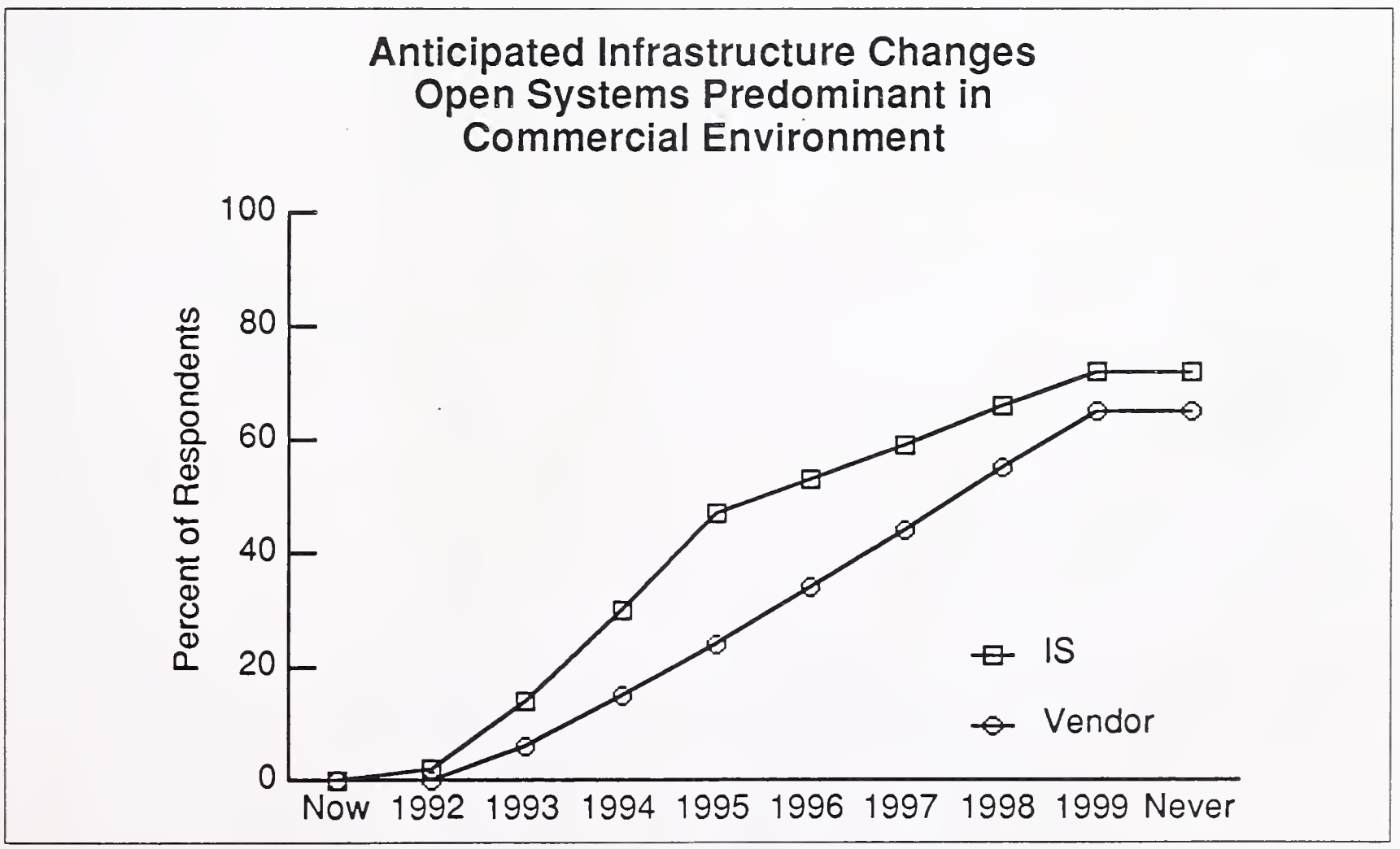


EXHIBIT VI-3I



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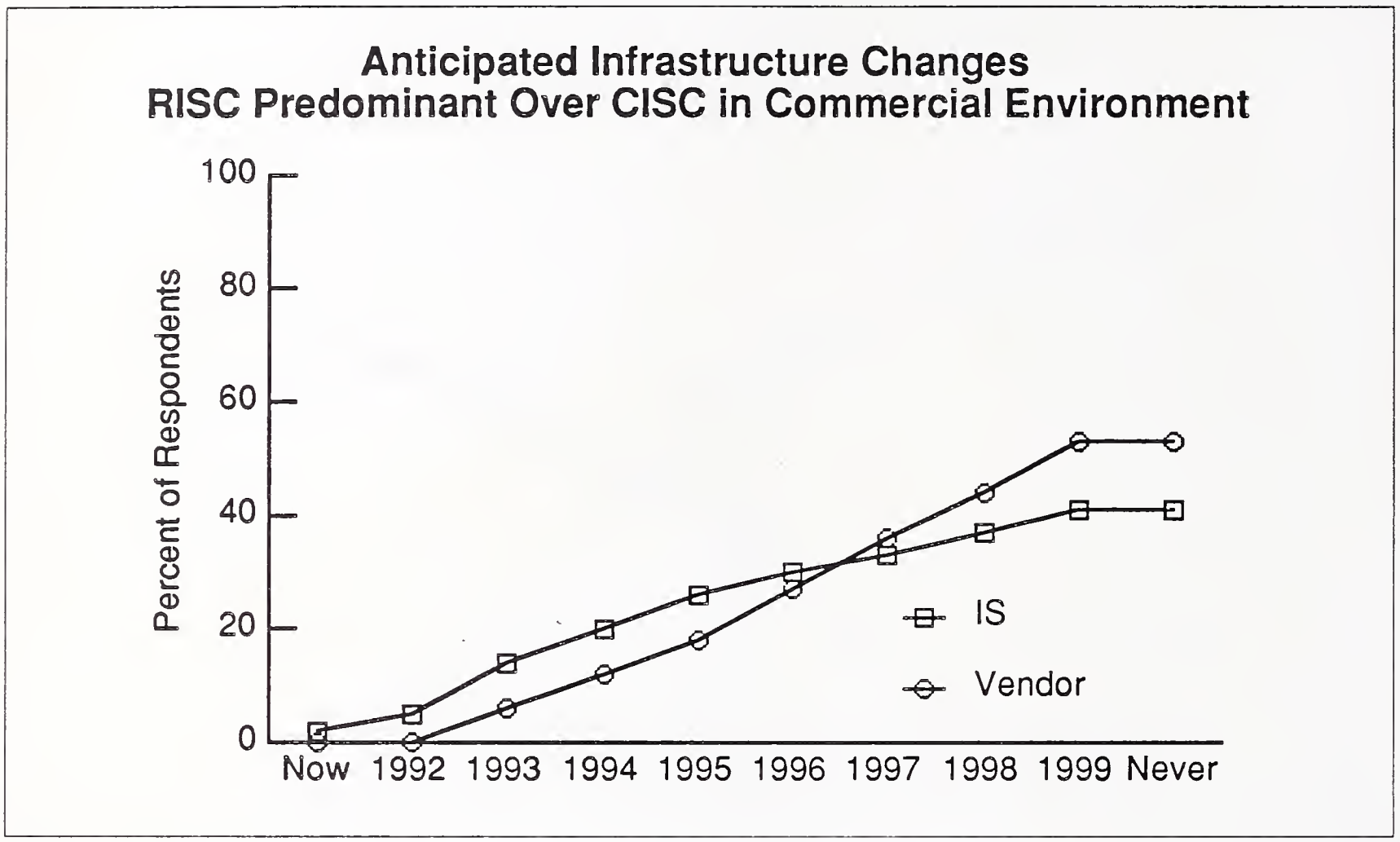
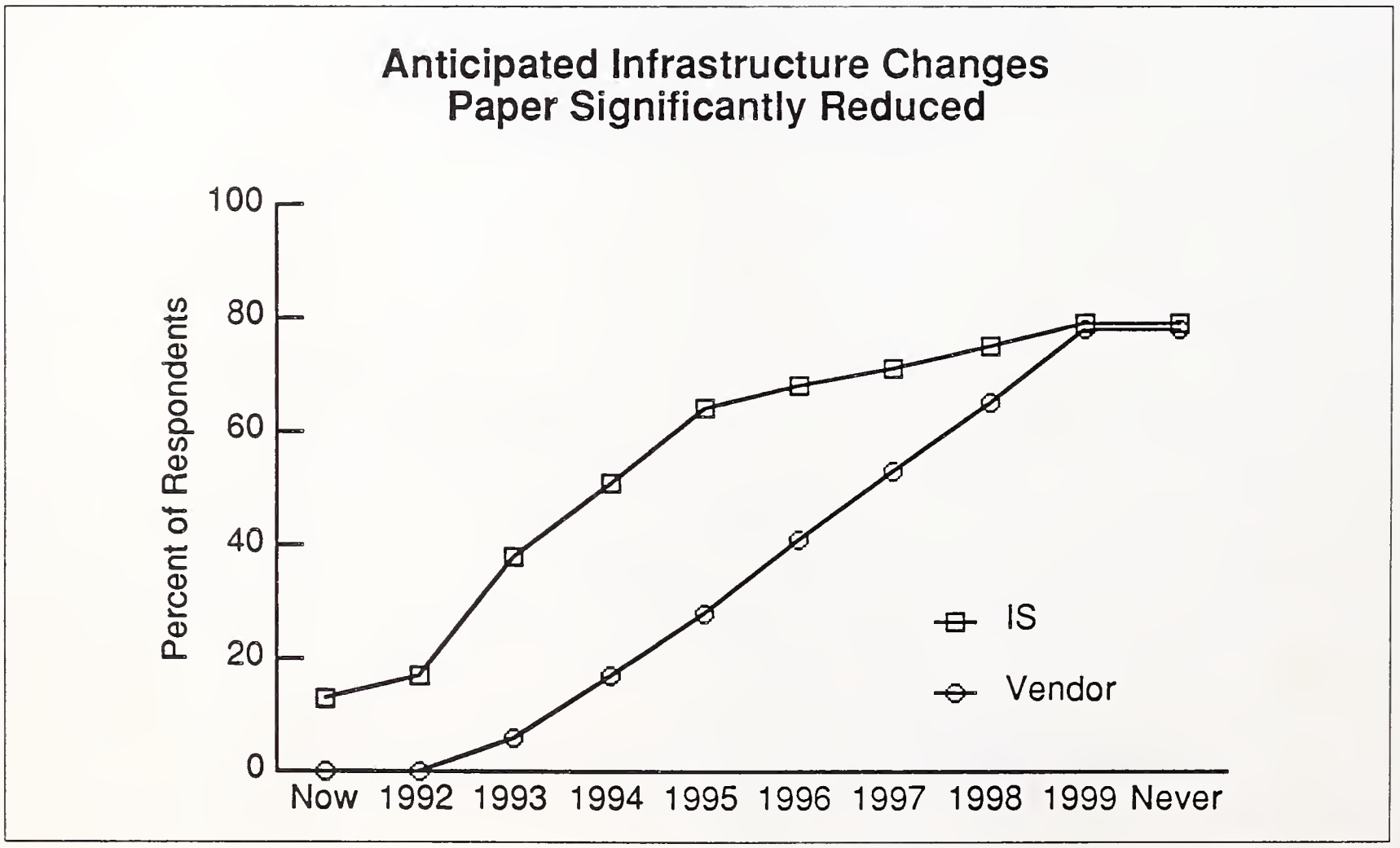


EXHIBIT VI-3K



1. General Comments

If we discount the 1994 data point, that has been inserted between the 1993 and 1995 responses, it is possible to reach the following general conclusions by scanning the 11 charts.

- Few repondents feel that infrastructure changes have already occurred, and few anticipate significant shifts during the next two years (1992 and 1993). This is probably because current plans do not include significant (or specific) downsizing efforts.

- There is a sharp increase in the respondents who feel that some of the infrastructure changes will occur by 1995. This increase is probably because 1995 is far enough in the future to warrant optimism rather than because there are specific long-range plans to effect such changes.

- There is some surprising agreement between IS management and vendors on the timing of some of the anticipated infrastructure changes. Regardless of terminological problems among the respondents, one thing seems clear: there are going to be significant changes in the architecture of computer/communications networks during the 1990s, and those changes are essentially away from mainframes. To that extent, downsizing is real!

2. Analysis of Specific Infrastructure Changes

In order to determine the "implementation schedule" for downsizing efforts, users were instructed to indicate when specific statements would apply to their organization's information systems infrastructure. The general structure of the question and the methodology used in plotting was described above. The specific statements and our analysis of the results are as follows:

- Exhibit VI-3a plots when IS and vendor management anticipate that mainframe use will be significantly reduced.

  - Though vendors seem to be somewhat more optimistic than users about a significant reduction of mainframe use, slightly more than 50% of each agree that this will occur by 1995.

  - Few vendors were prepared to say that such reduction would never occur, but over 25% of IS respondents felt that mainframe use could never be significantly reduced.

