Centralized versus Decentralized Computing: Organizational Considerations and Management Options

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The long-standing debate over whether to centralize or decentralize computing is examined in terms of the fundamental organizational and economic factors at stake. The traditional debate is evaluated, and found to focus predominantly on issues of efficiency versus effectiveness, with solutions based on a rationalistic strategy of optimizing in this trade-off. A behavioral assessment suggests that the driving issues in the debate are the politics of organization and resources, centering on the issue of control. The economics of computing depolyment decisions are presented as an important issue, but one that often serves as a field of argument in which political concerns are dealt with. The debate in this light appears to be unresolvable in the long run, although effective strategies can be developed when the larger issues are recognized. The current situation facing managers of computing, given the advent of small and comparatively inexpensive computers, is examined in detail, and a set of management options for dealing with this persistent issue is presented.

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INTRODUCTION

Managers of computing have confronted decisions about centralizing or decentralizing computing ever since the computer proved to be more than just another piece of office equipment. The debate has flourished for nearly twenty years in the information systems community. The goal has been to determine an appropriate arrangement for the deployment of computing resources in organizations, given user needs and the desire of management to control both costs and uses. A universally appropriate arrangement has never been found. Nevertheless, there has been a steady flow of advice on how to deal with this question, usually prompted by technological changes that affect the efficiencies of existing arrangements [EDPIDR 1979; Bernard 1979; Breslin and Tashenberg 1978; Bucci and Streeter 1979; Buchanan and Linowes 1980a, 1980b; Chervany et al. 1978; Demb 1975; D'Oliveria 1977; Ein-Dor and Segev 1978; McKenney and McFarlan 1982; Mertes 1981; Nolan 1979; Reynolds 1977; Rockhart et al. 1979; Withington 1980].

The terrain in which to make centralization decisions has been continually changing. Predictions about the "computing arrangement of the future" range from the conservative to the revolutionary: from the deployment of small, special-purpose computers in user departments, to net-

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worked distributed systems deployed throughout the organization, and even to remote intelligent terminals in employees' homes enabling the work force to "telecommute" instead of coming in to the office.[1] This rapid pace of change helps sustain the centralization debate. But as we shall see, the debate is rooted in more basic questions of organizational structure and behavior. Changing technology merely rearranges the forum in which these issues are debated. At a time of rapid technological change, with concomitant pressure to decide how "best" to organize the use of computing technology, a review of these basic issues will help make sense of a confusing subject.

This paper puts the issue of centralization versus decentralization of computing in perspective. It provides a working definition of these concepts and outlines the basic pros and cons of each. The traditional arguments are then discussed, focusing on the customary assessment of trade-offs between efficiency and effectiveness. A detailed examination of the problems with this traditional perspective concentrates on the critical importance of political and organizational factors, and notes the ways in which simple economic analyses of the alternatives can result in misleading conclusions. The examination reveals that control is the major factor in centralization/decentralization decisions, and that other aspects of the debate must be seen in light of this fact. The paper concludes with discussion of the options available to management in dealing with the centralization issue, given the political and economic factors that underlie the debate.[2]

1. THE DEBATE IN PERSPECTIVE

1.1 A Working Definition

Most conceptualizations of centralization and decentralization rely on some concept of distance: the distance between plant locations, the distance between organizational levels or operations, or the distance (physical or organizational) between where decisions are made and where they are enacted.[3]

[1] The predictions made about the potential impact of computing on organizations can be drawn from a wide variety of sources, including the popular press. Among the better grounded predictions and assessments are those by Buchanan and Linowes [1980a, 1980b], Dolotta et al. [1976], EDP Analyzer [1980a, 1980b, 1980c], Infotech International [1977a, 1977b], Jenkins and Santos [1982], King [1982b], Kraemer [1982], Kraemer and King [1982], McKenney and McFarlan [1982], Mertes [1981], Olson [1983], Rockart et al. [1979], Salerno [1981], and Statland [1979].

[2] This paper deals specifically with computer application to administrative data processing. It does not address the special cases such as process control applications or computer-aided design and manufacturing that typically do not require intraorganizational data sharing. However, many of the issues discussed here apply also to such applications.

[3] This paper addresses centralization as a policy issue (i.e., what centralization/decentralization policies should be followed under certain circumstances). It does not deal with centralization as an artifact of other forces. See Robey [1981] for a discussion of the impact of computing on organizational structure (i.e. computing use as it results in greater or lesser organizational centralization). The definition of centralization provided in this paper draws upon an established tradition of research in organizations. The reader is encouraged to review work by Blau [1970], Burns and Stalker [1961], Child [1973], Cyert and March [1963], Downs [1967], Lawrence and Lorsch [1969], Meyer [1972], Moore [1962, 1967], Perrow [1979, 1982], Pfeffer [1982], Simon et al. [1954], Wagner [1966], Weber [1947, 1952] and Zannetos [1965]. These provide both overviews and detailed definitions of the concept of

There are three separate aspects to the centralization issue. Centralization versus decentralization of control concerns the locus of decision-making activity in the organization. Centralization implies the concentration of decision-making power in a single person or small group; decentralization implies that decisions are made at various levels in the organizational hierarchy. Centralization versus decentralization of physical location concerns the siting of facilities. Centralized physical location has all facilities in one place; decentralized location spreads facilities around the region or the country, or even internationally. Centralization versus decentralization of function refers to the position of an activity or responsibility within the structure of the organization. For example, centralized accounting and control would require all departments and units to report financial data to a single unit, whereas decentralization might establish a number of profit and cost centers with their own accounting activities and require that only aggregated data be passed up to the corporate headquarters.

1.2 Pros and Cons of the Alternatives

Centralization of control preserves top management prerogatives in most decisions, whereas decentralization allows lower level managers discretion in choosing among options. The former strategy promotes continuity in organizational operations, but separates the making of decisions from their environment. If decisions are misguided owing to poor top-level understanding of the problem, or are subverted owing to poor enforcement at the lower levels, centralization can be disadvantageous. Decentralization of control forces lower level managers to take responsibility for their decisions, possibly improving their performance. It also encourages lower level managers to exploit innovative opportunities that improve unit-level performance. Decentralization of control can create problems if lower level managers are incompetent, are not appropriately held to account for their decisions, or make decisions that result in problems for other organizational units or for higher management.

Centralization of physical location capitalizes on economies of scale and preserves organizational integrity in operations. The economies of scale arise from exploiting the full potential of technologies that cause output to increase more rapidly than costs. The costs of duplicating overhead and facilities can be avoided, and organizational protocols are easier to enforce. However, these advantages can be outweighed by costs for organizational communications (including travel costs), transportation of raw materials and finished goods, and maintaining close ties to customers and clients. In special cases, such as military deployment or location of fire stations, the need for rapid response to unexpected situations also dictates the need for physical decentralization.

Centralization of organizational functions keeps performance in line with organizational protocols and standards, smoothes work flow on highly discrete tasks, constrains labor cost escalation by reducing the need for new employees, and allows close monitoring and adjustment of work activities to better correspond with overall organizational operations. Decentralization of functions is advantageous when the functions being performed require close cooperation with other units, when the tasks being done require great worker discretion and less central guidance, or when regular interaction with members of other organizational units requires too much "commuting" by individuals, either from the centralized functional department to the other departments, or vice versa.

The basic questions, then, revolve around tailoring organizational arrangements to meet the constraints of organizational size, the nature of the technology involved in organizational operations, and the needs of organizational clients and customers. These differences set the stage for

centralization and decentralization from the policy and artifact perspectives, and in particular illustrate the importance of the concept of "distance" in most uses of the terms. It should be noted that there is considerable ambiguity in the meanings ascribed to the terms centralization and decentralization as they are used in common discourse, and this ambiguity carries over into the research environment. See Pfeffer [1982] for a useful discussion of this matter.

the discussion of centralization and decentralization that follows.

2. THE TRADITIONAL DEBATE

There is some disagreement in the literature about the driving forces behind centralization decisions related to computing. Some hold that prevailing organizational structures dictate computing system arrangements [Allen 1982; Brandon 1970; Buchanan and Linowes 1980a, 1980b; Burch and Strater 1974; Burlingame 1961; Dearden 1965; Dearden et al. 1971; Demb 1975; D'Oliveria 1977; Ein-Dor and Segev 1978; Forest 1977; Glaser 1970; Golub 1975; Hannan and Fried 1977; Jenkins and Santos 1982; King 1978, 1980; Long 1982; Markus 1981; McFarlan 1972; Nolan 1973; Orlicky 1969; Patrick 1976; Perlman 1965; Phister 1975; D. Price 1965; H. Price 1969; Roark 1971; Robey 1981; Rockart et al. 1979; Scott-Morton 1975; Sprague and Carlson 1982; Statland 1979; Streeter 1973; Wagner 1966; Weiss 1975; Withington 1973, 1980]. Organizations with centralized control and/or location of most activities are likely to have centralized computing. Yet, computing policies are sometimes set without regard for other organizational practices, or even in efforts to change those practices [Chervany et al. 1978; Danziger 1979; Danziger et al. 1982; Kling 1978, 1980; Kling and Scacchi 1979, 1982; Kraemer and King 1979; Lucas 1982, 1984; Markus 1981; Rockart et al. 1979; Scacchi 1981; Wagner 1966]. The traditional debate over computing centralization does not provide a clear statement of the issues because computing has often been treated as a unique organizational resource that must be considered separately from other organizational activities. Thus there is a question about the appropriateness of various options for organizing computing activities in the context of other organizational arrangements. The logic of various options must be drawn from an assessment of the arguments provided by procentralization and prodecentralization sides in the debate.

