THE INFORMATION TECHNOLOGY
FUNCTION OF THE 1990s:
A UNIQUE HYBRID

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June 1991

CISR WP No. 225
Sloan WP No. 3332

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ABSTRACT

The role of the information technology (IT) function and its relationship to other business functions is under constant and growing examination. While centralization of some IT resources is occurring in a number of organizations today, in many there is a very perceptible, and much publicized, decentralization of IT resources and responsibilities to line divisions and functions. In this paper we attempt to provide a conceptual understanding of the IT function -- a generalization which may be useful to managers and educators, who must deal with these difficult issues. Our view is that the function will be long lived and that it will evolve into a hybrid type of organization with line responsibility for the management of technology, and staff responsibility for a number of other critical roles. The paper describes IT in terms of its staff and line responsibilities with emphasis on the nature of the IT infrastructure, which is significantly different than the infrastructures that support other staff functions of the firm. We also present the essential elements of the technology infrastructure and develop some principles for deciding which aspects of information technology should be managed centrally versus which should be managed in a decentralized manner. To summarize our view that the IT role is unique, we present a model of the function and then discuss two key emergent IT staff roles. Finally, the paper provides some prescriptive conclusions that will hopefully be of value to senior management, IT executives, and IT educators.

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INTRODUCTION

The role of the information technology (IT) function, and its relationship to other business functions, is under constant and growing examination. While centralization of some IT resources is occurring in a number of organizations today, in many there is a very perceptible, and much publicized, decentralization of IT resources and responsibilities to line divisions and functions. In fact, some organizations are questioning the need for an IT executive -- sometimes referred to as a chief information officer (CIO) -- or even a central systems department. This lack of certainty about the future of IT manifests itself in education as well; in some universities the legitimacy of information systems as a field of study is being questioned. In this paper we attempt to provide a conceptual understanding of the IT function -- a generalization which may be useful to managers and educators, who must deal with these difficult issues.

A few people, notably Dearden (1987), take the position that the information technology (IT) function is an anachronism that has served its purpose and should be allowed to wither and die. While not as extreme, Hopper (1990) foresees the ultimate demise of the IT function. However, the weight of today's opinion (Benjamin, Dickinson, and Rockart, 1985; Clemons and McFarlan, 1986; Rockart, 1988; Dixon and John, 1989; *Harvard Business Review*, 1990, pp. 176-182) is that the function will be long lived and that it will evolve into a hybrid type of organization with line responsibility for the management of technology, and staff responsibility for a number of other critical roles. In this paper, we build on this view, drawing on the managerial literature to explain why this is so.

The current confusion surrounding the present and future role of the IT function is not surprising. The function is unique in the roles it takes on and the services it provides. All other organizational functions are either line or staff in nature. As we will point out,

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however, the IT function must be conceptualized and managed as a line/staff hybrid *unique* in organizational history.

While some forward-thinking articles on this subject today do refer to the IT function as a "hybrid" (Dixon and John, 1989; von Simpson, 1990), they do not dwell on the reasons underlying the singular organizational form in which IT now finds itself. A firm understanding of IT's uniqueness is very important. Executives use "models" to make decisions. Attempting to model the IT organization after other functions in a company can lead to unfortunate outcomes. As we note in the final section, a line/staff hybrid model of the IT function leads to three major conclusions, to wit:

- the IT organization, most often with a strong central management, will be long-lived;

- the role of the chief information executive (the "CIO") will grow, not diminish in importance; and

- increasing attention must, and inevitably will be, placed on IT infrastructure.

To set the context, we briefly discuss in the next section some of the forces currently influencing the IT function. Then the paper describes IT in terms of its staff and line responsibilities with emphasis on the nature of the IT infrastructure, which is significantly different than the infrastructures that support other staff functions of the firm. We also present the essential elements of the technology infrastructure and develop some principles for deciding which aspects of information technology should be managed centrally versus which should be managed in a decentralized manner. To summarize our view that the IT role is unique, we present a model of the function and then discuss two key emergent IT staff roles. Finally, the paper provides some prescriptive conclusions that will hopefully be of value to senior management, IT executives, and IT educators.