  - Considering that IS executives have been condiditioned by decades of mainframe growth, the fact that nearly 75% see reduction of mainframe growth by the end of the 1990s is considered very strong affirmation of the appeal of downsizing.

- Exhibit VI-3b plots the time when significant client/server applications will be installed. Considering the fuzzy definition of client/server that currently exists, the results are not terribly surprising.
  - However, the fact that over 50% of IS managers and vendors specifically state that this will occur by 1993 is considered significant.
  - Then, by 1995, there is practically unanimity that client/server will have become an important part of the information systems infrastructure.
  - It is our opinion that this strong affirmation of client/server on the part of IS comes from "upsizing" rather than downsizing. Client/server architecture for the most part will be the direct result of the need to integrate workstations.
  - The question then becomes whether or not this will result in any significant downsizing of applications (or functions) from mainframes, and whether this will decrease mainframe use. It is probable that IS respondents made these assumptions when they supported the reduction in mainframe use.
  - The validity of these assumptions may determine the success of downsizing.

- Exhibit VI-3c shows that approximately 25% of IS management feels that major business applications will be converted to client/server more slowly, but vendors remain unanimous in agreeing that this will occur by 1995.

- Exhibit VI-.d shows that IS management feels that client/server will become the predominant architecture for new applications in the same timeframe in which major business applications are converted to that architecture. (In fact, it is probable that the IS respondents felt the questions were synonymous.) However, a significant percentage of vendor respondents perceived a difference in the two questions.
  - The percentages of IS and vendor management who feel client/server will be the predominant architecture for new applications is practically identical through 1995, when slightly over 60% of both respondent sets are in agreement with the statement.
  - This can be interpreted as meaning that, by 1995, approximately two-thirds of all new systems development will be done using a client/server architecture. This represents a substantial architectural shift that obviously must be supported with appropriate hardware and systems software.

- Obviously, a solid majority of IS and vendor management is assuming that this necessary hardware/software is (or will be) available at appropriate levels in the processing hierarchy, and that industrial-strength applications can be built using these platforms and tools.

- Because experience with developing major business applications using client/server architecture is now limited, the success or failure of applications developed during 1992 and 1993 will determine whether this longer range schedule is realized.

• Exhibit VI-3e indicates that a slightly higher percentage of IS management than vendors feels that minicomputers will disappear by 1995. Then, by 1999, around 60% of both IS and vendor respondents feel that minicomputers will no longer be used. Based on the strong vendor emphasis on RISC workstations/servers that was identified earlier, this is somewhat surprising. However, it can be explained as follows:

- IS management has been traditionally mainframe oriented, and since timesharing days, minicomputers have been viewed as tools for scientists and engineers rather than for commercial data processing. This can explain the fact that some IS respondents state that minicomputers have already "disappeared"—they simply don't have any in their organizations.

- Vendors, on the other hand, have products directed toward the minicomputer market and seem to be more pragmatic about the possibility of significant decline in the short term.

- Then, of course, the old problem of terminology comes into play also. Defining minicomputers as costing between $20,000 and $200,000 rather than based on architecture or perceived market (such as small business systems) would probably change the result substantially—few people would be prepared to say that computers in that price range are going to "disappear."

- However, the fact remains that 40% of IS respondents say minicomputers will disappear in their organizations by 1995, and this increases to 60% by 1999. Unquestionably, this has something to do with the size of responding organizations, but the most important point is that a significant percentage of mainframe-oriented organizations are obviously not thinking of downsizing from their large mainframes to minicomputers—either now or in the future.

- It is our opinion that this attitude is a residual of IBM account control—whether the IS department acknowledges it or not. This is a crucial point—the traditional IS aversion to minicomputers could delay some organizations from realizing the benefits of downsizing.

- Exhibit VI-3f indicates that IS and vendor respondents are remarkably similar in their opinions of when cooperative processing will become predominant. There are several points to be made about these results.
  - The percentage of IS respondents supporting cooperative processing is virtually the same as that supporting client/server as the predominant architecture in 1995—about 60% (Exhibit VI-3d). By 1999, cooperative processing will be supported by over 90% of IS respondents, compared to a little less than 80% for client/server.
  - It seems obvious that IS respondents are looking for more than simple file (or data) servers; they are looking for architected solutions between (or among) cooperating systems. This implies both high-quality systems software support (operating systems, DBMSs, and network management) and re-engineering of applications (with resulting requirements for high-quality development tools—languages and CASE).
  - It is also important that the percentage of both IS and vendor respondents supporting cooperative processing in 1995 is practically identical to that stating that mainframe use will be significantly reduced—a little less than 60% (Exhibit VI-3a). Thus the importance of cooperative processing in downsizing from mainframes seems apparent.
  - It should also be apparent that SAA is IBM's architecture for cooperative processing. It is the recommended information systems infrastructure for IBM customers in the 1990s.
- Exhibit VI-3g clearly shows that neither IS nor vendor respondents are buying SAA to the same degree that they are buying cooperative processing. Slightly over 30% of IS management and slightly less than 25% of vendors state that SAA will become the predominant commercial environment by 1995, compared to approximately 60% supporting cooperative processing. This leads to several simple conclusions:
  - Approximately half of those planning to embrace cooperative processing by 1995 will do so outside of SAA.
  - There seems to be an explicit assumption that non-SAA operating systems, DBMSs and network management systems can adequately support a cooperative processing environment.
  - This, in turn, leads to the implicit assumption that these non-SAA systems will effectively "cooperate" with SAA systems because, whether SAA is predominant in the commercial environment or not, there are certainly going to be a lot of SAA systems out there.

- Because cooperative processing is heavily dependent upon distributed data bases, the validity of these assumptions—especially in the area of distributed data base and network management—will determine the success of downsizing to heterogeneous cooperative processing environments.

- The validity of these assumptions has yet to be tested because: 1) few cooperative processing applications have been developed, and 2) SAA remains amorphous to IS managers and vendors alike.

- However, nearly 60% of IS respondents feel SAA will be the predominant commercial environment by 1999, compared to less than 25% of vendors. It would be a serious strategic error on the part of vendors to ignore the fact that a majority of IS management feels that SAA will eventually be predominant in the commercial (or business) market.

• Exhibit VI-3h shows that IS and vendors are in agreement as to when most data bases will be distributed. Since this is a key factor in downsizing, it is important to determine whether the responses are reasonable.

- IS respondents are fairly consistent in their responses to the interrelated questions concerning cooperative processing, SAA and distributed data bases. By 1999 cooperative processing receives the highest endorsement (a little over 90%), distributed data bases are next (a little over 70%), and SAA trails with (a little less than 60%). These numbers seem reasonable considering the following:

  · It is not difficult to visualize a form of cooperative processing that does not require distributed data bases; one has only to consider data capture and editing (error checking or transaction processing) being performed on a workstation in cooperation with a host (or server).

  · Therefore, it is reasonable that some IS respondents seem to view distributed data bases as a subset of cooperative processing.

  · Then, of course, the SAA responses should be lower because they represent only the commercial environment and data bases will obviously be distributed in other environments.

- A substantial portion of vendors obviously feel that data bases can be distributed (and hopefully managed) outside of the SAA environment since there is a three-to-one ratio between distributed data bases and SAA. Is this reasonable, considering the fact that data base integrity, synchronization and security are the primary factors inhibiting downsizing? The answer to this question is obviously of critical importance to this study, and we shall reserve judgment until later.

- Exhibit VI-3i presents the surprising fact that a higher percentage of IS respondents believe that open systems will be predominant for commercial work than of vendors. This is especially striking in 1995, when nearly twice as high a percentage of IS management supports this statement. This exhibit sent us back to our spreadsheets to check our data base integrity and synchronization, but we could not avoid explaining this phenomenon.

  - The answer is actually quite simple: when IS managers think of open systems they also think of PCs and DOS, and many intend to downsize to PC LANs in a client/server environment. They accept the Bill Gates definition of an open system, and most feel this environment will still be predominant for commercial work in 1995.

  - When vendors think of open systems they think mostly of RISC and UNIX. They accept the Sun Microsystems definition of open systems, but not many are naive enough to believe that RISC workstations are going to be predominant in the commercial market by 1995.

  - By 1999, IS and vendor respondents are reasonably close with a little over 70% of users and approximately 65% of vendors feeling that open systems will predominate for commercial work.

  - This leaves us with only one small problem: when you combine the percentages of IS respondents stating that SAA will predominate by 1999 with those favoring open systems, you get a total of approximately 130%! What are those IS executives trying to tell us, you ask?

  - It seems that there are those who feel that OS/2 EE, under the SAA umbrella, will become a standard for a certain amount of commercial work by 1999; and,

    - Either feel that IBM will have "opened up" that platform by then, or
    - Feel that any de facto standard becomes open by definition.

  - Then, of course, there is another and even more likely explanation for this seeming ambivalence on the part of IS management. They probably expect to have platforms that can co-exist in the proprietary and open worlds by 1999, and they probably don't care which "predominates" at any given point in time.

  - We consider this to be reasonable if it is, in fact, the attitude of IS management. What is says is that open versus proprietary is much more important to vendors than it is to customers who just want to make effective use of information technology regardless of the technical arguments and political maneuvering of vendors. We sometimes forget this.

- Exhibit VI-3j also presents something of a surprise since a higher percentage of IS respondents feel that RISC will be predominant over CISC (complex instruction set computers) for commercial work by 1995 (slightly over 25% compared to less than 20% for vendors). However, 60% of IS management feels that RISC will never be predominant over CISC compared to slightly less than 50% of vendors who express this opinion. When compared with the other results, we obtain a fairly clear picture of the changes IS executives anticipate in their information systems infrastructure.

  - In 1995, half the users state that open systems will be predominant for commercial work (Exhibit VI-3i); and, of these, half state that these open systems will be RISC architecture (either workstation or minicomputer).

  - Unlike the earlier analysis of open systems versus SAA, we now find that when we add the percentage stating RISC will be predominant for commercial work to the percent stating SAA will be predominant (Exhibit VI-3.g.), the result comes out to practically exactly 100%.

  - It certainly appears that IS is being attracted to downsizing by more bang for a buck, and 40% feel that the potential cost savings are sufficiently attractive to erode IBM's control of the commercial market with its strategic proprietary systems architecture, SAA.

  - However, 60% of IS respondents still feel that SAA will be predominant in the commercial market, and this could mean that other mainframe and minicomputer vendors had better be prepared to go RISC or see their markets for proprietary systems and CISCs erode rapidly during the 1990s.

  - If the commercial market does break down 60-40 between SAA and RISC technologies by the year 2000, that will be a reasonably close approximation of IBM's traditional share of the commercial (business) market. The only difference is that IBM also intends to be in the RISC business.

  - With RISC giving impetus to a processing horsepower race at all levels, the overall market for computer hardware will probably be poor, in terms of both revenue growth and earnings, thoughout the 1990s. However, that doesn't mean there aren't opportunities for the innovative application of information technology, and we don't have to look very far to find them.

- Exhibit VI-3k highlights a major difference of opinion between IS and vendor respondents. Over 60% of IS and less than 30% of vendors feel that paper use will be significantly reduced by 1995, although more than 75% of both agree that this will occur by the end of the decade. Depending upon who is right in this regard, there are going to be either some outstanding opportunities missed or some major systems development failures between now and 1995.

  - Vendors (and consultants) have been talking about paperless offices until it has become something of a joke in the industry. However, we are now possessed of the technology to make it happen, users are obviously excited, and vendors seem to be adopting an extremely cautious approach to the problem.

  - Are IS executives overrating information technology, or are vendors undervaluing the ability to apply it effectively enough to control the paper information overload problem that information technology itself has created? It seems to be a little of both.

    - IS management is probably taking a somewhat myopic view of the paper handling problem, and as printers are "downsized" to become servers on local-area networks, the problem from their point of view disappears when there are fewer wide-fanfold stacks of paper to print, separate, collate, and distribute.

    - Vendors, on the other hand, are so conscious of the fact that office technologies of the 1980s created new and attractive markets based on the production of paper documents, that they either cannot (or will not) recognize that a major problem has continued to get worse.

  - The shift from paper to electronic media has begun, and whether it proceeds as anticipated by IS or vendors, there are going to be major changes during the 1990s. The last time such a major innovation occurred, clay tablets were replaced with paper. Whether we are downsizing from a few acres of file cabinets to an optical juke box or merely want to carry our personal files or technical library on an optical disk, the 1990s are going to be exciting times for IS, vendors and users alike.

The fundamental information systems infrastructure changes of the 1990s will involve the downsizing of centralized mainframe computers to smaller, more cost-effective, distributed systems; and the downsizing of a piece of 8.5" x 11" piece of paper to a microscopic cluster of bits on a magnetic or optical disk. Both IS executives and vendors tell us this is going to happen; but are they seriously thinking about specific applications to be downsized?