The most common arguments in favor of centralized computing have focused on location and function: that is, whether to centralize facilities and/or service [Berman 1970a, 1970b; Bernard 1979; Demb 1975; D'Oliveria 1977; Glaser 1970; Golub 1975; Joplin 1967; Solomon 1970b; Statland 1979; Streeter 1973]. There has been a preference for consolidation until problems of geographic dispersal and increasing size of operations forced decentralization. The advantages of centralized location (mainly hardware deployment) seemed especially compelling, given Grosch's law, that computing power could be obtained at a function equal to the square of the cost of the computer [Cale et al. 1979; Grosch 1953, 1975, 1979; Littrel 1974; Oldehoeft and Halstead 1972; Selwyn 1970; Sharpe 1969; Solomon 1966, 1970b]. This law, borne out in subsequent tests, offered a powerful incentive to centralize facilities in a single location, which frequently resulted in centralized computing control and functions as well. Until the late 1970s, the authors of articles on computing centralization were nearly unanimous in the conclusion that, regardless of its other impacts, centralization saves money [Bernard 1979; Glaser 1970; Golub 1975; D. Price 1965; Roark 1971; Selwyn 1970; Solomon 1970a; Statland 1979; Weiss 1975; Zannetos 1965].

Arguments favoring decentralization tended to focus not on economies, but on improved computing service for users [Demb 1975; D'Oliveria 1977; Glaser 1970; Golub 1975; King 1978]. The central question was control over use of the technology and physical access to computing facilities. A common admonition was that the department that controlled computing would dominate its use [Berman 1970a, 1970b; Bernard 1979].[4] Users who could not get access to the technology would not use it, thereby foregoing possible benefits of computing use. Users close to those in control and to the location of the technology, and who could interact directly with those pro-

[4] This discussion usually centered on the finance and accounting departments, where the first computerization of administrative data processing usually took place. This is a general comment, however. The first uses of administrative data processing in many universities took place in computing centers used primarily for research and instruction, while in engineering companies such uses often began on the machines normally used for engineering calculation.

viding computing service, would make greater use of the technology. Similarly, users with control or possession of their own facilities would utilize the technology more efficiently and effectively than under centralized conditions, thereby increasing the benefits that they derived from computing use [Berman 1970a, 1970b; Bernard 1979; King 1978].

The centralization debate has tended toward trade-offs, in which the organizational advantages of centralized control, uniform operations, and economies of scale have been pitted against user department needs for ready access to computing and opportunity for fitting computing capabilities to department requirements [Demb 1975; D'Oliveria 1977; King 1978; Zannetos 1965]. The trade-off can be reduced to one of efficiency versus effectiveness [King 1978]. The proponents of centralization have argued that centralized computing ensures efficiency and permits effective service to users as long as good communications are maintained between the providers and the users. Centralization has been oriented toward top-down control: control of computing costs, control of computing uses, and in some cases control over the information being processed. The proponents of decentralization have argued that properly developed, decentralized computing arrangements are profitable, even if somewhat more costly, because they improve the productivity of computer use [Wagner 1976]. Decentralization has been oriented toward bottom-up productivity improvement: improved exploitation of computing for departmental tasks and improved system design to meet user needs.

The high cost of computers caused most organizations to adopt relatively centralized computing policies, and proponents of decentralization usually had to fight an uphill battle. The advent of smaller, less expensive computers has greatly changed the dynamics of the debate. User departments can claim that decentralization is affordable, and maybe even less expensive than centralization. This change has created new challenges for managers faced with the responsibility for selecting a computing strategy for their organization.

3. ORGANIZATIONAL CONSIDERATIONS IN THE DEBATE TODAY

If the new technologies have made decentralization affordable, why not decentralize? The answer is twofold. For one thing, although it is now possible to buy powerful computer processors for a fraction of what equivalent machines would have cost a decade ago, the costs of computing entail more than just the procurement of processors. For another, computing has grown in size, complexity, and centrality to many facets of organizational life. Decentralization of computing often means decentralization of important organizational activities. It is necessary, therefore, to look beyond the traditional to the new and more complicated factors that make centralization versus decentralization such a potent and persistent issue. We identify two factors that appear to be of special importance: the politics of organization and resources and the economic dynamics of deployment decisions.

3.1 The Politics of Organization and Resources

The politics of organization and resources refers to those formal and informal means by which decisions are made as to how different organizational units are treated in terms of resources, influence, and autonomy [Arrow 1974; Benson 1983; Child 1973; Cyert and March 1963; Danziger et al. 1982; Downs 1967; Kraemer and King 1976; Lawrence and Lorsch 1969; Lucas 1984; Markus 1981; Meyer 1972; Moore 1967; Niskansen 1973; Perrow 1979; Wildavsky 1976; Yin 1979]. Often the roles taken by specific units dictate their organizational power and resources. But sometimes there is considerable uncertainty about which roles various units should assume in the "best" interests of the organization, and disagreements must be resolved through political processes involving the different interests at stake.

3.1.1 Consensus versus Divergence in Goal Setting

The centralization debate is fueled by disagreements over goals and the means for accomplishing them. Much of the prescriptive management literature assumes that the ends are agreed on: that computing is a tool to be utilized in the "best" interests of the organization [e.g., Allen 1982; Axelrod 1982; Dearden et al. 1971; Ein-Dor and Segev 1978; Gibson and Nolan 1974; Golub 1975; McKenney and McFarlan 1982; Nolan 1973, 1977, 1979, 1982; Orlicky 1969; Rockart et al. 1979; Scott-Morton 1975; Sprague and Carlson 1982]. According to this literature, the goal of computing policies is to provide services at the most effective level given costs, to maximize the organization's profitability and performance through use of computing, and to improve information flow throughout the organization to expedite operations and management. This goal-oriented view sees the organization as a system of interrelated tasks, staffed by employees who are primarily concerned with maintaining and improving organizational performance [Danziger et al. 1982; Kling and Scacchi 1979, 1982; Scacchi 1981]. In this rationalistic framework, computing systems are instruments (or in more elaborated settings, "environments") that, when properly managed, help the organization to meet its goals, adapt to its surroundings, and improve the performance of its employees.

Computing policy in this context seeks to deploy computing resources in a manner that best facilitates their productive use and maintains managerial control over important organizational information. The task of management is to ensure that this tool is made available to users at the lowest feasible cost, taking into account factors such as geographical remoteness, specialized user needs, or high concentrations of demand for service that might warrant costly solutions. The hallmark of a rationalistic approach is the attempt to balance efficiency and effectiveness. The design of policy concentrates on the overall goals of the organization.

The weakness of the rationalistic approach lies in its assumption of consonance between the goals of individual organizational actors and the stated goals of organizational leadership [Danziger 1979; Danziger et al. 1982; Kling 1980; Kling and Scacchi 1979, 1982; Markus 1981]. In fact, there are important differences among factions within most large and complex organizations that suggest the presence of conflict and disagreement over organizational goals and the means for meeting them. A behavioral view of organizations suggests that individuals value their personal opinions and the needs of their own departments more highly than they do those of the organization at large.[5] Computing is seen as package consisting of both technologies and the intentions behind their use. It is used to further the goals of specific organizational actors (e.g., top management, financial controllers, data processing professionals) in ways that might or might not improve organizational performance or help meet organizational goals.

The behavioral perspective has been conspicuously absent from the discussion of centralization and computing. Disagreements over computing policies have been attributed to misunderstanding of either the facts or the goals. In this rationalistic interpretation, the solution to disagreements is to conduct fact-finding studies (e.g., cost-benefit analyses) and to set or clarify goals through discussion (e.g., user committees). It is seldom suggested that the facts are simply elusive, or that disagreements on goals are intractable.

Although the behavioral complexion of computing policy making has been neglected in discussion of centralization is-

[5] This section relies on behavioral research in organizations, little of which deals directly with computing use in organizations, but all of which is relevant. In particular, it reflects the work of Allison [1971], Arrow [1974], Burns and Stalker [1961], Child [1973], Cyert and March [1963], Downs [1967], Lawrence and Lorsch [1969], Meyer [1972], Moore [1962, 1967], Niskansen [1973], Perrow [1979, 1982], Wildavsky [1976], and Yin [1979]. Of special importance to this analysis is the observation that the idea of genuine "organizational goals" can be illusory [Allison 1971; Cyert and March 1963; Downs 1967; Niskansen 1973; Perrow 1982]. Organizations may appear to follow coherent policies, but in fact goals are often generated by internal organizational conflict and undergo frequent change. In studies of computing this has been noted by Danziger [1979], Danziger et al. [1982], King [1978, 1982a, 1982b], Kling [1980], Kling and Scacchi [1979, 1982], Kraemer and Dutton [1979], Kraemer et al. [1981], Markus [1981], and Scacchi [1981].

sues, many studies indicate that the primary factors in setting policy are the intentions behind computing use, not the nature of the technology itself [Danziger et al. 1982; King 1982b; King and Kraemer 1984; Kling 1980; Kraemer et al. 1981; Lucas 1982; Markus 1981; PPRO 1980]. In small, narrowly focused organizations, the interests of all the actors in the organization might coincide. But such organizations are usually too small to be facing the centralization issue. Larger, more complex organizations usually have many and diverse social groupings, multiple organizational tasks and objectives, and more decentralized decision-making structures. A single decision-making group that speaks for all interests is unlikely [Kling 1980]. Disagreements over how best to use computing are therefore endemic to such organizations.