MAJOR INFLUENCING FORCES

The question of the role(s) of the IT function, and the way in which it should be managed, is particularly significant at this time. Five major influences are shaping both management's perception of the function and its evolution. They are:

1) The increasingly high level of expenditure for IT within the firm, and a growing concern that IT is not delivering its money's worth. Year by year, the accretion of IT applications within the firm has created an increasingly expensive technology infrastructure and suite of applications. Current studies in the trade press indicate a significant growth in the percentage of firm revenues spent on IT (Alter, August 1989). In a growing number of cases, information-intensive firms are spending greater than 5% of revenue on IT. As these IT expenditures increase, more management attention is being paid to the function. Evidence convincing to senior management that hard benefits result from use of the technology is difficult to come by (Strassmann, 1985; Loveman, 1988).

2) The perception that IT resources should be close to the "user organization". Personal computers are increasingly powerful. Local area networks have come into their own. And, most important, it is increasingly evident that real progress is made when user management is deeply involved in directing the IT resource to key business uses.

3) The increasing economic attractiveness of IT as a capital investment versus labor and other forms of capital (Benjamin and Scott Morton, 1988). IT's cost performance and functionality have improved rapidly as compared to labor costs for the past three decades. There are clear indications that this will continue for at least another two decades. This cost performance imperative has had the effect of continually increasing the demand for IT applications and supporting hardware and software technology.

4) The increasingly powerful functionality of IT as a coordinating technology, enabling electronic integration of business processes within firms, across firms, and within markets (Rockart and Short, 1989). Malone (1988) defines IT as the first coordinating technology, contrasting it with production technologies. Coordinative properties most critical in enabling integration of business process (Yates and Benjamin, 1991) are collapse of time and distance, accessibility of organizational memory (data, image, and procedure), access to others, and flexibility of process design. It is these properties that are taken

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advantage of in the electronic integration of the firm, as manifested in electronic hierarchies and markets (Malone, Yates, and Benjamin, 1989).

5) The recognition that IT can play a major role in supporting the firm's strategy. This manifests itself in the ability to eliminate the buffers of inventory, people, and time that clog today's business processes in most organizations (Rockart and Short, 1991). World class competition is forcing companies to streamline their business processes, eliminating these and other costly buffers which were acceptable in less competitive times, but cannot be tolerated today. Effective IT use is seen as integral to maintaining organizational integration without these buffers which formerly "lubricated" the organization.

THE NATURE OF THE IT FUNCTION

The net impact of these divergent, often conflicting, forces is that the role of IT, and its relationship to the business functions, is under constant and growing examination. Management, although often aware of the benefits of IT, is perplexed about how much to invest and, more germane to our purpose here, how to organize the function in order to gain both effective business systems and efficient use of information technology. To cast some light on this organizational issue, we first turn to two business theorists -- Alfred Chandler and Henry Mintzberg. In particular, we focus on their views concerning the nature of line and staff functions.

Contrasting Roles of Line and Staff

Line and staff relationships within organizations have evolved in a consistent and orderly way since the 1850s. The first to carefully examine this issue was Chandler (1962). He described the development of the modern corporation from individual small businesses in a market-dominated society to large, vertically integrated enterprises over the 120 years from 1850 to 1970. Chandler's perspective on line and staff personnel was simple and straightforward. They were two separate classes of people. Line managers were the "doers" and staff professionals were the "appraisers" and "standards setters" for the organization.

Writing more recently, Mintzberg (1979) provides an enlarged view of line and staff. He sees line consisting of three hierarchical levels: the "apex" (the decision-makers of the organization), the "middle line" (mid-level managers), and the "operating" core (who carry out the basic work of the organization). Line managers, therefore, are "those managers in the flow of formal authority from the strategic apex to the operating core" (Mintzberg, 1979, p. 21).

Mintzberg's view on staff is also richer and more complex. He defines two different kinds of staffs, the *technostructure* -- "the analysts who serve the organization by affecting the work of others" (Mintzberg, 1979, p. 29): who set standards, analyze, and advise the line decision-makers at various levels of the organization, and the *support staffs* who "support the functions of the operating core indirectly, outside the basic flow of operating work," such as the public relations department or the cafeteria.