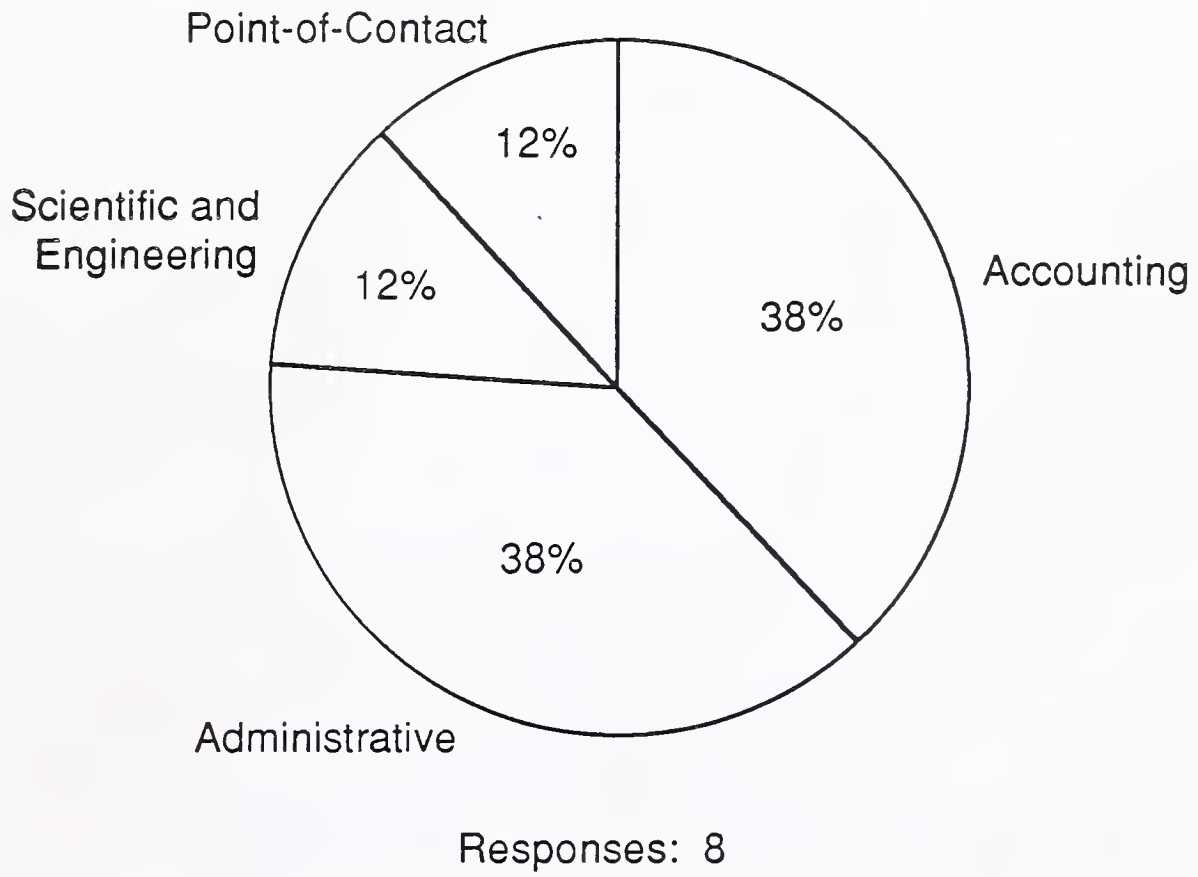
D
Promising Applications

INPUT asked IS executives which specific applications they considered most promising for downsizing; and that had been completed, were planned for 1992, or were to be implemented in the future. The question required the respondents to list the applications (rather than check them off of a prepared list). This has the advantage of identifying real application projects (as opposed to prompting a check mark against something that might be nice to do), but it requires classification of the results into broad applications areas.

The results were impressive. Forty-two of fifty-two responding IS executives listed specific applications they were planning to downsize, and there is every indication that they are beginning to implement the structural changes in their information systems infrastructure that were indicated above. We have classified and charted these promising applications in Exhibit VI-4.

EXHIBIT VI-4A

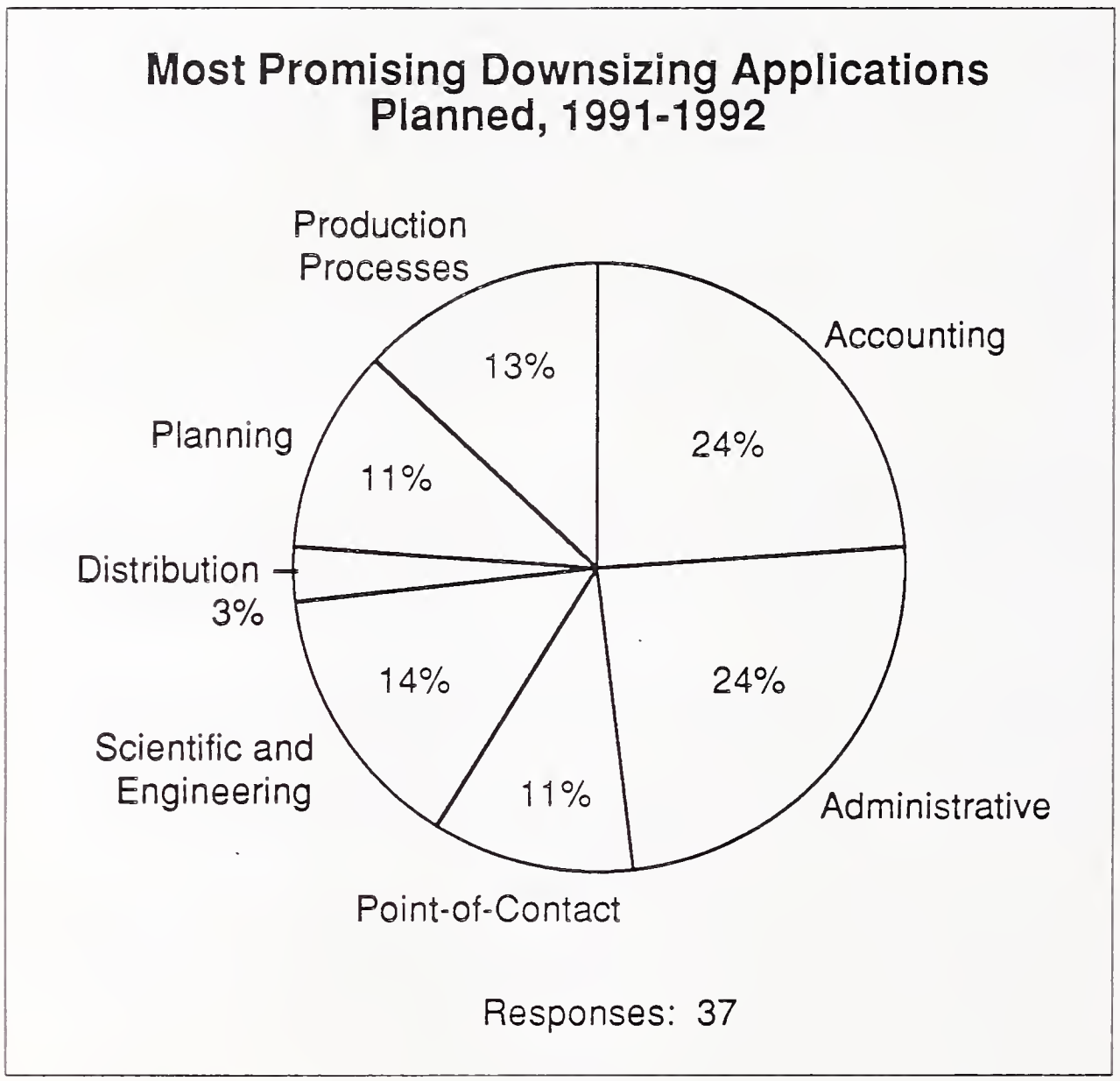
Most Promising Downsizing Applications Completed



Responses: 8

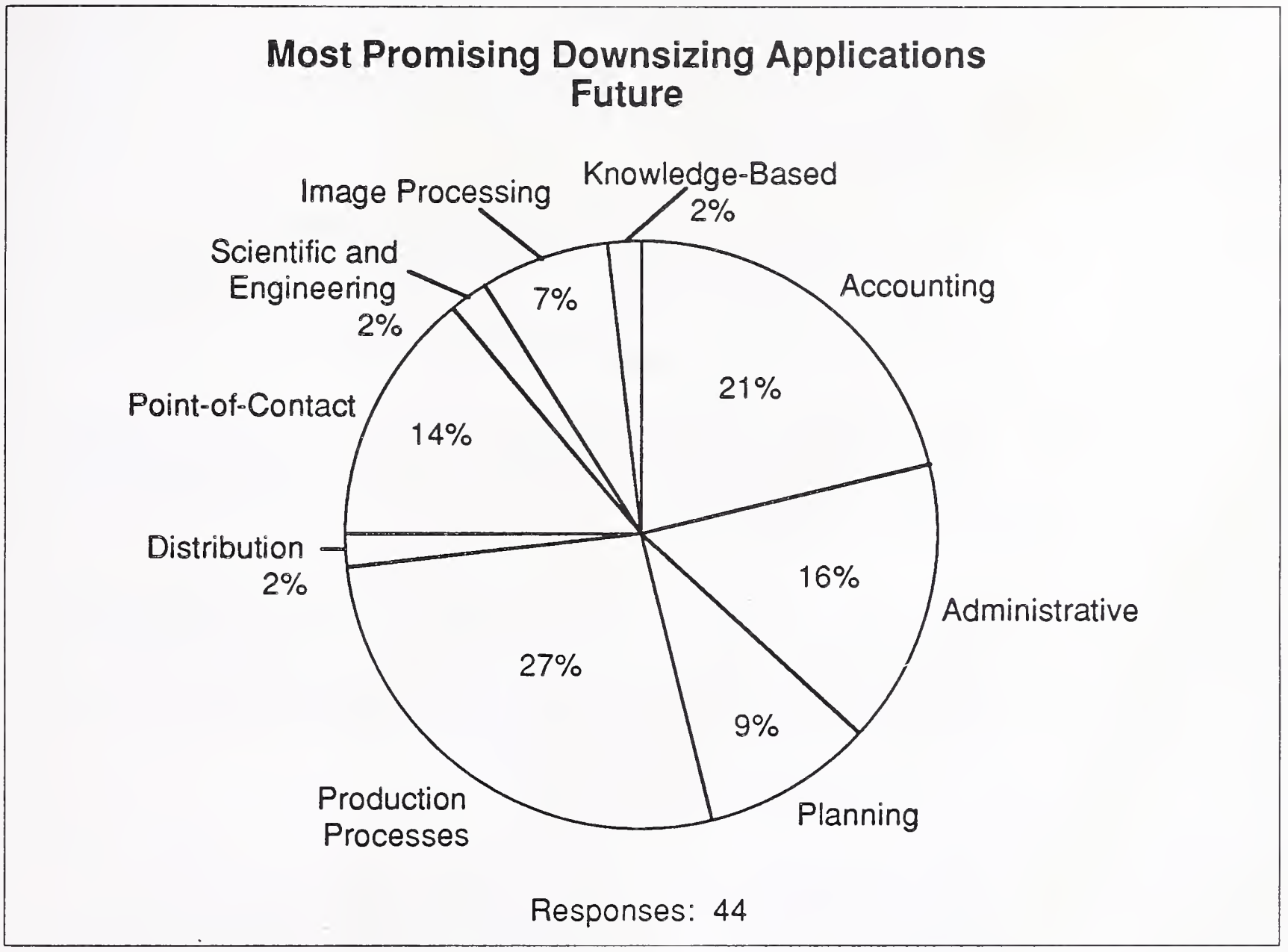
- Exhibit VI-4a shows the applications that have already been downsized. As might be expected from the earlier results, not very many downsizing projects were reported as having been completed. Only eight of the IS executives reported downsizing projects that had already been completed. These were mostly accounting and administrative applications well known to the IS department, and therefore requiring minimal effort to downsize.

EXHIBIT VI-4B



- Exhibit VI-4b presents the downsizing application projects that were planned for completion during 1991 and 1992. The thirty-seven downsizing applications under way when this research was conducted came from twenty organizations and indicates a dramatic increase in downsizing activity. The applications being downsized still tend to concentrate in the accounting and administrative areas, but the trend into other applications areas is noticeable.

EXHIBIT VI-4C



- Exhibit VI-4c displays the downsizing application projects either planned and scheduled for completion after 1992, or being considered for future implementation. Forty-four applications were listed by twenty-two IS executives and there is a noticeable increase in emphasis upon upon production processes (either factory or office) that require more careful analysis. In addition, image processing and knowledge-based systems are mentioned for the first time.

When we consider that 80% of IS respondents are planning downsizing projects, it lends credence to the anticipated shift in applications platforms presented in Exhibit V-8. The trend away from mainframes is very real across a broad applications set. It is obvious that downsizing requires a considerable systems effort that goes beyond normal maintenance (that continues to absorb a substantial portion of the IS budget). Since maintenance of existing systems is mandatory, scarce development resources must be diverted in order to pursue downsizing. Therefore, it is safe to assume that IS executives expect some payoff from this effort.

We asked them what benefits and/or consequences they anticipated as a result of their downsizing plans and the resulting innovations in their information systems infrastructure.