Students of organizational change suggest that in many complex organizations, polices swing back and forth between centralization and decentralization [Lawrence and Lorsch 1969; Moore 1962, 1967]. Studies and discussion of organizational goals are important in setting computing policies, and genuine consensus is sometimes possible, but the task requires sensitivity to a wider array of organizational interests than those represented by the dominant decision makers.

3.1.2 *The Driving Factors in the Debate*

From the behavioral viewpoint, there are nine organizational objectives that drive the centralization/decentralization debate over how to manage computing:

(1) The need to provide computing capability to all organizational units that legitimately require it.
(2) The need to contain the capital and operations costs in provision of computing services within the organization.
(3) The need to satisfy special computing needs of user departments.
(4) The need to maintain organizational integrity in operations that are dependent on computing (i.e., avoid mismatches in operations among departments).
(5) The need to meet information requirements of management.
(6) The need to provide computing services in a reliable, professional, and technically competent manner.
(7) The need to allow organizational units sufficient autonomy in the conduct of their tasks to optimize creativity and performance at the unit level.
(8) The need to preserve autonomy among organizational units, and if possible, to increase their importance and influence within the larger organization.
(9) The need, wherever possible, to make the work of employees enjoyable as well as productive.[6]

These nine objectives can be viewed from a rationalist perspective, with the goal in formulating policy being to balance each against the others so as to optimize the overall result. The problem with such an approach is that, depending on to whom one talks, a different set of priorities for these considerations will emerge. Moreover, in some cases, they contradict one another. For example, the need to maintain integrity in operations across the organization may conflict with the desires of organizational units for autonomy. The way in which these different factors interact can be seen in the following illustrative history, which briefly recounts the evolution of pol-

[6] The importance of entertainment value in the extensive adoption of computing technology has been overlooked in most of the research, but the success of computer-based entertainment products and the use of games as major marketing tools by computer vendors suggests that this is an important factor. It is clearly a major component of the widespread acquisition of computers for home use [Vitalari and Venkatesh 1984], and a large number of fascinating computer games have been developed (and are actively played) at universities and other organizations. The entertainment potential of computing plays an important role in encouraging experimentation and learning among those who develop and use computer systems, and lessens the apprehensions that new users might otherwise have about getting involved with computers. The author's experience indicates that most people are curious about computers and desire to experiment with them and use them, given the chance. Resistance to use of computing seems to persist only as long as there is uncertainty about the impact of computer use on one's job and status within an organization.

icies governing administrative data processing over the past two decades.[7]

3.1.3 An Illustrative History

Computers were first applied to tasks that were easily rationalized and programmed. In organizational data processing these were usually in areas such as payroll preparation and accounting that had well-developed procedures, which allowed them to be automated easily, and large processing volumes, which made automation attractive. Such tasks frequently were already semiautomated on unit record equipment. The conversion of these tasks to digital computing was a natural progression. At the same time, there was a trend toward centralization of the financial control function in many organizations for other reasons [Simon et al. 1954]. Centralized computing in the finance/accounting unit was a logical step. Capital and operations costs related to computing could be easily managed through existing decision processes within the finance/accounting unit, especially the normal budgetary process whereby the department negotiated for its share of organizational resources. The finance/accounting unit controlled the computing system and could tailor the system to meet its needs. Well-established communications channels between finance/accounting and top management facilitated upward flow of important financial information. The finance/accounting unit could justify increased organizational investments in computing on grounds that they would serve the "whole organization." This centralization of computing began the evolution of a new form of bureaucracy based on the special skills of computer technicians [Danziger 1979]. The newness and mystique surrounding computers gave reports printed by computers authority that other reports did not have, while the technical complexities of computing were used to buffer the finance/accounting department from objections to specific reporting requirements imposed on other units.[8]

This exclusive relationship between the finance/accounting unit and the computer did not last very long. Other organizational units began to see possible applications of the computer, and to explore means for exploiting the technology. These new users could either acquire their own computers or use the services of the finance/accounting unit. This posed a dilemma. Because computers were large, stand-alone machines, their high capital costs and Grosch's law suggested that other users should share the finance/accounting computer. The finance/accounting unit's experience with computing helped ensure that computing services would be provided in a competent manner. And the close ties between finance/accounting and top management ensured that the latter's interests would be served. However, sharing meant that the new users would lose some departmental autonomy by placing their own data processing tasks (which in some cases were semiautomated or computerized) in the hands of another organizational unit. This had two disturbing results for the operating units: It moved an important function out of its home unit to another unit, and it provided the finance/accounting unit with a powerful rationale for increasing its own budget and staff, and thereby its power and influence in the organization. New users found that they were required to follow the finance/accounting department's guidelines for computing use, and that their jobs would generally receive lower priority. Finally, the finance/accounting unit maintained an exclusive hold over the exciting and status-raising technology of computing.

Complaints from operating units brought this situation to top management's attention, and the response to this dilemma was usually an edict aimed at balancing the high procurement costs of computing with the needs of various user groups. Decentralized

[7] This history is a hypothetical synthesis based on the comments of many who experienced and wrote about the evolution of computing use in organizations over the past two decades (as found in the references). Many organizations never had the experiences reported here.

[8] Excellent accounts of the influence that computer-generated reports can have are found in Danziger et al. [1982] and Kling [1980].

computing centers were established in organizations where geographical considerations required them, or when operating units had sufficient influence to overcome the centralist arguments of economies of scale and integrity of use. But in most organizations the centralist arguments prevailed, usually on economic grounds. The computer center remained in the finance/accounting unit, and procedures were set up to allow access by other users [Gibson and Nolan 1974; Nolan 1979].

Neither the centralized nor the decentralized strategy proved to be perfect. Where multiple centers were established, there arose criticism of "proliferation" of expensive computers and lack of technically competent computing operations, as well as difficulty in meeting the needs of top management for information. Costs for computing did indeed rise rapidly, partly because of growing applications of the technology and partly because of the exploitation of the budgetary leverage computing provided to the departments that had their own computers.[9] The professional cadres of data processing specialists that had emerged were able to consolidate their power around their professional knowledge, buffering themselves from demands from both their clients and top management [Danziger 1979; Danziger et al. 1982]. In response, some organizations centralized (or recentralized) computing to gain or regain control of the increasingly important and complicated data processing function. In other cases, control over computing tended to devolve to the decentralized facilities as part of a larger decentralization of organizational activity.

There were also problems with centralized installations. Centralization helped top management contain costs and retain control over the growth and use of the technology, but also resulted in serious disagreements between the finance/accounting unit and other users, who found themselves increasingly dependent on an important resource controlled by a "service agency" with little understanding of their needs or little inclination to take their problems seriously. They were also becoming increasingly dependent on the technical data processing specialists who worked for the finance/accounting unit (as were the finance/accounting users also).

In many organizations these pressures resulted in the creation of independent data processing departments, usually under direct control of top management. This reform was designed to preserve the benefits of centralization while reducing the interdepartmental disagreements about access to services. It also moved computing closer to top management by elevating the status of the data processing professionals. Computing services were to be run like a business, providing high-quality services to all users while achieving maximum efficiencies and effectiveness in the computing operation. To overcome disagreements among user departments about priorities and quality of service, and to improve accountability to top management, these independent data processing units established managerial mechanisms such as structured needs assessment procedures, complete with cost-benefit analyses, to assess user requests for new systems or rewrites of old systems. They also established "chargeout" policies to impose pseudomarket constraints on use of computing services. Training of managers and users in use of computing was increased. Finally, user policy boards and steering committees were established to help determine organizational needs for computing and the means to meet them. In short, these reforms were part of a concerted effort to find facts and establish consensus on goals, in keeping with the rationalist view.[10]

Unfortunately, the upward movement of data processing in the organizational hier-

[9] Budgetary leverage refers to the role computer use can play in justifying increases in departmental budgets. In this respect, computing is like many other organizational activities (particularly those with bureaucratic characteristics) that justify and enhance the organizational positions of the units that carry them out [Danziger 1979; Kling 1980; Kraemer and King 1976; Markus 1981; Wildavsky 1976].

[10] Policies of this kind are discussed by Danziger et al. [1982], Ein-Dor and Segev [1978], Gibson and Nolan [1974], King and Kraemer [1984], Kraemer et al. [1981], and Nolan [1973, 1977, 1979, 1982].

archy removed it even further from the operating needs of user departments. The establishment of an independent data processing unit under the control of top management made it difficult for some users to negotiate favorable terms for service, since the independent unit was there to serve "all" users. In fact, the user departments that made the heaviest demands on computing services, such as the finance/accounting unit, immediately became the most important "customers" of the new independent data processing department, since they provided the bulk of the data processing department's business. But even the major users faced loss of autonomy in their operations, inflexibility in exploiting the productivity-improving potential of the technology, and lack of opportunity to experiment with computing. They now had to accept the standards of the data processing department. The creation of the independent data processing department accommodated several of the major considerations in the centralization/decentralization debate, but by no means all of them.

The centralized, independent data processing shop dominated data processing from the mid-1960s to the mid-1970s. During this time the economic advantages of centralization prevailed, but new technological capabilities such as time sharing over remote terminals and use of job entry/output sites provided users with more direct access to the computing resource. This decade of stability began to give way in the mid-1970s, however, as technologies such as the minicomputer arrived. The minicomputer could provide considerable computing power but at a much lower price than large mainframes. Minicomputers could do many of the smaller jobs then being done on the large mainframes, and allowed acquisition of computing capability in small pieces. Departments that had depended for service on the centralized computing installation could assemble a computer system in a number of inexpensive, incremental purchases. Individual purchase approvals could be made at much lower levels in the organization hierarchy than those required for purchase of large and expensive mainframes. As long as these purchases were not questioned, the establishment of minicomputer operations in user departments could proceed. In many organizations a number of satellite or stand-alone computing centers built around minicomputers emerged.

In the late 1970s the microprocessor again cut the cost of basic computer equipment. By 1980 a computer system with an 8-bit processor, 48K main memory, 5-megabyte hard disk drive, operating system, terminal, and printer could be purchased for less than $6,000. Expenditures this low are almost insignificant in the budgets of major departments in large organizations, and could be easily approved. A new era of "proliferation" was under way.

3.1.4 The Current Situation

Small and inexpensive minicomputers and microcomputers have radically changed the centralization/decentralization debate. User departments can now obtain their own computing capability, in some cases without the knowledge of top management or the central data processing department, and in other cases by arguing that the cost is so low that the economic benefits in favor of centralization no longer apply. Widespread use of small computers can provide highly individualistic service to all the departments needing computing, allow users to establish and maintain autonomy in their operations using their own equipment, and provide users with hands-on opportunity to enjoy computing use while improving departmental productivity. The prodecentralization forces in the debate can now argue that Objectives 1, 3, 7, 8, and 9 of those listed above are met. Concern for costs (Objective 2), they argue, is no longer an issue since these machines are so inexpensive to procure, and off-the-shelf software for such systems makes it possible to keep operations costs down.

Assuming for the moment that these arguments are correct, there remain several problems. First, the use of computer systems by users not familiar with the broader requirements of system management might compromise the quality of computing activity in the organization (Objective 6). Many practices that the centralized data processing shops have learned over the years, often at considerable cost, will not be known to the new users. These include methods for forecasting system requirements and costs, development of backup and fail-safe procedures, adoption and enforcement of documentation and maintenance standards, and effective methods for dealing with vendors and suppliers. Individual installations might reduce the impact of problems in these areas, but the aggregate of such problems throughout the organization could be serious.

Second, giving user departments carte blanche to establish their own computing operations increases the likelihood of disintegration in interdepartmental operations (Objective 4). This is especially true if incompatible systems are adopted through which interdepartmental information must flow, but it applies even to situations in which small systems are compatible with one another at the hardware and software levels. Unless the whole package of procedures and protocols required for smooth use of the technology is standardized throughout the organization, there arises the opportunity for serious mismatches from one department to another. The dilemma of deciding between organizational standardization and departmental autonomy persists.

Third, the devolvement of data processing activities to the departmental level can increase the difficulty of obtaining data for top management use (Objective 5). For years a major goal of the data processing profession has been to enhance the provision of information to top-level decision makers. But this is difficult even with centralized operations. The problems are not so much in the technology, but in determining what information to provide and how to provide it. The adoption of differing departmental standards and protocols makes uniform collection of data for upward reporting more difficult, whereas the imposition of organization-wide standards again diminishes departmental autonomy.

Should computing be centralized or decentralized? Unfortunately, there is no easy answer. The fundamental considerations in the debate over centralization persist, regardless of the technology. It is not so much a question of where the computer processors are located or how they are acquired. Rather, the issue is control over computing: who does it, what they do with it, and how they do it. Control must reside someplace. It cannot be shared equally among different groups of different opinions. The basic question has never been, "Which way is best?" It is usually, "Who's way is it going to be?" The advent of small computers with low purchase prices does not change this. It merely alters the bases on which the various sides take their positions and construct their arguments.

The issues involved in centralization/decentralization decisions are deeply tied to organizational behavior, and the consequences of centralization/decentralization politics become increasingly important as organizational investments in and dependency on computers increase.

3.2 The Economic Dynamics of Deployment Decisions

Economic opportunities or constraints are often the most extensively discussed criteria in the political process of deciding whether to centralize or decentralize. Changing economic conditions keep altering the economic rationales behind either course of action. As long as the economies inherent in different deployment strategies are undergoing change, there can be no permanent resolution to the centralization question on economic grounds. To understand the economic dynamics of computing as they relate to centralization/decentralization decisions, the issue can be structured in terms of the costs and benefits and how they interact.

3.2.1 Computing Costs

The cost dynamics of computing have changed substantially over the past two decades. Nowhere has this change been more dramatic than in the relative costs of hardware and software. Boehm [1979, 1981] claims that in 1955 computer hardware costs dominated software costs 7:1, but by 1985 software costs are expected to dominate hardware costs 9:1. This is a dramatic reversal, with equally dramatic effects on perceptions about the costs of computing generally. Hardware is usually acquired before software, and so this shift has reduced the entry costs of computing.[11] Start-up has become comparatively less costly than successfully implementing computing systems that meet organizational needs. Computing now appears to many decision makers as inexpensive, but a closer look reveals that this is not so.

The little comprehensive research on the costs of computing that exists suggests that they remain substantial, and are often higher than they are estimated to be [King 1982b; King and Schrems 1978].[12] There are many hidden costs, such as expenditures for computing-related staff in user departments not accounted for in computing budgets [Morrisey and Wu 1979], staff time of users and upper management who must deal with intrusions and disruptions arising from computing [Leintz and Swanson 1974; Leintz et al. 1978], and "lost" productivity owing to employees who spend their time "playing" with computing [Kling and Scacchi 1982; Scacchi 1981]. Such costs can rightly be attributed to many cross-departmental functions, but they can be significant.

Computing costs are not only high, but appear to be going up [Buss 1981; Dolotta et al. 1976; King 1982b; Nolan 1979; Phister 1979], a paradoxical situation, given the decreasing costs of computers. Dramatic reductions in price/performance ratios for computer processor hardware have been more than offset by higher price tags for facilities, software procurement, software maintenance, data management, data communications, and computing management.

These costs are rising for five reasons. The first is growth in application. As computing use grows and the number of applications in operation increases, so does the demand for both technical and managerial people to develop these systems and maintain them. And demand for programmers, systems analysts, and managers skilled in data processing administration has kept well ahead of supply, bidding up the price of their labor. This condition will continue as long as the need for new talent is not offset by an increase in the supply and/or productivity of such labor.[13]

Second is increasing maintenance costs. System maintenance has been estimated to consume most of programmers' and analysts' time [Boehm 1979, 1981; Ledbetter 1980]. Kommunedata, a publicly owned service bureau in Denmark that provides computing to all 276 municipalities and counties in the country, estimates that it devotes approximately 20 percent of system development manpower per year to maintenance of each system that it develops [Romer 1979]. Boehm [1979, 1981] estimates that by 1985, 70 percent of all software expenses will be for maintenance. Department of Defense software maintenance costs run between $2.5 and $4 billion per year, and this figure is going up.[14] As the number of systems increases, so do the carrying costs of maintenance. Maintenance also requires high-quality software documentation, which is expensive to pro-

[11] The choice of hardware first, followed by choice of software, is a practice that might be changing. This is especially true in the area of smaller computers, where availability of certain software packages directs the customer to equipment that supports those packages. This phenomenon is clearly evident in the case of the rapid migration of personal computer users to the IBM PC, which almost instantly upon release became the standard around which personal computer software would be written. Nevertheless, the computer itself remains the most expensive single purchase when first obtaining a computer system, and its price (with necessary peripherals and operating systems software) constitutes the "entry price" of computing.

[12] This account is of necessity constrained by a lack of detailed, empirical assessment of the economic impact of computing. Useful references to this subject include King and Schrems [1978], Phister [1979] and Roark [1971].

[13] There has been considerable discussion about alleviating this problem, the most common proposal being that of improving the productivity of individuals who develop software [Boehm 1979, 1981; Chrysler 1978; DeRoze and Nyman 1978; Fisher 1974; Freeman 1983; Ledbetter 1980; Leintz and Swanson 1974; Morrisey and Wu 1979; Phister 1979; Scacchi 1984; Zelkowitz 1978]. Whether such methods and tools will make up the difference is unclear. If they do not, equilibrium will be achieved when the pace of systems development slows.

[14] This figure is obtained by multiplying estimated DoD software expenditures of $5 billion per year [Boehm 1979; Fisher 1974] by estimates of maintenance as a percentage of overall costs for military software, thought to be between 50 and 80 percent [Boehm 1981; Leintz et al. 1978].

duce [Boehm 1979; DeRoze and Nyman 1978; Fisher 1974; Leintz and Swanson 1974; Leintz et al. 1978], and is a low-priority task in most software environments. Because of the high turnover rate among programmers, those who design systems seldom stay around long enough to help maintain them through the system cycle. Large and complex systems are built by teams of programmers in which no single analyst or programmer understands the whole system, and so the task of maintaining them is often experimental, time consuming, and expensive.

A third factor is the growing complexity of systems, and the disruptions caused when they are implemented and when they malfunction [King and Kraemer 1981; Kraemer and King 1979, 1982; Nolan 1979]. Simple, routine applications (e.g., a billing program for an electric utility) are basically automated versions of previously manual operations. Their scale and complexity are relatively low. However, as efforts are made to improve these systems by adding new features (e.g., providing customers with comparisons of this year's electricity use to last year's), their implementation requires considerably more preparation, training, and time, all of which are very expensive. Complex systems are more likely to malfunction and are more difficult to fix because of their interdependency in operation [Kling and Scacchi 1982; Scacchi 1981]. Most fixes are like "patches" sewn on the fabric of the system. Often, they do not solve the problem, but "work around" it. In complex systems, patches frequently generate new problems, which then must be patched as well. Eventually, the design integrity of the original system is destroyed, and systems often must be completely rebuilt before their expected useful life is over [Boehm and Standish 1982; Kling and Scacchi 1979, 1982; Ledbetter 1980; Leintz and Swanson 1974; Leintz et al. 1978].