E

Anticipated Benefits and Consequences

Both IS and vendor respondents were asked to indicate whether they agreed or disagreed with a list of anticipated (or possible) benefits and consequences of downsizing. The percentage of respondents agreeing with the specified benefits and consequences is presented in Exhibit VI-5, and arranged in decreasing order of user agreement.

Just as with the overrated-undervalued chart (Exhibit V-1), results that fall close to 50% indicate that respondents are equally split between agreement and disagreement. Therefore, only results that deviate substantially are considered significant.

Even a perfunctory glance at the chart reveals that a much higher percentage of vendors agree on the benefits and consequences of downsizing than do IS executives. While this is understandable, major differences of opinion about benefits between IS managers and vendors indicates that some change in marketing strategy may be necessary.

1. Downsizing Benefits Expected by IS Management

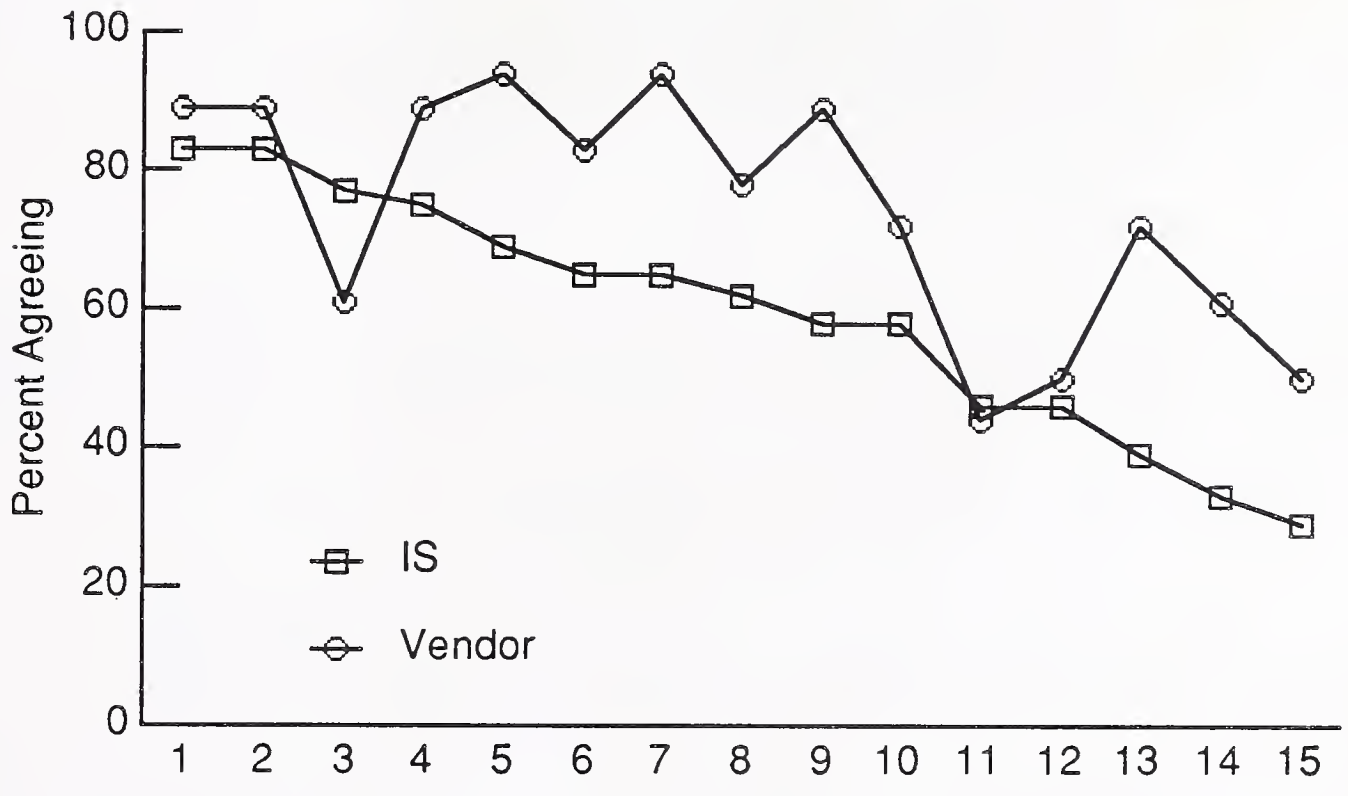
When reviewing the benefits and consequences that IS executives expect from their downsizing efforts, it is important to remember how they responded to the question concerning the factors prompting downsizing (Exhibit V-12). The three most important factors prompting downsizing were all related to cost—lower IS costs, better hardware price/performance, and reduced development costs. We do not find cost factors high on the list of benefits now anticipated by IS executives.

- The top four benefits anticipated by the IS respondents (those that 75% or more of them agree upon) are generally unrelated to cost savings (with the possible exception of faster systems development, which is always difficult to quantify). They are:

  - Improved responsiveness to user information requirements (83%)
  - Broader range of choices (products and services) (83%)
  - Faster, easier systems development (77%)
  - More effective use of information technology (75%)

EXHIBIT VI-5

Anticipated Benefits and Consequences



Key	*Benefits and Consequences*	*IS*	*Vendor*
1	Improved User Responsiveness	83	89
2	Broader Range of Choices	83	89
3	Faster Systems Development	77	61
4	More Effective Use of IT	75	89
5	Improved Process, Product, Service	69	94
6	Reduced Hardware Costs	65	83
7	Improved White-Collar Productivity	65	94
8	Role and Expense of IS Reduced	62	78
9	Better Business Planning and Decisions	58	89
10	Improved Bottom-Line Performance	58	72
11	Reduced Software Costs	46	44
12	Flatter Management Structure	46	50
13	Improved Data and Info. Quality	39	72
14	Better Management Control of IR	33	61
15	Data Base Management to Users	29	50

- Cost-related benefits fall in a second-tier range of approximately 65% to 50% agreement. In other words, while the top-rated benefits were agreed upon by a ratio of over 3 to 1, cost-related benefits are, at best, agreed upon by a ratio of 2 to 1 and then descend toward disagreement. The cost-related factors and their percents of agreement are as follows:

  - Substantially reduced hardware costs (65%)
  - Improved white-collar productivity (65%)
  - Diminished role and expense of central IS department (62%)
  - Improved bottom-line performance (58%)
  - Substantially reduced hardware costs (46%)

- Downsizing consequences that could represent important benefits to operating management seem even less likely to IS executives, although approximately 70% did agree that improved process, product, or service to customers could result. The other management consequences were:

  - Better business planning and decision making (58%)
  - Fewer levels of management (46%)
  - Improved data and management information quality (39%)
  - Better management control of information resources (33%)
  - Data management responsibility transferred to users (29%)

At the extremes of anticipated benefits and consequences, IS management respondents can be paraphrased as saying: "We will be able to be more responsive to user information requirements, but they won't ever accept (or we won't give up) responsibility for data management."

Between these extremes, they are saying that the cost savings that prompted downsizing may or may not occur; and there is a risk of deteriorating data and information quality, and loss of control over information resources.

One would almost get the impression that IS executives are being forced into downsizing by corporate executives and users if it were not for the fact that they agree IS will have an improved techological environment. The main benefit that IS managers seem to see in downsizing is that they will be able to make the right technological decisions—they are rightsizing!

2. Downsizing Benefits Expected by Vendors

Vendor expectations of the benefits of downsizing are dramatically higher than those anticipated by IS management. Since many IS respondents already have downsizing projects under way, it is probable that they are in a better position to determine the benefits that will actually accrue in their particular organizations—there are seldom pleasant surprises in systems development projects.

However, it is possible that IS does not fully appreciate the benefits that operating management may achieve from downsizing—especially when managerial and professional employees (rather than clerical) are empowered with both processing power and data. The experience with personal computers in the 1980s is not directly comparable with the downsizing of major business applications.

Nevertheless, when comparing the IS and vendor responses to specific benefits, it is difficult to escape the conclusion that vendors are generally overrating the benefits and users are generally undervaluing them.

- Vendors are in general agreement with three of the top four IS-anticipated downsizing benefits (improved user responsiveness, broader range of choices, and more effective use of information technology). The one striking exception is faster, easier systems development, where only 61% of vendors agreed with this benefit compared to 77% of users. This is the only case where vendors are less optimistic than IS about the anticipated benefits of downsizing, and it can probably be explained by the following:

  - IS sees users becoming involved in the systems development process, and this literally means that the process will be easier and faster from their perspective.

  - On the other hand, some vendors working with end users realize that downsized business applications involve increased systems analysis, "cooperation" with central IS, documentation, etc. that was never required in the good old days of whipping out numbers off a spreadsheet.

- At this point, IS responses fall below the 3 to 1 (75%) level, whereas vendor responses reach some rather lofty heights, and most of these vendor-anticipated (or promised) benefits are associated with major management concerns. "Agreement ratios" of vendor responses are as follows:

  - Improved process, product, or service for customers (over 15 to 1)

  - Substantially reduced hardware costs (approximately 5 to 1)

  - Improved white-collar productivity (over 15 to 1)

  - Diminished role and expense of central IS department (over 3 to 1)

  - Better business planning and decision making (about 8 to 1)

  - Even improved bottom-line performance is about 3 to 1.

- It is important to remember that these benefits are being attributed specifically to downsizing and not to information technology in general. If true, downsizing is going to produce benefits to management that have been promised since the early days of "electronic brains," but have yet to materialize.

- After the lofty benefits outlined above, we come back to reality with the realization that substantially reduced software costs are unlikely. Vendors stray over the "disagreement line" of 50% with only 45% agreeing that this will be a benefit, and vendor and IS responses are identical.

- There are two remaining disagreements between vendor and IS respondents concerning the benefits of downsizing, and they are both important.

  - While vendors and IS agreed that problems of data quality were the most important factor inhibiting downsizing (Exhibit V-13), they are far from agreement on whether downsizing will result in improved data and management information.

    · Vendors agreed with this statement by a ratio nearly 3 to 1 (72%).

    · IS disagreed with this statement by a ratio of nearly 2 to 1 (39%).

    · This is a serious disagreement on an extremely important factor!

  - Then there is the politically charged question of whether downsizing will result in better control of information resources.

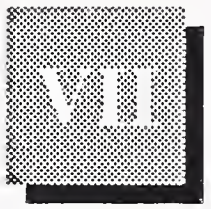
    · Vendors agreed with this statement by a ratio of 1.6 to 1 (61%).

    · IS disagreed with this statement by a ratio of approximately 2 to 1 (33%).

    · This difference of opinion depends upon whether one feels that operating management or corporate management should be controlling information resources; and this, in turn, relates to fundamental management theory concerninng centralization versus decentralization.

After reviewing all of these data, we can only conclude that there is a trend toward downsizing, and that this trend is associated with a competitive environment that is dictating new approaches to business management. Since information technology itself is changing the competitive environment, and new management philosophies require changes in the structure of information technology, it is extremely difficult to determine what is cause and what is effect.

However, in order to understand what is "going on out there," and to identify both problems and opportunities associated with the application of information technology in this environment, it is necessary to have some framework for understanding the innovation process.



A Market Analysis Framework

Downsizing by its very nature implies change, and the changes that are indicated by the research for this study are dependent upon many related networking factors that will determine the success of any downsizing effort. It is beyond the scope of this study to pursue any of these factors in detail, but their importance in the rightsizing decision process (whether downsizing or upsizing) will become apparent as we briefly review them.

A

Important Factors in Network Architectures

1. Operating Systems

The performance, functionality and quality of operating systems is a more critical factor than hardware characteristics in determining application and functional distribution over the processing hierarchy.

- To equate Windows and DOS with OS/2 EE in terms of quality of basic operating systems functions, such as memory management, would be a critical error in deciding whether to downsize major business applications. Wrapping DOS up in a pretty package doesn't ease the pain of having applications abort without explanation. The question of whether OS/2 is dead continues to be raised, and if OS/2 *is* dead, the market for downsizing critical business applications to PC LANs will be adversely impacted. (This is not intended to imply that certain applications functions cannot be distributed from host computers to PC LANs.)

- To equate UNIX with MVS/ESA in terms of quality of basic operating systems functions, such as systems administration (including security), would be a critical error of judgement when downsizing from a mainframe to a UNIX-based client/server environment on either minicomputers or RISC workstations. Here is what a respected technical journal had to say about UNIX being used "as its creators intended it to be used":

- "Such open systems cannot ever be made secure in any strong sense; that is, they are unfit for applications involving classified government information, corporate accounting, records relating to individual privacy, and the like." [25]

- The respected journal was AT&T's *Technical Journal* in 1984. Since then, the most highly publicized cases involving security violations have centered around UNIX-based systems, and even the UNIX faithful who gathered at the UNIX Expo International trade show in 1991 reportedly felt "...that UNIX by and large lacks commercial-grade features such as systems management and security." [26]

MVS/ESA requires an enormous amount of systems resources and is the primary reason the mainframe market is such an attractive target for downsizing. However, one must look closely at the deficiencies of alternative operating systems before becoming mesmerized by hardware price/performance comparisons.