A fourth factor is the growth of integrated systems on which organizations depend. Integration means the interconnection of different systems or subsystems to form larger systems. Large efforts to build integrated systems from the ground up have been attempted, but most have not been successful [Kraemer and King 1979; Scacchi 1984]. To the extent that system integration does occur, it comes by linking together otherwise stand-alone applications, so that the output of one component serves as input to another. Integration makes systems more complicated, which increases system costs, and also requires successful and timely performance of organizational units that use the systems. Integration among unintegrated systems is usually coordinated through policies and protocols that allow for slippage along the boundaries: delays and problems can be taken care of within the system or unit before it is necessary to interact with other systems or units. Integrated systems make organizational units more interdependent in real time, so problems in one system or unit can literally stop progress in others simply by disruption of the process of interaction.

A final factor contributing to the growing cost of computing is the fact that many existing systems will have to be rewritten in the next decade [Boehm and Standish 1982]. A large number of major systems were developed during the 1960s and 1970s, with several features in common: They were very large systems to do large routine tasks such as accounting and record keeping; they were applied to important tasks so that they could not simply be abandoned; and they were developed under obsolete hardware and software technologies. Many such systems are still operating today, running under emulation on modern mainframes. But they are becoming exceedingly costly to maintain, and in many cases, unreliable in operation. The costs that will be incurred in rewriting these systems are substantial. Rewrites must take place apart from the existing systems (which must still continue in operation), and on top of other demands such as maintenance of existing systems and development of entirely new systems. Rewrites will also incorporate modern software engineering techniques in order to keep long-run maintenance costs down, but these will require major up-front development investments.

In summary, the overall cost of computing is rising rapidly as new systems are implemented, as the price of technical talent increases, as maintenance costs of existing systems mount, as the complexity of computing systems increases, as previously stand-alone automated tasks are linked together in complex, integrated systems, and as the need to rebuild older systems becomes more acute. The only factors that might alter these cost dynamics are a dramatic increase in the productivity of the technical specialists who build and maintain such systems (brought about through implementation of new methods and/or technologies), or a curtailment in the growth of computing application causing the demand for such resources to fall back in line with supply.

3.2.2 The Question of Benefits

Computing is used because it has demonstrable benefits. These benefits do not accrue across the board, but are primarily concentrated in those applications of the technology that assist in conducting routine, well-understood tasks [King and Kraemer 1984; King and Schrems 1978]. Benefits predicted as the most significant economically—cost reductions and staff reductions—have not appeared as expected, and are now seldom promised in systems proposals [Edelman 1981]. The primary benefits of computing have been three: improved speed and accuracy for some tasks, avoiding the need to hire new staff; qualitative improvements in operations (e.g., reduced error rates, more flexibility in reporting and data manipulation, a greater range of analyses available); and increased capabilities for performing structured but complex tasks (e.g., airline reservation systems).

Benefits from computing application to more complex and uncertain tasks such as management decision making are more difficult to ascertain. Most claims that applications such as decision support systems "save money" weaken considerably on close examination because extensive development costs are usually excluded from the cost–benefit equation [King and Schrems 1978]. There is a propensity for measurable costs to outdistance measurable benefits, which is why "runaway costs" and "cost overruns" are familiar terms, whereas "runaway benefits" and "benefit overruns" are not. The learning costs that go into building successful systems are accrued by way of the cost overruns incurred in development of unsuccessful or marginally successful systems. Despite structured design and other techniques for "deliberately" producing successful systems, most development is a trial and error process. The failure rate is just as high as it was 15 years ago [Buss 1981].

The economic benefits claimed for most systems are not based on the amount of money saved, but on the differences in the character of the tasks performed with computing, which seem beneficial to the using organization.[15] Often, these benefits are intangible, particularly those dealing with "improved information." This problem is illustrated by experience with another information technology, the office photocopier. This technology has increased both the volume and velocity of paper flow. But what is the "benefit" of having copies of memos go personally to five people instead posting a copy in a central location where all can see it? Improvements in organizational information flow and communication are extremely hard to measure. Often, no one knows what the information flow or the quality of communication was in the first place, and it is difficult to put a value on the change even if it can be firmly measured.

It is argued that the economic benefits of computing are demonstrated by the fact that so many organizations use it.[16] This argument makes two critical assumptions: that the true costs, short run and long, are known to the organization when it makes its decisions, and that estimates of the benefits it will receive are reasonable and not exaggerated. If these two assumptions are in error, outcomes can be drastically different from expectations. The benefits of

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[15] The fact that little rigorous research has been done does not mean that tangible benefits do not accrue from advanced applications. Edelman [1981] presents data suggesting that direct economic benefits from cost savings and avoidance do sometimes result from such applications. See also Axelrod [1982].

[16] This is based on the assumption in theories of welfare economics that households are the best determiners of their own welfare. There are obvious exceptions in which intervention is required from outside agents (e.g., experts), but as a general rule this assumption seems reasonable.

adopting computing systems are not necessarily economic; some adoption decisions are made on strict economic grounds, but most are influenced to some degree by other organizational and political factors (e.g., department managers' strategy to become a computer user to build their budgetary claims, or simply the desire to have their own computers).

A final problem in assessing the benefits of computing across organizations rests in the choice of the applications evaluated. Successful systems demonstrate what is possible, but not what is likely to happen in most instances. Predicting industry-wide potential of computers on the basis of experiences of a small number of highly talented organizations is unwise. Sophisticated applications and innovations appear sparsely across the population of organizations [King 1982a; Kraemer et al. 1981]. A given organization might have one or two significant and successful innovations, but the rest are either rather routine applications or are failed examples of more ambitious efforts. The benefits of such innovations are often discussed in terms of their demonstrated potential in a few special cases, and not on their probable performance in wide deployment.

A summary of what is known about the benefits of computing in organizations yields seven findings:

(1) Benefits seem to be difficult to pinpoint in strict, economic terms, although the fact that computing has been and continues to be heavily adopted and used suggests that organizations believe that the benefits are there.

(2) Direct economic benefits, such as staff reductions and cost savings, seem not to have materialized in most applications of computing to administrative data processing.

(3) Indirect economic benefits, such as improved capabilities and cost avoidances or displacement, do seem to have accrued as a result of computerization of administrative data processing.

(4) Most of the measurable economic benefits from computing appear to come from fairly routine applications (e.g., accounting, record keeping).

(5) Economic benefits from advanced applications such as decision support systems and planning systems are more difficult to identify, especially in relation to their costs, although recent research suggests that they do accrue in some circumstances [Edelman 1981].

(6) Claims of economic benefit are usually made to justify proposed computing developments, but other organizational and political factors figure prominently in motivations to engage in computing.

(7) Regardless of the potentials for computing benefits demonstrated by advanced user organizations, most organizations will take longer to realize such benefits if they in fact do so at all.

These findings do not suggest that computing is unbeneficial in economic terms. Rather, they imply that there are other kinds of benefits that play a role in organizational decisions about computing, and that the hoped-for economic benefits of computing systems often do not accrue according to plan.

3.2.3 Computing Costs and Decentralization

This review of computing costs and benefits provides a base from which to analyze the impact of decentralization. The experience in large organizations over the past two decades suggests that decentralization entails organizational changes that are likely to prove costly for two primary reasons.

The first factor is the expansion of computing activity as users gain control of computing resources. If computing activities were undertaken only to improve efficiency and effectiveness, there would be no problem. But computing lures users for other reasons, not the least being its attractiveness as an exciting and potentially useful technology. Faith and delight in computing is a strong motivator for adoption, and often overcomes the need for "demonstrated benefits" in the decision to adopt [Danziger et al. 1982; Kraemer and Dutton 1979; Kraemer et al. 1981; Turkle 1979]. This phenomenon is not new. Technological advances in such fields as automobiles, photographic equipment, home entertainment equipment, household appliances, and medical technology have led to major increases in consumer expenditure.[17] As new capabilities emerge, the perceived needs of users increase.

This seems likely to happen in the case of new, small computer systems. When a user department acquires an inexpensive system to take care of simple departmental needs, the needs often begin to grow, as do investments in the system as new and more enticing equipment becomes available. Before long, the overall investment has grown far beyond expectations.

A case recently observed by the author illustrates this. A university's financial administrators were dissatisfied with the service that they received from the campus computer center, and bought a fairly powerful minicomputer to do their own computing jobs. They hired ten people to staff the enterprise. Within three years they had two minicomputers, were buying a third, and had a computing staff of forty. The computer center they left had also grown bigger. These users had the best of intentions when they got their own system, but they did not know what the computer staff had learned over the years: that computing is a very expensive business. To accomplish their goals they continually had to increase their investment. And their investment was the university's investment. In very few cases does a computing installation, centralized or decentralized, get smaller and cheaper over time.

When control over computing procurement and system development decisions devolves to users, unwise investments can be made, sometimes without the knowledge of top executives. A situation like this came to light recently in a computer printer manufacturing company that was deliberating over whether to make a $300,000 investment in new equipment for the data processing center.[18] Someone suggested that the money might be better spent for microprocessors for users. A study revealed that user departments had already spent over $1 million on microcomputer and minicomputer equipment in the previous twelve months, without the knowledge of the data processing department. Had the organization instituted and maintained strict centralization of acquisition control, it might have been able to review and guide these procurement decisions. But that would have entailed planning costs to develop protocols, and increased management costs for monitoring and evaluating the decisions of subunits.

Aside from the question of whether sensible expansions of computing use take place, there is the further probabability that in time the small, decentralized systems will become true satellites of the larger centralized systems. This will occur in cases where users with their own minicomputer or microcomputer systems desire to share data or establish electronic communications links with the central resource and with each other. Under this arrangement, the new systems become additional "terminals" connected to the mainframe. When users begin to make substantial demands for data, capabilities for uploading and downloading files, and establishment of electronic mail and other office automation capabilities, the central resource will have to be upgraded to deal with the demand. Thus, instead of decentralization through use of minicomputers and microcomputers signaling the demise of the mainframe era [Breslin and Tashenberg 1978], it could signal the beginning of an era in which both the centralized and decentralized computing activities of the organization grow dramatically. In a sense, each new microcomputer or minicomputer installed in a user department can be thought of as either a potential data processing center or another terminal to the mainframe; in some cases they will be both.

The second major factor suggesting that decentralization of computing will increase computing costs arises from disruptions in organizational operations that often accompany decentralization [Uttal 1982]. Decentralization requires change, which must be carried out coherently throughout the organization. Too often, decentralization

[17] Systemic research on the adoption and use of computers in the home is relatively new. See Vitalari and Venkatesh [1984].

[18] The author thanks Suzanne Iacono for assistance in compiling this information.

occurs by default as beleaguered data processing departments simply give users permission to get their own systems, or users get their systems without asking whether anyone else thinks they should or not. In such cases there are no comprehensive plans. Implementation of completely new systems in these decentralized operations will expand the number of applications the organization must support, whereas displacement of services provided by central data processing can duplicate existing systems. In either case, costs rise.

More important is the likelihood that decentralized users will develop systems that clash with current tasks and interactions with other departments. Systems and their operation will require constant adjustment to bring everything into harmony. If left alone long enough, things might "sort themselves out" through natural processes. But this can take a long time and exact a considerable toll in frustration and resources.

The dilemma for the organization, however, is that there are high costs from either careful control or no control. A coherent decentralization plan will be expensive because the technical details and the interests of the different parties involved make the task complicated, and there are considerable costs for implementing even well-developed plans. Careful control requires a commitment to explore the options, work out the compromises, and make the considerable up-front investment in planning necessary to execute a coherent change. There must be some incentive for top managers, data processing professionals, and users to seek the creation of a plan. Often the incentives are not present, or at least not present in equal measure for all, so that gradual evolution toward decentralization appears to be the easier course. Unfortunately, this approach is often more costly in the end, as changes must be made to "reintegrate" computing operations with top management desires and to restore coherence in computing uses and activities. Whether or not the investment that decentralization requires of the organization is warranted depends on the benefits to be derived.

3.2.4 Decentralization Benefits: Possibility and Reality

We have discussed the hoped-for benefits to users from "stand-alone" decentralization (i.e., small, independent computer activities in user departments): easier access to the technology, increased user involvement in system design and modification, increased sophistication in the use of the technology, and the opportunity for users to decide for themselves how computing best can be of service to them. However, these benefits will only accrue to users (and thereby to the organization overall) if the uses themselves are beneficial. Users must know how to distinguish wasteful from productive applications. User involvement in design will produce systems of greater utility only if users are sufficiently knowledgable about computing to design in the most productive features while leaving out fancy but costly "wish list" features. Users almost certainly will learn more about computing, but this knowledge must be comprehensive enough to engender a sophisticated understanding of computing and its role in the organization.

Where users will acquire these knowledge skills is unclear. A shortage of high-quality data processing personnel already exists, and so hiring complete staffs of specialists for user departments will be prohibitively expensive. Vendor-provided training might be technically valuable, but is unlikely to teach the more subtle skills of evaluating and judging the worth of systems needed to make users discriminating in their assessments.

Additional considerations arise with networked, as opposed to stand-alone, decentralization. There have been a number of advantages anticipated from combining decentralization strategies with telecommunications and networking technologies. Users will be able to "share" machines, thereby avoiding the loss of large available capacity from centralized arrangements. They will be able to tap into network-wide databases, reducing data redundancy and integrating their work with others in the organization. They will also be able to use their own and other machine or network resources and data interactively and more efficiently. Networking requires interdependency of equipment, and will reduce the tendency of decentralized units to adopt equipment that is incompatible with other units. Finally, networking will improve relations among units, facilitate organization-wide controls and computing management, and reduce problems of maintaining top management control common to decentralized, stand-alone systems.

These benefits are technically feasible, but they are even less likely to occur than are the benefits from stand-alone decentralization. They depend on unproven technological capabilities and uncommon organizational behaviors. The ability to share computing resources among networked machines is limited at this time. The major experimental networks (e.g., ARPANET and CSNET) do not allow actual linking of machine resources, but merely allow users to communicate with other network users or to move to the machine of their choice to conduct their work. Computing power is not shared among machines, but among users and host organizations, using a heavily subsidized recharge system that radically distorts the cost picture perceived by both hosts and users.

There are more serious limitations with the emerging network technologies, especially local-area networks designed to allow machine-to-machine communications at high data rates [Paul 1982]. The goal of designing such networks is to enhance communications among users and allow them to use different resources available through the network. Such networks could, in theory, provide a means for having both centralized and decentralized computing simultaneously. Shared functions (e.g., large processors, databases, special machines, or peripherals) could be provided from one location but be available to all through the network. Local users with their own processor and storage capabilities would also be able to use the shared resources through the net. The primary technical problems arise from the lack of standards for communications protocols, file structures, databases, and operating systems. Moreover, the basic goal of networking, which is to tie together different components (and therefore users) in the computing environment, will be difficult to accomplish as long as the various equipment manufacturers are undecided about whether universal standards should be adopted.[19] These problems may be solved in time, but as yet networks are not available in the same sense that mainframes or terminals are. Beyond these technical problems there are also unresolved management concerns, such as who will be in control of the networks and who will be allowed to connect to them. Networking is still experimental, and organizations that adopt networking must accept the attendant risks of experimentation.

The problems of data sharing engendered by decentralization also persist in a networked environment. Information provides users with power in proportion to the desirability of the information to others, and few organizational units are comfortable giving other units or higher management open and easy access to their data [Pettigrew 1972]. Centralized data processing forced departments to relinquish and centralize their data. But once users have their own systems, there will be no centralized authority to enforce data sharing through direct sanctions on computing use. Formal rules governing access to data are weak mechanisms of enforcement, since there are many ways for users to make the actual accessing of the data costly to those trying to get it. Users with their own computing capability can be difficult to hold in compliance with organization-wide rules. Networked decentralization will not necessarily alter this situation.

Increased interaction among users might not be facilitated by networked systems, either. It is dangerous to infer too much from experimental networks such as ARPANET and CSNET, because they involve technically sophisticated users (academic, research, and professional) with the needs

[19] The question of standardization has a long tradition in the computing field. The most notable split in standards has been in the differences between IBM and IBM-compatible equipment and those of most other manufacturers. But there has been a lack of standardization in basic communications protocols even within given vendors' product lines. The whole issue of communications and networking standards is in turmoil at this time, and how it will be resolved (or even whether it will be) remains an open question.

and skills to communicate with others on their highly subsidized nets. For most organizations the integration of work through networked computing will take a long time to evolve and will entail substantial costs as users learn what the networks facilitate and what they do not.

Compatibility of equipment will not be ensured by networking unless highly centralized control of procurement is maintained. Networked arrangements are subject to the same pressures that create incompatibility in other organizational contexts. In extreme cases, decentralized organizational computing centers adopt the strategy of "maximum feasible incompatibility" in computing equipment and operating systems procurement to make it difficult and costly for other centers to absorb them if the decision to decentralize computing is reversed.

Nor will networking decentralized computing establishments necessarily facilitate managerial control, because possession of computing capability is nine-tenths of the law in control of the technology. Decentralized units will seek to build up their capability to meet their own needs, possibly weakening the ties to the network and reducing managerial control options. Without serious top management restrictions at the unit level, and real control at some central node under direct managerial control, there is only the budgetary process and broad-brush, top-down policy to enforce management expectations on user behavior. Such weak enforcements are often more costly and less effective than the more direct control of access to computing resources that a central computer center provides.

3.3 The Interaction of Political and Economic Considerations

The importance of political versus economic considerations in the centralization debate depends on the situation at hand. When there is considerable organizational upheaval under way, political considerations can overshadow economic factors entirely. This can happen when departments are competing with one another for resources to expand, when top management is seeking to reestablish control, or when a new managerial strategy is being implemented (e.g., a move from highly central corporate control to divisional control). In other cases, the economic issues can turn undercurrents of change into serious options, or even force changes in order to take advantage of new opportunities. As we have seen, the high costs of computer processors once required many organizations to move departmental data processing activities to centralized units, but the declining costs of computer processors have recently enabled a movement of such activities back to departments. Other economic factors, such as the rising costs of software development and maintenance, the costs of networking, and the problem of supply and demand in the data processing labor market have equally important effects.

Neither the political nor the economic factors can be considered universally dominant. However, the fact that many organizations have chosen and stayed with less economical arrangements suggests that political factors often are paramount. This observation requires some qualification. The question of what is economical might entail more than the obvious costs and benefits: An expensive organizational strategy may be pursued because it is expected to yield long-run benefits. Nevertheless, the politics of organization and resources remains the fundamental factor in the centralization debate. Economic issues are frequently weapons in the discussion over policy that serve political ends. This does not mean that the economic issues are unimportant. Rather, it means that the larger set of factors behind the call for either course of action must be considered. We shall now address the basic management options for centralization/decentralization policy with these factors in mind.