2. Data Base Management Systems

Years ago, during the course of INPUT research on DBMSs, a respondent stated "IMS has eaten up more CPU cycles than even IBM could have dared to hope for...". Now IMS has evolved into the high-performance standard for transaction processing, and relational DBMSs have become IBM's standard for SAA and distributed data bases—relational DBMSs can eat up more CPU cycles than IMS even did.

It is wise to remember that IBM refused to release DB2 for years because, despite arguments to the contrary, there are inherent performance problems with the relational model that can only be mitigated by careful systems design. This is important because it raises some serious questions about the impact of downsizing. For example:

- How careful will users of downsized applications be in their requests for data that remains centralized? And what will be the impact of casual user requests that require—let's say—unrestricted JOINs against a large corporate DB2 data base? Will the 3090 mainframe be brought to its knees when receiving such requests?

- What will be the impacts on performance of the XYZ relational-like DBMS running on a RISC workstation or minicomputer as application data bases grow upwards from, for example, 100 megabytes of data? Will ad hoc reporting and queries against these data bases be responsive enough to support the needs of management? How long will it take to reorganize large data bases on these systems?

- Will the RDBMs make sequential files and other data models obsolete? Or will object management replace all data base management as we know it?

- Aren't DBMSs just an extension of basic operating systems functions? And shouldn't the two be tightly integrated, as they are under OS/400 on the AS/400?

- Since the relational model is mathematically correct, shouldn't it be "mechanized" into data base machines (servers)? At the very least, couldn't sorting be downsized from mainframes and mechanized?

3. Network Management Systems

Perhaps the most important factor determining performance at PL/1 (network performance) is the cost/performance of communications among the network levels. Trade-offs between communications cost and responsiveness will determine how data and processing should be distributed, and this in turn will determine which applications and functions should be assigned to which processing levels. IS departments will become increasingly involved with communications problems such as bandwidth and queueing problems as they consider appropriate applications and functions to downsize; and communications departments will become increasingly concerned with new forms of data (images, digitized voice, video, etc.).

As mentioned previously, the problems involved with distributed data base management will increasingly be communications problems, and problems of network management will increasingly be those associated with data base integrity, synchronization and security. (A two-phase commit presents problems that go far beyond conventional ACKing and NAKing.) This raises the following questions:

- Aren't data communications an extension of basic operating systems functions? Shouldn't they be tightly integrated within the network operating system itself?

- On the other hand (depending on where you are coming from), aren't operating systems functions just a subset of network management? And doesn't this imply that data base management and network management must become essentially indistinguishable under a "network operating management system?"

- Shouldn't all information systems (including artificial information) be viewed as just another communications problem much as Flores and Winograd propose in *Understanding Computers and Cognition: A New Foundation for Design* [27]? And, since the "new foundation for design" places emphasis upon the role of artificial systems in facilitating human acknowledgement and commitment, is not this a major consider-

ation in determining the applications and functions that can be downsized? (What processing level should be permitted to commit the institution by communicating with outside vendors, customers or competitors, and for what?)

4. Data Integrity, Synchronization and Security

Downsizing implies that the classic problems of distributed data base management (data integrity, synchronization and security) are going to increase. Although it is obvious that there are trade-offs to be made between the potential cost savings of downsizing and the increased risk of data base contamination and/or breaches of privacy and security, evaluation of these trade-offs is extremely complex.

Among the questions that must be answered in order to evaluate the trade-offs are the following:

- How secure is the target downsizing platform (hardware, software, environmental)? What are the institutional exposures for this particular application or function?

- What are the possible exposures to corporate control mechanisms? Will the data be used (and/or manipulated) for interorganizational in-fighting involving resources, power and politics?

- What is the potential exposure to litigation if breaches of privacy and security occur because employees are being "empowered" at lower levels in the organization? And, how many potential law suits can the advantages of downsizing support (if this is, in fact, an exposure)?

- Will there be organizational changes accompanying downsizing that will increase the reliance upon artificial information because levels of management have been removed? And, will the quality of knowledge deteriorate in the new environment (remember, knowledge becomes data and must be managed by the system)?

5. Information Entropy

As more people are empowered with data through downsizing (and we assume that this is a factor in the struggle between users and the corporate IS function), it is probable that information entropy will increase. This manifests itself when the volume of information increases more rapidly than the value of the content—either because redundancy increases more rapidly than new information, or because conflicting information increases.

- Will the increased computer power and human effort necessary to maintain order among the new information flows within the organization more than offset the cost savings from downsizing? Or, more important, will the decision making process itself be impaired by increased information entropy?

- How will these new information flows impact organizational structures? Will these new structures (presumably with broader span of control) become less "formal" and how will that be accepted by management schooled in traditional organizational theory?

- How will the artificial information associated with downsizing impact the traditional views of artificial intelligence—the symbol manipulation tradition and the neural networks tradition? Specifically, just how important is increased entropy when:

  - The main problem associated with the symbol manipulation tradition is the formalization of the right way to deal with external entropy;

  - And the neural network tradition considers randomness a source of order? [28]

- What, indeed, will be the impact of downsizing and changing information flows at performance levels 3 and 4? (Exhibit III-1). We didn't ask this question before personal computers were installed in the 1980s, and there are now those who feel that the impact at both the work unit and institutional levels may have been negative.

6. Devaluation of Humans?

Assuming that downsizing, and the integration of information and knowledge with data during the 1990s, will actually improve performance at all levels (PL/1 through PL/4), there are still human, economic and social factors that must be considered. In fact, as more computer power is pushed into the workplace, and people deal more with machines than they do with other people, the whole nature of work changes. Prudent management is beginning to question the potential consequences of information technology.

Some of the more difficult questions have been raised since the earliest days of computers.

- Will the 1990s see the devaluation of human brains as feared by Norbert Wiener (the father of cybernetics)? [29] And, what kinds of brains—clerical, professional, management—will be devalued and by how much?

- Do people want to be empowered? Or, do they just want to work in a clearly defined job without the pressure of electronic monitoring of their performance down to every click of a mouse and every key stroke?

- Will there be increased resistance to the advance of technology? Will "playful" hackers evolve into modern day Luddites to destroy our networks, just as their predecessors tried to cripple the machines of the industrial revolution?

- Will empowerment result in peer pressure to avoid "intellectual rate busting" as documented by Shoshana Zuboff in *In the Age of the Smart Machine—The Future of Power and Work*? [30] Will this create an ever-widening split between the executive level and the operator at the human/machine dyad?

Though it is doubtful that IS executives are currently connecting all of these complex issues with downsizing, it is inevitable that they will surface as planning and implementation of downsizing progresses. Downsizing implies more than rolling out one box and rolling another one in—it implies fundamental changes in the information infrastructure, organization, working environment, and the management mind-set.

The 1990s is going to be the decade of innovation!

For over 15 years, INPUT has emphasized the need to take a more holistic view of computer networks. There is now growing awareness that, as we enter the 1990s, we remain largely ignorant of what all the talk about "information architectures" and "infrastructures" really means. The need to understand the artificial has been rather neatly summed up by Massimo Negrotti (Professor, Director, Institute of Methodology and Economic Statistics, University of Urbino):

"In addition, we have begun very recently, due to natural and unpredictable adjustments or abnormal events, to investigate the relations between the technological environment and the natural one. But while we know enough to be able to build particular classes of technological devices very effectively indeed, we lack a body of organized knowledge about the whole technological system we have built up around us (and in some cases within us). On the one hand we know almost all the rules (for instance physical rules) for designing and building different machines but we lack any systematic knowledge on the relations among them and, furthermore, between them and humans. Whatever we call it: "Technological Environment" or "Cybernetic Society", the new environment seems to be largely unknown in concrete terms." [28]

What this means in the real-world business environment is that the information systems infrastructure may dictate the ways companies actually operate; and as machines get more "intelligent" they may assume a life of their own and artificial information will come to dominate that created by humans.

The highly centralizing information systems infrastructure that continues to dominate commercial data processing has supported the traditional management practices of hierarchical organization, centralized planning, and cost control. What will happen when egalitarian empowerment of employees with computer power and data actually occurs? To say that we "lack any systematic knowledge" on relations among networked computers and the humans who use them is rather scary, but it seems apparent that the respondents to our study are going to find out.

It is our belief that humans are beginning to question, as never before, what the application of the new machines is going to mean to them and their organizations. There is less inclination to chase after the latest information technology, and more reluctance to (or fear of) change. Whether considering SAA, or downsizing to a client/server architecture featuring RISC workstations, users are being asked to make major changes in the way they do business.

It is becoming increasingly important to understand (and/or anticipate) the human element in the adoption of, and adaptation to, the changing technological environment because the pace of technological innovation continues to accelerate.

B

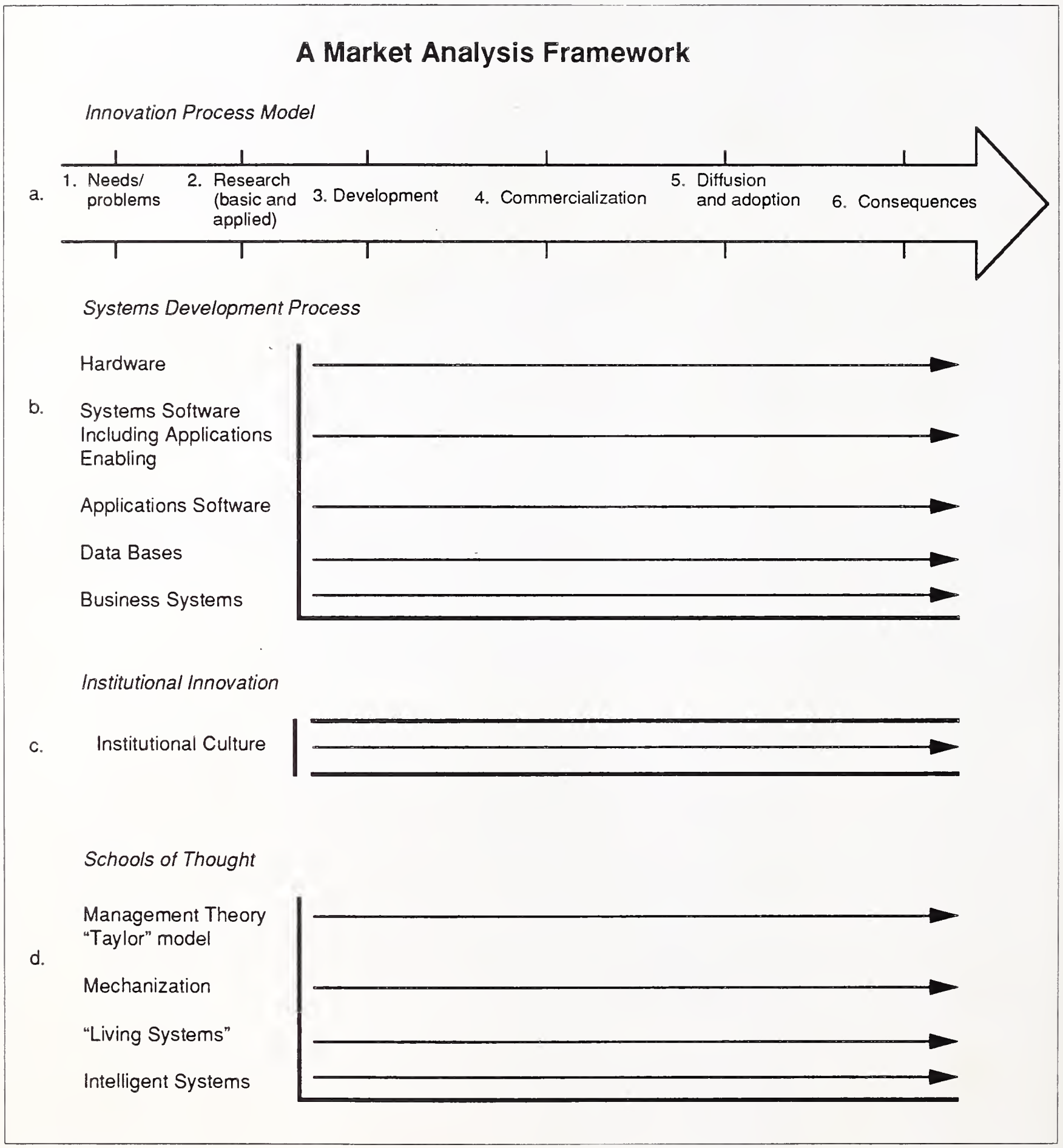
An Innovation Model

The innovation process—whether for a new type of hybrid corn or the latest reduced instruction set computer—has been studied for decades. Some relatively understandable models of the process have been developed, but they have limited value when applied to the diffusion of specific information technology products and services. This is true because information technology itself is the major driving force in innovation in business, government and the professions. This results in exceptionally complex layers of innovation that will determine the rate of diffusion (adoption) of specific new technological developments in information technology itself.