4. MANAGEMENT OPTIONS IN CENTRALIZATION VERSUS DECENTRALIZATION

The fundamental question, when one looks carefully at the issue of whether to centralize or decentralize computing, is who will have control over procurement, use, and management? Traditional studies suggest that centralization generally is less costly to the organization. As the assessment of economic dynamics above implies, this is likely to remain the case despite falling entry costs for computing. But factors beyond economics are involved, and the economics themselves are often complicated. The challenge facing managers is to find an arrangement for computing that meets user needs as well as providing them with an opportunity to experiment with and learn about the technology, without writing a blank check for computing or creating problems for management control and organizational operations. We shall summarize the major management options for dealing with this challenge, and suggest a strategy for finding the appropriate option given organizational conditions.

4.1 A No-Option Option

Managers do not have the option of letting the issue resolve itself in a convenient and appropriate manner. There are two reasons why this option is foreclosed. One is the continuing presence of organizational factors that keep the debate alive, regardless of the strategy followed. The question is not whether the issue must be addressed, but when and how often. The other is the disappearance of automatic managerial control over computing growth resulting from the declining significance of computer procurement decisions. Unless managers want to issue categorical directives governing procurement and use, which in itself raises difficulties (e.g., Is a sophisticated programmable calculator a computer?), users that want small computers will probably find ways to acquire them. And even categorical directives can be disobeyed, subverted, or simply ignored.[20] Managers now must face and deal with a much more complex set of decisions than in the past.

[20] The author is familiar with one military organization that circumvented federal regulations centralizing procurement of computers by buying microprocessor-based diagnostic equipment not covered by the regulations, removing the microprocessors from the equipment, and throwing the rest away. Most administrative rules have loopholes. For a more detailed assessment of the effectiveness of policies governing computer procurement see General Accounting Office [1977].

4.2 The Centralization Continuum

Table 1 presents the major options managers have in arranging for the three major aspects of computing: control, location, and function. Each is presented as a continuum between extreme centralization and decentralization strategies. The intermediate arrangements noted do not capture all possible points between the extremes, but they do illustrate how one might arrange a compromise. Note also that even extreme decentralization does not preclude some organization-wide controls, facilities, or functions. There still might be a need for centralized arrangements to take care of organization-wide tasks such as computing personnel management. The key factor in extreme decentralization is that user departments are free to acquire their own computing capabilities and build their own computing operations. The intermediate arrangement has certain aspects of control, location, and function reserved for the center, while other aspects of these dimensions are devolved to user departments. The primary discriminator between centralized versus decentralized arrangements in this case is corporate versus user department needs.

As we have seen, each alternative has advantages and drawbacks. Extreme centralization keeps computing activity and growth under control of the center. It can provide economies of scale, and substantial overhead justification for procurement of expensive but specialized capabilities. It allows management to control adherence to organizational standards in system design and quality, and keeps track of computing activity. On the other hand, extreme centralization can result in the creation of an insensitive bureaucracy that fails to meet user needs, and that is difficult for users to interact with. In some cases, centralized operations grow lazy and fail to exploit new opportunities that computing might offer. Moreover, centralized service providers must account for their expenses, which tend to be significant and organizationally obvious. If computing is provided as an overhead item, top management often will wonder whether good use is being made of this expensive function. If computing services are charged back to users, the users often feel they pay too much for the services they receive. This is exacerbated if there are frictions between the central computing service and user departments. When backlogs for development of new systems grow long, which they do when maintenance demands of existing systems grow large, users begin to wonder whether their best interests are served by the centralized facilities. The lure of low entry costs for getting their own computing capability provides a strong incentive for departments to lobby for decentralization, backed up by claims of poor service and high costs from the centralized facility.

Extreme decentralization, on the other hand, provides much greater flexibility for users in exploiting computing technology and adapting it to their needs. It gives them the opportunity to learn about computing in much greater detail, which can eventually make them more effective consumers of this technology. Properly handled, it can build up the computing talent of the overall organization by creating a "grass roots" computing culture. It can enhance the willingness of departments to accept changes that might be beneficial to the organization. It can also improve productivity when sensible applications of the technology take place at the departmental level that could not or would not be provided by centralized service. The drawbacks of extreme decentralization are that overall organizational costs of computing are likely to rise. This is acceptable if productivity improvements rise commensurately, but this will not happen unless the departmental uses of computing are well planned, well executed, and well maintained. New users have yet to learn the lessons their more experienced counterparts have learned, and the price for this learning can be dear. Moreover, departmental personnel who become competent in computing soon discover the marketability of their new talents, and either demand wage increases or leave for better opportunities (sometimes within the larger organization). If they stay, they may begin to view themselves more in terms of their computing activities than their functional responsibilities, causing personnel problems. Perhaps most important for top management, extreme decentralization can make it very difficult to keep computing activities in line with organizational goals. Once user facilities and computing operations are in place, the costs of change to conform to new organizational guidelines can be prohibitive. Giving away control is often easier than getting it back.

Intermediate arrangements appear to be a promising compromise solution. It can be very effective to retain centralized control, facilities, and functions in cases where this is necessary or desirable, while allowing limited decentralization where the payoffs are likely to be high. Thus top management might reserve for the center those activities and functions upon which the organization as a whole directly depends, while allowing users to take advantage of the technology within guidelines ranging from strict to relaxed, depending on circumstances. This strategy will probably characterize most computer-using organizations in the future, but intermediate arrangements have important drawbacks. The question of which compromise arrangement to pursue is difficult to answer, and in its own way embodies the problems of the overall debate. It is sometimes impossible to differentiate between computing activities that are organization wide and those that are department specific because some serve both purposes. The question remains whether control should be left to the center or transferred to the outlying units.

Intermediate strategies also require extensive attention from both top management and departmental management. Planning and executing an intermediate arrangement requires creation of protocols to govern who is responsible for what and in which cases. Central management must find a way of relinquishing some control to departmental management while encouraging conformance to the goals of the overall organization. Once arrangements are in place, they must be maintained and enforced. The creation of a compromise does not eradicate the root causes of centralization disputes; it merely finds a way of acknowledging the different interests involved and providing them with at least some of what they want so they can get on with the organization's business. The same

Table 1. Major Management Options in Centralized versus Decentralized Computing

	Control	Location	Function
Extensive centralization	Consolidation of all decisions regarding computing procurement in one place, systems development and maintenance, priority setting for systems work and resource usage, accounting for resource use, and responsibility for evaluation of computing's contribution to the organization and quality of service. Users make inputs to these decisions through advisory mechanisms, such as an advisory board, or by direct contacts between the central control unit and departmental management and users.	Establishment of one (or very few) consolidated facilities for provision of computing resources and services, including processing, storage, major peripherals, and physical environments (e.g., terminal rooms, tape storage). Allow users access to these resources and services through remote terminals and RJE equipment, installed and maintained by the central facility, and maintain contacts with users for service requests by establishing appropriate mechanisms (e.g., assigning "account managers" to different user groups to deal with user needs and problems).	Consolidation of all major computing functions (e.g., hardware operations, systems and applications programming, telecommunications, quality control, documentation, maintenance, and systems management) into one or very few centers, colocated with the centralized facility. Require departments to conform to central protocols for use of these functional resources. Training of users done by the centralized resource. Allow users to manage only those computer-related functions directly related to their departmental activities (e.g., data entry). Allow user participation in system design. Have users evaluate the service provided by the centralized functions.

Intermediate arrangements	Retention of central management control, either through an appointed executive or a committee (which might include user representatives), over all major computing procurements (e.g., choice of vendors, large purchases, compatibility standards, and networking characteristics), all organization-wide systems decisions, setting of organization-wide computing priorities, accounting for systems investments and use, and monitoring of system quality. Allow users to make department-level decisions for departmental computing equipment procurement, departmental systems planning, quality control, and systems management, but under strict guidelines provided by the central control group. The central control group would either directly enforce organizational guidelines, or would suggest to higher management when and what enforcement actions are necessary.	Consolidation of major computing resources (e.g., large and expensive equipment, databases, network facilities) into one or very few centers, and make these available to users through remote access equipment. Allow users to create their own facilities for smaller scale, department-related computing activity. Maintain oversight of the scale of user operations to ensure against extensive duplication and waste. Establish, where appropriate, networking among central and user facilities to allow transfer of data and files, and sharing of resources.	Consolidation of major functions (i.e., highly specialized or expensive functions) such as systems programming, telecommunications management, database management, network management, or quality control. These might be consolidated in a "pool" arrangement provided by a major facility, or as a staff function of upper management. Allow users to acquire their own functional capabilities for department-related needs such as applications programming and local database management. Users manage and maintain their local facilities.
Extensive decentralization	Devolution to user departments most or all decision-making authority over procurements, system development and maintenance, priority setting, system use accounting, and quality control. Enforcement of organizational expectations about productivity resulting from user-based computing activities would be through normal merit review and monitoring of departmental computing activities.	Devolving to users the right to establish their own computing facilities where they choose to do so. Require users to utilize centralized facilities only when necessary to meet organization-wide needs when these needs cannot be met through use of networking.	Devolution to users the authority to establish their own functional resource centers, and permit total user control over filling the activities of those resource providers into departmental operations. Users provide for their own facility management, quality control, and training, though perhaps through contractual deals with other departments.

changes that affect the traditional centralization debate will affect any compromise.[21]

4.3 Mixed Strategies

The discussion thus far has focused on the three points along the centralization/decentralization continuum. It is not necessary, however, to maintain the same degree of centralization across the board. For example, some organizations maintain centralized control and facilities, while allowing users to acquire their own applications programmers or other functional capabilities. These mixed strategies can work well, but there are some restrictions. Theoretically, one could choose any cell from each column in Table 1 when determining computing arrangements. In practice, mixes can only be made by choosing cells across or downward to the right of the table. Thus, for example, it would be possible to have highly centralized control, somewhat decentralized facilities, and either somewhat or widely decentralized functions. It is not feasible to choose mixes by moving upward to the right, because of the critical influence of control over location and function, and that of location over function.