All of this means that market forecasting for new computer products, services and concepts is extremely difficult. It is important to have a framework for understanding these interrelated innovation processes in order to set the framework for any meaningful market analysis. Though it

is beyond the scope of this study to pursue such analysis in any detail, the framework we shall employ is depicted in Exhibit VII-1, and our general comments are as follows:

EXHIBIT VII-1



- Exhibit VII-1a is a general model of the innovation development process used by Everett M. Rogers in his landmark study on the diffusion of innovations. [9] While Rogers qualifies the model by saying the phases are somewhat arbitrary, do not always occur exactly in order, and may be omitted for certain innovations, they certainly seem appropriate for most information systems development projects with which we are familiar. However, we would make the following observations about the model as it applies specifically to information technology:

  - Unlike many other innovations, information technology has the perplexing characteristic of having negative consequences that only additional innovation in information technology can alleviate. For example, during the 1980s the production of paper documents was automated using word processing and desktop publishing, creating a paper glut that can only be alleviated by information technology (image processing).

  - In other words, the information age tends to feed on itself; the consequences in Phase #6 become the "needs/problems" of Phases #1, and represent a new "opportunity" for additional innovation.

  - It is important to anticipate consequences, not only to identify new opportunities, but also because unanticipated consequences can slow (or halt) the diffusion of current technologies.

- Exhibit VII-1b shows the familiar layered elements of the information systems development process with which we are all familiar. Despite years of experience with the problems associated with asynchronous development cycles across these layers, the rate of diffusion at one level always seems to come as a "surprise" for the next level. For example:

  - Hardware is normally developed first and is greeted with appropriate awe. (Just imagine, I have more processing power in my briefcase than was required to develop the atomic bomb.)

  - Frequently, systems software has to catch up with the hardware and this is greeted with appropriate frustration. (What is the use of having all this memory if I can't use it?)

  - After selecting and installing an impressive array of hardware and systems software the reality of applications development is sometimes greeted with a sense of utter amazement. (Do you mean that after buying all these high-tech "solutions" I actually have to think about what I really want my computer do for me?)

- Finally, after going through the entire "waterfall model" of the systems development process for an executive information system, and after having gotten all the hardware and software in place including an idiot-proof, multimedia, executive workstation that can read the mail, take dictation, make coffee, and hold intelligent conversations with Wall Street analysts; then, and only then, is the horrible fact discovered that the availability and quality of data won't even support an accounts receivable system, much less the new knowledge-based decision support system. (Who is going to do all the dirty detail work necessary to ensure that the data bases don't become contaminated, now that we have fired all the data base administrators and data entry people?)

- Then even if the hardware, software and data associated with the new system are all perfect, it must be integrated with existing internal and external systems of varying quality—all of which have the potential of adversely impacting the quality (or even viability) of the new system in unpredictable ways. (Do you mean our best customer refuses to use our on-line order entry system because they don't like our new telephone system?)

- Vendors and users alike are confronted with horrendous planning problems as the benefits and consequences of innovations at various levels trickle down the systems development process. Downsizing opens up an especially difficult set of questions at each level.

  - What is the proper hardware platform? Will it be rendered obsolete by new technology before downsizing benefits are realized?

  - What systems software will be used? UNIX? Windows? OS/2 EE? OS/400? DBMS? Language(s)? CASE tools?

  - Which applications will be downsized and how?

  - Can data base integrity, synchronization and security be maintained in the downsized environment?

  - What open and proprietary systems must the downsized application(s) be integrated with?

  - Is it all worth it?

- Exhibit VII-1c lists institutional (organizational) culture as being a significant factor in regulating the adoption of information technology. The fact that it is merely listed on a single line is not meant to downgrade its importance. In fact, we are inclined to agree with Edgar H. Schein, Sloan Fellows Professor of Management at MIT, when he states (*Organizational Culture and Leadership*; Jossey-Bass Publishers, 1988):

"If there is to be a single conclusion drawn from this intellectual journey through parts of organization theory, social psychology, and anthropology, it is that leadership and culture management are so central to understanding organizations and making them effective that we cannot afford to be complacent about either one." [11]

Schein includes a comprehensive outline of "Growth Stages, Functions of Culture, and Mechanisms of Change" in his book that provides a framework for analysis of the changes that have occurred, and are occurring, in various companies in the information technology industry. However, our purpose here is to discuss one specific change mechanism mentioned in the outline—that of "technological seduction."

- Schein makes the following points concerning "technological seduction" [11]:

  - "At one extreme...the diffusion of technological innovation and various forms of acculturation...have subtly changed entire cultures."

  - "At the other extreme, it includes the deliberate, managed introduction of specific technologies for the sake of seducing organization members into new behavior, which will, in turn, require them to reexamine their present culture and possibly adopt new values, beliefs, and assumptions."

  - "The current practice of introducing personal computers to several layers of management and the mandatory attendance at training courses may be intended to serve a similar unifying function. Senior management sees too much diversity in the assumptions governing management decisions and brings this issue into the open by introducing a technology that forces decision-making premises and styles into consciousness. Some managers also see in the technology the opportunity to impose the assumptions that underlie the new technology itself, such as the importance of precision, measurement, quantification, model building, and so on, in which case we may be talking more about coercive persuasion following the seduction process, but in many cases the seduction is designed simply to surface the cultural diversity so that it can be addressed."

- It is probable that some of the early advocates of personal computers—whose purpose was "power to the people"—would consider "seduction" by management to be harassment. However, there are two important points to be made about management's role in the diffusion of innovative information technology:

- The consequences of the introduction of new information technology on organizational culture will be highly unpredictable, but

- Management's view of the role of information systems will play an important role in determining the structure of the information systems infrastructure and market.

- Exhibit VII-1d lists four schools of thought that have been identified in making effective use of information technology in business systems. [12]

  - The Management Theory School is an outgrowth of industrial engineering and cost accounting, which emphasize work measurement and simplification, cost-cutting, hierarchical management and control. The Japanese refer to it as the "Taylor Model" after Frederick Taylor, who did much of the early industrial engineering work early in this century. This school of thought is still alive and well, and we see it reflected in heavy emphasis on financial management and the power of the corporate controller. Most current business systems have been developed based on this school of thought by management whose mind-set remains firmly rooted in the Taylor model.

  - The Mechanization School was prompted by early enthusiasm for computer hardware and the tools of operations research, cybernetics, and normative decision theory. Mechanization is based on the premise that algorithms can be developed that will permit automatic scheduling of processes and events. After a flurry of enthusiasm in the 1950s and 1960s (and considerable progress in specific areas such as production scheduling and inventory control), it was determined that management decisions of a more general nature could not be "programmed", and this school of thought has tended to be ignored by developers of most business applications.

  - The "Living Systems" School is based on the social and systems sciences (including GST) that developed in parallel with computer technology in the 1950s and 1960s. It was predicated on the assumption that human and economic behavior could be modeled and predicted if we only had enough data and computer power. In the 1970s, it led to centralized corporate planning functions and the sale of a lot of computer equipment, but the models and forecasts never lived up to expectations. There is now a trend toward downsizing centralized planning functions and "empowering" lower levels within the organization, but this seems born more out of frustration with central planning departments than with increased enthusiasm for the new technology.

- The Intelligent Systems School is based on a broad interdisciplinary foundation with the primary direction coming from artificial intelligence (in its broadest definition) and the decision sciences. Conceptually, substantial progress has been made over the years, but outrageous claims and heated controversy on the outer limits have detracted from that progress. Whereas the Mechanization School breaks sharply along the line of whether decisions are programmable or non-programmable, the Intelligent System School begins to address the "maybe" situations based on the concept of a bounded rationality that does not demand an optimal solution. While expert, or knowledge-based, systems received considerable attention during the 1980s, the impact on management and the professions in any but the narrowest of domains has been minimal.

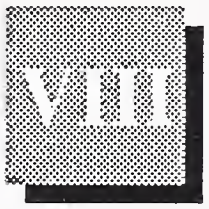
Management mind-set concerning information technology will determine the rate of diffusion of new information technology within the organization. These innovations will, in turn, impact management style and organization in unpredictable ways that may or may not change management mind-set. At the present time, the following general observations may be made about management mind-set:

- There continues to be dissatisfaction with the performance of the IS department in implementing new applications systems. To the degree that downsizing removes responsibility for systems development from a central systems function to operating entities, it will be favorably received by management.

- Many senior executives have been disappointed with the investment in computer technology since it is not perceived as having improved either productivity or institutional performance. It will be difficult to increase investment in information systems technology without quantitative evidence that it improves institutional performance, and downsizing will only be encouraged to the degree that it reduces information systems expense.

- The personal computer revolution has caused management to take a very narrow view of the capabilities and potential of computer technology—a view that tends to reinforce the mind-set of the Management Theory School of Thought. Information technology has been the corporate controller's source of power, and to the degree that downsizing threatens to diminish this centralized control it will be resisted strenuously from a position of great strength—that of "owning" the corporate data bases.

Therefore, it would be understandable if management had ambivalent feelings about downsizing, and our research results tend to support the fact that it does. Those ambivalent feelings exist because of uncertainty about the complex technologies that are being employed, and also because there is beginning to be a major shift in management thinking.



Conclusions and Recommendations

As we attempted to put downsizing into perspective, many conclusions (and opinions) concerning the research results, current computer/communication networking technologies, and the downsizing market environment were included in the body of the report. We shall now summarize and refine those conclusions. For this purpose, the market analysis framework (Exhibit VII-1) presented in the previous chapter will be used.

A

Summary of Conclusions

- All of the research for this study points to the fact that downsizing is currently the predominant trend in a rapidly changing information systems infrastructure. Both IS and vendor responses strongly support this conclusion by clearly indicating a diminished role for mainframes, and IS is strongly of the opinion that the primary factors prompting downsizing are associated with cost reduction (Exhibit V-12). Desk research indicates the current emphasis upon downsizing is long overdue at the mainframe level, where more cost-effective hardware technologies have been available for two decades.

- Despite the predominance of downsizing, it is important to understand that the rapid diffusion of personal computer technology into the business environment during the 1980s could also be properly described as downsizing and that when viewed from the "bottom up" there is now a parallel trend toward "upsizing." This is clearly mainfested by the necessity to integrate intelligent workstations in either client/server or cooperative processing architectures. This upsizing (or data dependency) of workstations was clearly demonstrated by IS and vendor responses to the question concerning anticipated infrastructure changes during the 1990s (Exhibits VI-3d and f).

- The combination of downsizing from mainframes and upsizing from relatively independent IWSs to more complex network architectures means that the role of minicomputers (by INPUT's definition) should become more, and not less, important during the 1990s (see Exhibit VIII-1). This has resulted in a "technological battle zone" around the $20,000 level as minicomputers, RISC workstations and PCs fight over the data server turf. This war has the following characteristics:

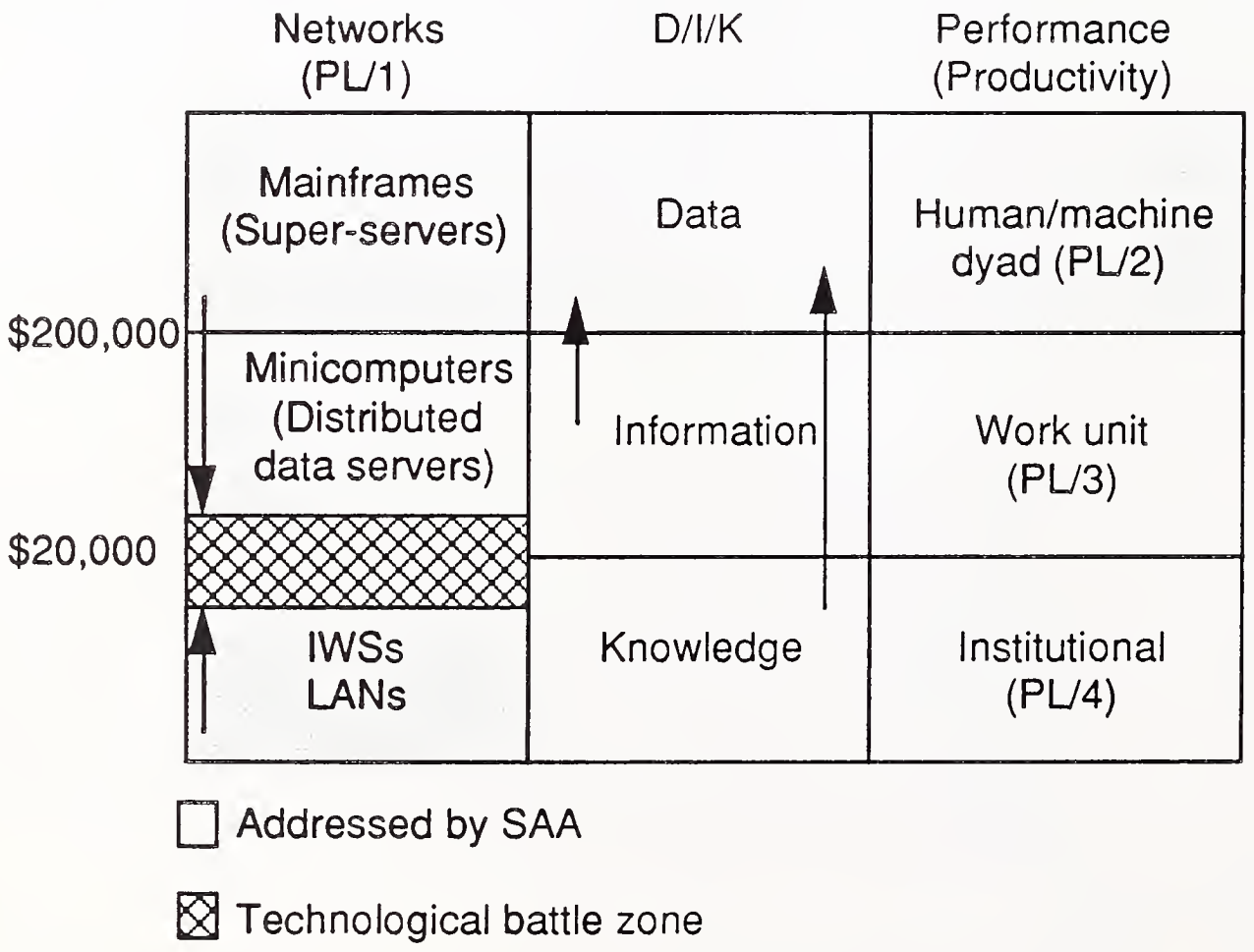
  - IS management feels that minicomputers are the best platform for distributed data base servers (Exhibit V-3), but vendors feel it should be a RISC workstation/server (Exhibit V-6).