This does not imply that a federation of independent users cannot form a consortium and pool their resources to establish a centralized computing facility with centralized functions. This can and does happen, as when the federation of local governments in Denmark created Kommunedata to provide computing service to nearly every local government in the country [Romer 1979]. But such examples do not undermine our argument for several reasons. In the first place, the practical effect of the federation's action is to place somebody (i.e., the central facility's leadership) in control. A board of directors representing the federation might provide policy direction and hire and fire the director of the service, but they cannot practically control the function of the service from the top down. Second, most arrangements of this kind (including Kommunedata's) soon begin to feel the tugs of centrifugal force as members of the federation want to pull out and develop their own capabilities. If the independent units do retain control, this is an option they can pursue. If they cannot pull out, they have relinquished control.

This leads us back to the issue of the relationship between location and control, and the influence of location over function. As we noted earlier, those who control centralized facilities can direct the actions of users of the facilities by simply witholding or restricting service to user departments that fail to comply with facility management. Centralized facilities will usually be responsive to highly centralized, top management controls, but they need not be responsive to a consortium of users.

Location (or facilities, in the case of computing) influences function in the same way that control influences facilities. Functions that are dependent on computing are tied to the facilities they utilize, and must conform to their demands. Moreover, when functional resources such as programmers are decentralized to user departments, split loyalties can result. Analysts and programmers serve their departments, and may even depend on departmental evaluations for their employment and advancement, but they are part of the culture of computing. They need access to the facility's computing resources, and they share common bonds of knowledge and career with its staff. Yet it is possible to have centralized facilities and decentralized functions as long as the responsibilities of the decentralized specialists to their operating departments are clear.

When facilities are decentralized but functional personnel are not, computing personnel find themselves facing the problem of employees in "matrix organizations": Their administrative home is in the central department or pool, but they work in the decentralized departments of facilities. The people who evaluate them for advancement within the pool do not have much contact with the work they actually do. Eventually, these functional specialists tend to move their positions to the facilities and depart-

[21] Intermediate arrangements such as those suggested here have been the subject of many recent articles on organizing the use of computing and information technology in organizations. See in particular Allen [1982], Buchanan and Linowes [1980a, 1980b], Jenkins and Santos [1982], Lucas [1982], McKenney and McFarlan [1982], Rockart et al. [1979], Sprague and Carlson [1982], and Withington [1980].

ments that they serve. Thus decentralized location encourages decentralized functions.

The practical options for arranging control, location, and function in computing therefore tend to flow downward from control arrangements. This limits the options suggested by Table 1, but is advantageous in that it reduces the number of alternatives that management must consider. As long as control is seen as the crucial dimension of the centralization/decentralization debate, and the arrangements for location and function reflect the behavioral realities that arise from control decisions, sensible arrangements are possible. It should also be noted that there might be more than one stable configuration for an organization within this framework.

4.4 Choosing an Option

The final question to consider is which option is appropriate for a given organization. There is not sufficient space here to describe all the cases in which various configurations might be appropriate, but here are some guidelines for the decision process.

First, control must be recognized as the most important issue in making centralization/decentralization decisions. The prevailing norms of the organization can provide guidance for dealing with control over computing. If the organization is highly centralized in most of its operations, a highly centralized control arrangement for computing is possible and probably sensible. Similarly, if the organization follows highly decentralized control policies, such as establishment of operating units as profit centers, decentralization of control might be necessary and desirable. Most organizations have a range of control arrangements, depending on what is being controlled. Decisions about control over computing should parallel those organizational arrangements governing the areas in which it is applied. Thus, if computing is applied mainly to centralized financial activities, centralized control of computing should be appropriate. On the other hand, if computing tends to be a general-purpose resource used for many different kinds of applications at the department level, and departmental managers have considerable autonomy in how they run their operations, some decentralization of control to these managers might be appropriate. The goal is to ensure that the arrangements for controlling computing are not wildly out of keeping with other organizational practices.[22] Computing should not be thought of as a tool by which the basic structures and behaviors of organizations can be changed.

Second, the issue of control must ultimately be decided by central management, who retain responsibility for overall organizational operation and performance and cannot avoid being judged for its decisions. This remains true whether there is a deliberate or an unconscious policy regarding control of computing. Central managers should remember that decentralization of

[22] Committees are a popular means for incorporating the ideas of outlying units into direction provided from the center. This approach has recently been recommended as a means of dealing with the new era of centralization/decentralization issues [Nolan 1982]. Research into the effectiveness of user committees suggests that they are not very effective at solving major political problems in the management of computing [King and Kraemer 1984; Kraemer et al. 1981; Kraemer and King 1981]. It seems that the basic problems of control remain. The growing literature on the subject of citizen participation provides a useful analogy to the problems faced by incorporating users in political decision processes. For example, Arnstein's [1969] "ladder of participation" suggests that there are eight "rungs" representing levels of actual power conferred on participants: citizen control; delegated power; partnership; placation; consultation; informing; therapy; and manipulation. Only the top three confer genuine power on committee members, and these of course require that actual power be relinquished from the center. The middle three rungs provide for some opportunity to assess the desires and frustrations of committee members, but action on these remains the perogative of the existing elite. The bottom two rungs can actually result in deterioration of performance because the committee can serve as a shield behind which inadequately performing central actors can hide while maintaining the appearance of sensitivity to users. Perhaps the most useful role that committees can serve is to help improve the sensitivity of both data processing specialists and users to one anothers' needs and problems, and facilitate what political scientists call "mobilization of bias" among participants around genuine problems that can be solved by collective action.

control can be profitable in some circumstances, but it can also be a source of many problems if not done in a manner that ensures benefits for the organization. Recentralization of control can be difficult or even impossible, and will usually be expensive.[23]

Third, managers should be cognizant of the ramifications of computing location decisions, which should be delayed until the issue of control is settled. Decentralization of computing location often has the practical effect of decentralizing control. Centralized control and decentralized location are possible and perhaps desirable, but the arrangements must be thoughtfully worked out, implemented, and enforced.

Fourth, location decisions should be based on a careful assessment of the actual uses the organization makes of computing. If those uses depend on computing capabilities that are only provided by large and expensive processors or other costly resources, it might be infeasible to decentralize. Many organizations have discovered too late that the small machines purchased by departments are incapable of handling certain major applications now being done (i.e., the large central systems must be retained), or that the portfolio of applications desired by the departments will soon outstrip the small initial systems. Many smaller computer systems have limited expansion potential. Failure to review present and future applications can result in naive expectations about which computing resources will be required.

Fifth, location decisions should be based on current technologies, not on expectations about new possibilities. Emerging data communication technologies, by allowing networking, expand the options for deploying computer equipment. However, this technology is still in its infancy. Only the most technically advanced organizations will succeed in the endeavor to install sophisticated network systems. If past trends in diffusion of new computing developments hold true, the majority of organizations will not be able to adopt this technology for at least five years. More important, networking does not alleviate the problems of control raised by decentralization of location, and in some cases it can create new problems, as we have seen. At the very least, networking is an integrating technology, and as such brings with it the difficulties associated with integrated systems noted above. New technologies do not provide a simple fix for the problem of centralized versus decentralized facilities.

Sixth, current arrangements should be evaluated carefully before a change is implemented. Too often, problems with present arrangements stimulate demands for major change when these problems might be attenuated by minor changes. Sometimes, increasing the resources of the computing center can meet these user needs at lower cost than establishing decentralized facilities and functions. Conversely, if decentralized arrangements are causing trouble for integrating applications and meeting organizational guidelines for compatibility of equipment, stricter procurement protocols and centralized approval for procurements might be the answer.

Seventh, it should be recognized that there is a drive toward decentralization of computing among users. This drive is likely to grow stronger as entry costs for computing decrease, for reasons that we have discussed at length. The development of appropriate computing arrangements requires a careful assessment of the factors motivating the proposal to decentralize. Improvements in effectiveness and better user departmental uses of computing are likely to be cited, whereas a desire to gain new resources, increased budgetary leverage, or the entertainment value of computing will probably be left out. All of these factors can

[23] It is frequently suggested in prescriptive literature on the management of computing and data processing that top management should be actively involved in decision making. Recent research suggests that intensive involvement of top management in such decisions is associated with higher levels of computing problems, although why this is the case in not clear from the data [King and Kraemer 1984; Kraemer and King 1981]. More often, what data processing managers need is not the involvement of top management, but their support. A lack of top management input to decision making still allows for appropriate decisions to be made in many cases, but a lack of top management support for the data processing managements' decisions can easily cripple their implementation.

play a role in proposals to decentralize computing, and it is sometimes difficult to determine what is really at issue.

5. CONCLUSION

The debate over centralized versus decentralized computing has been around for a long time, and will be around for a long time to come. Changes in the technology will not resolve the issue because the most important factors in the debate are grounded in constant reassessment of where control of organizational activities ought to reside. Changes in technology merely alter the options available and the economies surrounding them. Nevertheless, decisions must be made at least for the short run. Computing capability must be provided, preferably in a manner that services the subunits of the organization and the organization as a whole. There is no universal "best" solution, and so each organization must find its own. With proper attention to the endemic organizational issues surrounding the debate, the economics of various arrangements, and the prevailing norms and goals of the organization, it is possible to construct an arrangement that will serve until new technological or organizational developments force a reconsideration.

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