  - Hardware price/performance (MIPS) is the primary weapon being used to wage this war, and there have already been a lot of casualties as computer processing power becomes a commodity.

  - Before this war is over practically all participants will agree with William Tecumseh Sherman that "War is hell."

EXHIBIT VIII-1

Trends of the 1990s



- It is important to understand that downsizing is only one aspect of "rightsizing" and that price/performance of hardware is only one criterion for determining whether downsizing will be effective and how rapidly it will occur. When raw price/performance can be readily translated into cost savings, downsizing will occur rapidly. (It was not necessary to have national conferences or major research efforts to determine that word processing and publishing applications should be downsized to personal computers, or that CAD applications should be downsized to RISC workstations.)

- There are a multitude of reasons that mainframe commercial data processing applications have been so resistant to downsizing in the past. These are related to the fact that new hardware technology must go through the multilayered systems development process depicted in Exhibit VII-1b in order to become integrated within the existing information systems infrastructure. Since innovations at each level of the systems development process must go through the entire innovation process model (Exhibit VII-1a), and each of the development layers poses a formidable hurdle to new technologies, it is necessary to replace installed mainframe applications. Consider where the following key downsizing components stand in relation to the innovation process.

  - UNIX was not designed for the business environment and competing organizations (and numerous alliances) are currently working against each other in the first three phases of the innovation process (needs analysis, research, and development). Despite the fact that UNIX is being heavily promoted in the commercial market, diffusion for business applications has not been great; and adverse consequences are indicated in specific areas such as security and systems administration.

  - The enormous "investment" in COBOL applications and the continuing effort required to maintain these programs represents a substantial obstacle to conversion to other languages (i.e. C+...) or implementation using PC applications development tools (spreadsheets, DBMSs, etc.). Despite claims to the contrary, CASE does not present an easy or effective way to convert these applications to new hardware/software environments, and re-engineering remains expensive even though it has the potential for significant application improvement with or without downsizing.

  - Data bases, upon which commercial applications are based, have been developed using mainframe systems software and applications enabling tools (DBMSs). Mainframes have literally become large data base machines and the total conversion of these data bases to another hardware/software platform, or to a distributed environment, is indeed

a daunting task beyond the capability of current technology. File transfer systems present problems of data base integrity, synchronization and security that have been identified as primary factors inhibiting downsizing (Exhibit V-13).

- Data and information flow associated with existing business systems is generally toward the highly centralized mainframe hosts where the data bases are maintained and managed. These centralized data bases are a source of power for both the IS department and corporate management. This centralization has traditionally provided focus for IBM account control, but downsizing threatens to disrupt not only current data and information flows, but longstanding IS management styles and relationships.

- The current information systems infrastructure and its associated data and information flow, combined with the slow pace of innovation in the layered systems development process, has resulted in a "trickle down" distribution of the benefits of new information technology to end users.

- The inherent strength of mainframe-based business systems to resist downsizing is confirmed by respondents who rate mainframes best for commercial applications, vendor support, hardware/software architecture and reliability, data base and network management facilities, applications software availability, security and connectivity—practically everything important to IS professionals (Exhibit V-4). Balanced against this imposing array of traditional IS values is the fact that mainframes are complex, expensive and difficult to use. Well into the 1980s, corporate management was generally willing to pay a premium price for what were perceived as high-quality products.

- Now, despite the formidable technical and management obstacles downsizing is facing, our research indicates it is proceeding with surprising scope and speed. IS respondents have specific plans to downsize a wide variety of applications (Exhibit VI-4) and are proceeding despite the fact that many do not now anticipate the hardware/software cost savings that supposedly prompted the downsizing efforts originally (Exhibit VI-5).

- It seems apparent that there has been a major change in the institutional culture in many companies. The selection, use, and architecture of information technology is no longer being left to the central IS department with the support of the corporate controller and planning functions. It is our belief that this change has occurred because the very usefulness of large corporate data bases and central planning is being called into question by companies that have not been able to indentify tangible benefits despite enormous past investments in mainframe information technology. The "trickle down" theory just doesn't seem to be working.

- Though many IS departments do not believe that downsizing will help in vital areas such as "improved process, product or service to customers," "improved white-collar productivity," "improved data and management information quality," and "better business planning and decision making," vendors enthusiastically support these as anticipated benefits (Exhibit VI-5). This is an important dichotomy of opinion, and from it we can conclude the following:

  - IS departments still have a "trickle down" mind-set, but are also especially sensitive to the very real problems associated with distributed data base management.

  - Vendors are more in touch with the requirements of end users, their need for information and data access, and their ability to make effective use of information technology through the use of improved implementation tools.

  - Since most IS departments do not anticipate that end users will have responsibility for data quality (Exhibit VI-1), the key factor in determining the effective (and timely) implementation of downsizing will be distributed data base management.

  - Vendors and users are either relying upon IS to maintain data quality or do not understand the problems of distributed data base management.

  - IS, on the other hand, seems to doubt that end users will be able to make effective use of information technology—an attitude born of the fact that IS is accustomed to dealing with the complexity of mainframe computers and demonstrating the fact that the IS department has, all too frequently, been isolated from the operational aspects of the organizations it is supposed to serve.

  - The fact that downsizing is occurring, even though it requires a major change in organizational culture, indicates that IS may also be insensitive to shifts in management mind-set concerning the role of information technology.

  - Executive management seems to agree with vendors and end users that downsizing information technology and decentralization are necessary to remain competitive in an increasingly competitive world market.

- The experience of the 1980s has convinced enlightened management that centralized planning and tight financial control as epitomized by the Management Theory School of Thought just doesn't work in today's environment. This has the following ramifications in terms of the other schools of thought and downsizing:

- Mechanization of function within the information systems infrastructure, as close to the information source as possible, is necessary. Downsizing is required whether this mechanization consists of building intelligence into a scanner, eliminating paper from the workplace, or capturing specific human knowledge at the workstation level (Exhibit VIII-1).

- The "Living Systems" School of Thought recognizes that humans in an information network are not interchangeable parts whose functions can be exactly prescribed from above. Current management thinking is to empower humans with information so they can contribute to the success of the organization. In the case of information workers, this implies ready access to both information technology and data.

- The Intelligent Systems School of Thought believes that artificial systems can be substituted for a substantial portion of what human beings are doing in the business environment. Difficulties arise in determining exactly what knowledge workers do and how they do it. By empowering humans with information technology, and differentiating at the human-machine dyad, machines will become more intelligent as humans use them. In addition, the machine can "observe" what the human is doing and capture individual knowledge at its source.

  - It is beyond the scope of this study to describe these management schools of thought in any detail (much less analyze their social, economic or human implications). However, it seems obvious that downsizing information technology is the key to implementing the integration of information and knowledge with data (Exhibit VIII-1); and this integration is necessary to support the new management concepts that are evolving.

  - It is also obvious that the capture and integration of information and knowledge as close to its source as possible increases both the importance and difficulty of distributed data base management.

- Proprietary systems, and especially IBM mainframe systems, currently have control of most business data. Downsized systems must coexist and "cooperate" in this environment. SAA is IBM's architecture for downsizing (or rightsizing), and the AS/400 is the designated platform for distributing data bases. Therefore, it becomes extremely important for both IS and vendors to understand SAA and the AS/400, even if both are considered "overrated" (Exhibit V-1).

- SAA addresses performance at two levels: hardware/software (PL/1) and the human/machine dyad (PL/2), and it is also IBM's solution to the problems of distributed data base management. It does not specifically address productivity at the work unit level (PL/3) or institutional performance (PL/4), which are the most important concerns of management (Exhibit VIII-1). This leads us to the following conclusions:

  - Mainframe hardware/software technologies are lumbering along the timelines of the systems development process (Exhibit VII-1), always playing catch-up with current business systems requirements.

  - IWSs are still trying to penetrate the various levels of the systems development process without adequate systems software, applications software or the data they need to be successful for critical business systems.

  - The AS/400 has dropped straight through the systems development process to the "bottom-line" business applications where it is beginning to address PL/3 and PL/4.

  - It is necessary to recognize and understand the success of the AS/400, not only because it competes with other downsizing platforms (and IBM mainframes), but because it could also be the key to successful downsizing of mainframe applications and distributed data base management.

  - If SAA and the AS/400 present some solutions to problems that may inhibit the advance of downsizing such as distributed data base management, competitors should not hesitate to take advantage of those solutions. The really high payoff for both customers and vendors is in facilitating the integration of information and knowledge with existing data through re-engineered applications that support the advanced schools of management thought, thereby improving performance at PL/3 and PL/4. Those squares on the information technology chess board remain wide open.

- The AS/400 appears to be the logical platform to integrate the proprietary (IBM) and open systems worlds in the downsizing environment of the 1990s. Not only will the AS/400 eventually play an important role in IBM's downsizing strategy, but it could serve as a convenient conduit for downsizing mainframe data bases for the open systems world (see Exhibit IV-1) Unfortunately, it is currently being largely ignored by IS management in large companies, competitive vendors, and even "competing" areas within IBM.

- It will not be possible to ignore the AS/400 as downsizing proceeds in the 1990s. It will present a challenge to technologies competing against it, and an opportunity for those that elect to take advantage of it.

B

Recommendations for IS Executives

- Understand the real motivation for downsizing in your company.
  - If the primary factor prompting downsizing is cost savings, be sure those objectives can be achieved through reduced mainframe costs. This can only be done with a thorough understanding of the strengths and weaknesses of the target hardware/software platforms and their associated operating costs. Be sure you understand your alternatives.
  - If the primary motivation is more effective use of information technology in furthering broader management objectives, be open-minded in the analysis of these objectives, and accept the fact that the role of IS could change significantly.
  - It is our belief that downsizing has the potential to favorably impact all four performance levels (Exhibit VIII-1), and that is probably what management has in mind. If so, you are confronted with a major opportunity and challenge. Be prepared to take advantage of this opportunity and accept this challenge.
- Be sensitive to any shift in the schools of thought about the role of information systems—either positive or negative. It is extremely important for IS to provide the leadership in defining both the capabilities and limitations of information technology and the possible impacts that changes in the information systems infrastructure may have on the way the organization is managed.
- Understand both the potential and limitations of new downsizing technologies—especially systems software—and provide advice and counsel to both management and users on these technologies. Give special attention to the frequently neglected area of standards as they apply to the current controversy surrounding proprietary and open systems. The stage is set for chaos if downsizing plans neglect this important area.
- Avoid adopting (or permitting) innovations in the information systems infrastructure just to prove they won't work. IS will be held responsible for failure regardless of who had the bright idea.
- Take the time (and opportunity) to re-engineer applications before they are downsized, and select the methodology to be employed carefully. The re-engineering effort will frequently be more beneficial to the organization than will any potential cost savings from new hardware.

- Approach downsizing in the broader context of data, information and knowledge integration, and their flow within the organization. Design an information systems infrastructure based on information flow rather than on the hardware components. The push to downsize provides an excellent opportunity to take a broader view of information systems that includes manual (paper-based) systems and the human element (knowledge-based systems).

- Accept a role that will essentially be one of quality control through the effective management of data, information and knowledge within your organization. Though this has frequently been a thankless role in the past, it is necessary; and, properly performed, will be appropriately recognized and rewarded by management sensitive to the more advanced schools of thought.

- Concentrate on the consequences of the innovations that are occurring in both technology and management as the result of downsizing. Rather than reacting or "proacting"—think! The changes occurring in the 1990s are going to be vital to the success of your company and your career. Vendors and consultants may be able to stimulate your thinking, but only you have the specific knowledge to make practical application of rapidly changing information technology.

- Be prepared to live in a rapidly changing technological environment that will be split between the proprietary and "open systems" worlds. Regardless of which world you currently inhabit or which you would prefer to live in in the future, both are going to be real in the technological environment of the 1990s. Concentrate on the tight integration of these two worlds through effective sharing and management of data, regardless of your personal biases or those of your preferred vendor(s).

C

Recommendations for Vendors

- Approach downsizing in the commercial environment from the perpective of facilitating innovative management and improving work unit productivity (PL/3) and institutional performance (PL/4) rather than on the basis of raw hardware price/performance.

- Understand the importance of the total information systems development process and how your product and/or service can be integrated in improving that process. Be sensitive to, and objective about, both the potential and limitations of downsizing technologies—especially systems software.

- Recognize that "rightsizing" is the goal of customers, and that a "proper" hierarchy does, in fact, exist. Do not force downsizing either prematurely or improperly into the information systems infrastructure; adverse consequences can only slow diffusion or adoption in the commercial marketplace.

- Do not underestimate the problems associated with distributed data base management and the importance of data quality in effective downsizing of either applications or functions.

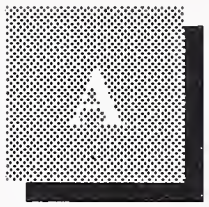
- Concentrate on the improvement of existing business processes at the work unit level (PL/3) by encouraging re-engineering of existing applications during the downsizing process.

- Understand the importance of the various schools of thought concerning the role of information systems, and emphasize the key role of downsizing in achieving the goals of the "Living Systems" and Intelligent Systems Schools of Thought. Establish the relationship between these schools of thought in improving institutional performance (PL/4).

- Recognize the realities of the "bi-polar" world that is evolving between SAA (or other proprietary systems) and open systems; and the necessity that those worlds be integrated. To the degree that SAA may establish certain de facto standards (such as SQL) or solve certain problems such as distributed data base management in a heterogeneous environment, take advantage of SAA.

- Recognize that high-performance hardware and development tools alone are not "solutions" to problems in the commercial world. Be prepared to demonstrate to customers that your products or services can really assist in the total systems development process. In order to do this, it is necessary to have both general and specific business knowledge.

- Remember that quality in terms of reliability, availability and serviceability are essential in the commercial environment. Business users do not take kindly to unrecoverable systems errors.



Information Systems Questionnaire: Downsizing, Upsizing, and Rightsizing

Note: The following questionnaire was used to interview users about downsizing. The questionnaire for vendors contains essentially identical questions.

INPUT is conducting extensive research to determine current trends in the distribution of processing, data, and applications over hierarchical networks of computer systems. This questionnaire should be completed by the corporate function (or individual) responsible for planning information systems architectures for the 1990s.

Your answers to these questions, combined with other research currently being conducted, will provide information concerning these architectural trends and knowledge pertaining to the driving forces behind them. In appreciation for your participation, we have included a research bulletin on the downsizing issue. Please mail your completed questionnaire by August 26, 1991 to: Doug Tayler, INPUT, 1280 Villa Street, Mountain View, CA 94041.

To receive a summary of the survey's findings, please provide your name and address. No salesperson will call you and your responses to the survey will be kept in strict confidence.

Name: _____ Title: _____
Company: _____
Address: _____
City: _____ State: _____ ZIP: _____
Phone: _____

Thank You,
Douglas H. Tayler
Vice President, Research

Demographics

1a. What is your position/title? _____

1b. Which of the following describes your information systems organization?
____ Corporate IS ____ Division IS

2. In which of the following industries is your organization?

___ Discrete Manufacturing
___ Process Manufacturing
___ Transportation
___ Utilities
___ Telecommunications
___ Retail Distribution
___ Wholesale Distribution
___ Other (Specify)

___ Insurance
___ Medical
___ Education
___ Services
___ Federal Government
___ State & Local Gov't
___ Banking & Finance

3. What is the revenue of your organization?

a. Revenue
___ Over $10 Billion
___ Over $1 Billion
___ Over $500 Million
___ Over $100 Million
___ Over $50 Million
___ Under $50 Million

b. Number of Employees
___ Over 10,000
___ Over 5,000
___ Over 1,000
___ Over 500
___ Under 500

4. What is the size of your organization's information systems expenditures?

___ Over $500 Million ___ Over $100 Million ___ Over $50 Million
___ Over $10 Million ___ Over $5 Million ___ Under $5 Million

5. From its inception, the computer industry has been subject to continuing cycles of first *overrating* the importance of innovative developments; and then, when they do not meet our expectations, *undervaluing* them. This profound observation was made by Lady Lovelace concerning Babbage's analytical engine over 150 years ago, and "overrating-undervaluing cycles" can be identified for practically every information technology development since that time.

What is your opinion of the current status of the following technologies and concepts? (Indicate with a ✓).

Technologies	Overrated	Undervalued
A. Reduced Instruction Set Computers (RISC)	_____	_____
B. UNIX operating systems	_____	_____
C. CASE/Re-engineering	_____	_____
D. IBM's Systems Applications Architecture (SAA)	_____	_____
E. LAN-based relational data base management systems (RDBMS)	_____	_____
F. Image processing systems	_____	_____
G. Artificial intelligence (AI) and expert systems	_____	_____
H. Fourth-generation languages (4GLs)	_____	_____
I. IBM's AS/400	_____	_____
J. Voice recognition	_____	_____
K. Pen-based systems	_____	_____
L. Personal computer productivity tools and solutions	_____	_____

Concepts	Overrated	Undervalued
M. Downsizing	_____	_____
N. Cooperative Processing	_____	_____
O. Client/Server	_____	_____
P. Outsourcing	_____	_____
Q. Open Systems	_____	_____
R. Strategic Systems	_____	_____
S. Distributed Data Bases	_____	_____
T. Portability	_____	_____

General Hardware/Software Attributes

6. Rank the platforms in order (from 1 to 4) based on how well each of following attributes describes them. We have used the IBM product line for examples of the four platform types. For example, our ranking for "Small Physical Size" finds the PC ranked 1, RISC processors ranked 2, etc.

Attributes	Mainframe (S/390)	Minicomputer (AS/400)	RISC (RS/6000)	PC (PS/2)
Small Physical Size **(example)**	4	3	2	1
Cost Effective				
Easy to Use				
Very Secure				
Good Architecture (hardware-software)				
Good Connectivity				
Good for Commercial Applications				
Good for Scientific Applications				
Good Bargain				
Open Architecture				
Good Reliability (hardware-software)				
Good Distributed Data Server				
Good Data Management				
Good Network Management				
Complex (hardware-software)				
Easy to Program				
Easy to Operate				
Good Vendor Support				
Good Applications Software				

General Architectural Attributes

7. Using a check mark (✓) indicate the *predominant* processor location of each application and data base—first the current predominant location and then where you anticipate it will be in 1995.

	CURRENT				1995			
Applications	Main-frame	Mini-computer	RISC	PC	Main-frame	Mini-computer	RISC	PC
Accounting								
Administrative (office)								
Planning—Forecasting								
Purchasing								
Production Process (factory-clerical)								
Distribution (warehouse-inventory)								
Point of Contact (sales-customer)								
Transaction Processing								
Research, Education, Training (including libraries)								
Scientific and Engineering								
Image Processing								
Knowledge-based (expert system)								
Data Bases								
Financial/Accounting								
Planning								
Operational (transaction)								
Image								
Research & Education (including libraries)								
Administrative (office)								
Archival								

Factors Prompting and Inhibiting Downsizing

8a. Please rank the following factors in order of their importance in *prompting* downsizing. (1, 2, 3...n, with 1 being the most important, 2 being second, etc. Rank until you do not think the factors are important.)

	Rank
Management's desire to decentralize	_____
User's desire to control information systems	_____
Better price/performance of hardware	_____
Reduced systems development costs	_____
Go to open systems environment	_____
Improve service to customers	_____
Cut total information systems costs	_____
Need to re-engineer (improve) existing applications systems	_____
Improve quality of management information	_____
Organizational flexibility	_____
Availability of specification software	_____
Other _____	_____

8b. Please rank the following factors in order of their importance in *inhibiting* downsizing. (1, 2, 3...n, with 1 being the most important, 2 being second, etc. Rank until you do not think the factors are important.)

	Rank
Cost of re-programming	_____
Management's need (desire) for centralized control	_____
Problems of data base integrity, synchronization and security	_____
Cost of data base conversion	_____
Increased data management costs	_____
Increased software expense	_____
Increased network complexity	_____
Loss of vendor support	_____
Appropriate applications software not available	_____
Inadequate (or inappropriate) systems software	_____
Reliability of hardware/software vendors	_____
Other _____	_____

Downsizing Plans and Attitudes

9. Using a (✓), indicate your current plans (or thinking) about downsizing. Check all that apply.

___ Entire mainframe(s) will be replaced with client/server LANs.

___ Entire minicomputer(s) will be replaced with client/server LANs.

___ Most new development will be done for client/server LANs.

___ Most new development will be done on "open systems" and include RISC architecture servers and workstations.

___ Entire applications (including data bases) will be off-loaded from host systems to client/server LANs.

___ Entire applications will be off-loaded, but data bases will remain on hosts.

___ Data bases will be distributed from mainframes to multiple minicomputer servers.

___ Data bases will be distributed from mainframes to multiple micro-based servers.

___ Data bases will be distributed from mainframes to multiple micro-based workstations.

___ Data will be distributed from mainframes (and among servers) by file transfer.

___ Some application functions will be distributed, and applications will be "cooperatively processed" between (and among) mainframes and minicomputers.

___ Some application functions will be distributed, and applications will be "cooperatively processed" between mainframes and client/server LANs.

___ Some application functions will be distributed, and applications will be "cooperatively processed" between mainframes and workstations (RISC or PC).

___ Some application functions will be distributed, and applications will be "cooperatively processed" between (and among) minicomputers on WANs and client/server LANs.

___ Downsizing will be accomplished primarily under IBM's SAA.

___ Downsizing will emphasize "open systems" and UNIX.

___ Downsizing can, and will, be accomplished using Microsoft Windows and DOS.

___ Downsizing is a major objective, and integral part, of our information systems plan.

___ There is no specific plan to downsize, as such; but we do plan to re-engineer applications to take advantage of new hardware-software technologies.

___ We are currently working with end-user departments to downsize some of their applications.

___ We feel some end-user downsizing efforts are costly and dangerous, and we are controlling these efforts to the best of our ability.

___ Downsizing frequently requires a transfer of responsibility for data and/or management information quality. Many advocates of downsizing (both users and vendors) either don't understand this, or prefer to ignore it.

___ Downsizing is a meaningless term and should be permanently banned from use.

Implementation Schedule and Consequences

10a. Using a (✓), indicate when the following statements will apply to your organization's information systems technology infrastructure.

	now	1992	1993	1995	1999	never
Mainframe use significantly reduced						
Significant client/server						
Applications installed						
Major business applications converted to client/server						
Client/server becomes predominant architecture for new applications						
Minicomputers "disappear"						
Cooperative processing becomes predominant						
SAA becomes predominant commercial environment						
Most data bases are distributed						
Open systems predominant for installed commercial work						
RISC predominant over CISC for commercial work						
Paper use significantly reduced						

10b. Many benefits and consequences are anticipated as a result of downsizing innovations. Indicate whether you agree with or disagree with each of the following.

	Agree	Disagree
Substantially reduced hardware costs	_____	_____
Substantially reduced software costs	_____	_____
Data base management responsibility transferred to users	_____	_____
Fewer levels of management	_____	_____
Faster, easier systems development	_____	_____
Diminished role and expense of central IS department	_____	_____
Improved responsiveness to user information requirements	_____	_____
Improved data and management information quality	_____	_____
Broader range of choices (products and services)	_____	_____
Improved process, product, or service for customers	_____	_____
Better management control of information resources	_____	_____
Better business planning and decision making	_____	_____
More effective use of information technology	_____	_____
Improved white-collar productivity	_____	_____
Improved bottom-line performance	_____	_____

Downsizing Applications and Functions

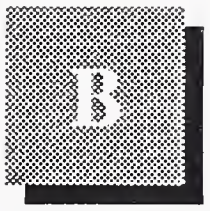
11a. Which specific application systems do you consider to be the most promising for downsizing?

Please check (✓) current status. Specify	Complete	Planned 1991-1992	Future
1.			
2.			
3.			

Why?

11b. Using a (✓) indicate the "proper" platform location for the following functions or objects.

	Mainframe (S/390)	Minicomputer (AS/400)	RISC (RS/6000)	PC (PS/2)
Workstation backup files				
Program and systems development				
Archival files				
Sorting (records >1 million)				
Secure data bases				
Transaction processing				
High-resolution graphics				
Image processing and storage				
Data reduction				
Distributed data base management				
Network management				
Knowledge-based applications (expert systems)				
Natural language processing				
Mission-critical data bases				
Repository management				
Planning data bases				
I/O-bound processing				
Compute-bound processing				



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