Interestingly, in his 17-page description of this more detailed organization, Mintzberg never refers to the information technology function. It may be that he found IT extremely difficult to classify. And so it is. Elements of IT are found today in three of Mintzberg's five organizational parts, both types of staff organization and one segment of the line.

The Line and Staff Nature of the IT Function

Clearly, IT has components in the *technostructure*. In almost every IT organization today there are "people who advise the line" and those who are charged with "setting standards" for hardware, software, networks, and so forth. There are also IT components who serve as *support staffs*, providing "help desks," running scientific time-sharing systems, and developing systems, for example.

These two sets of staff functions are clear. But what of the IT operations personnel, those people who actually run the networks and the day-to-day operations of the computers which perform the transaction processing and information producing systems of the firm. Are they part of the technostructure? Clearly not, since Mintzberg points out that people

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involved in the technostructure are primarily analysts and advisors. Are they part of the "support staff?" Here, again, Mintzberg will not allow this classification since support staff "exist to provide support to the organization outside the operating work flow" (Mintzberg, 1979, p. 30) and it is very evident today that if the IT function were to be shut down, the "operating work flow" would cease entirely in many organizations (banks, insurance companies) and be greatly disrupted in others (manufacturing firms, air express companies). How, then, are we to describe the organizational status of the people involved in managing and running IT "operations"?

The answer, in Mintzberg's terms, is that they are involved in a line function and are part of the "operating core." People in the operating core, he notes, perform four prime functions. They (1) secure the inputs for production; (2) transform the inputs into outputs; (3) distribute the outputs; and (4) provide direct support to the first three functions. Examples of direct support are "performing maintenance on the operating machines and inventorying the raw materials" (Mintzberg, 1979, p.24). We contend that there is now a clear example of IT direct support. It is the provision of "infrastructure services" (running the information technology infrastructure) by the IT operations organization.

The traditional model of line/staff describes an organizational construct where all operations critical to line commitments report to the line organizations. This model, however, does not reflect current and, we believe, future IT organizations. The key to the puzzle is the nature of infrastructure services, past and present.

NATURE OF INFRASTRUCTURE

Chandler (1962, pp. 145-153) describes how staff roles have evolved in order to meet the needs of administrative coordination. He uses, as an example, the development of the financial infrastructure by Donaldson Brown within DuPont and General Motors. Chandler's use of the term "infrastructure," with which we agree, is consistent with the definition that follows.

"A substructure or basic foundation, esp. the basic installations and facilities on which the continuance and growth of a community, state, etc., depend, as roads, schools, power plants, transportation, and communications systems" (Webster, 1984).

Evolution of Finance and Personnel Infrastructures

The seminal financial infrastructures at companies such as DuPont and GM were designed to provide the coordination necessary to manage the transition from multi-functional to multi-divisional businesses. They consisted of a chart of accounts and both planning and budgeting systems that facilitated the aggregation and interpretation of data from the functions and operating divisions. These financial infrastructures insured that the necessary data flowed from the line accounting systems to the financial oversight systems. They served their purposes well and became a model for most large businesses. This financial infrastructure became even more important as external legislative requirements demanded more complex reporting and defined an increased level of fiduciary responsibility for the financial executive and the CEO. The need to ensure the effective operation of this infrastructure added a "support staff" responsibility to the primary "technostructure" roles (cash management policy, financial advice) previously held by the function.

The external influence of legislative requirements of the 1960s and 1970s also created the need for an equivalent organization-wide personnel infrastructure. Thus, a second dual staff organization was born with "support staff" infrastructure responsibility (a clear mandate to manage an effective information gathering and reporting system concerning human resources in the organization) added to its traditional "technostructure" staff oversight and policy roles (hiring policies, compensation standards, etc.).

These support staff infrastructure activities embedded within well-defined staff organizations are not, however, very intrusive, and certainly not vital, to activities of the mainstream operational line managers. They merely report events after they happen and do not affect the line managers' ability to deliver commitments. Thus, they are not

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considered vital on a day-to-day basis, and line managers do not feel even a remote need for ownership of them. The IT infrastructure, however, is different in many ways.

EVOLUTION OF THE IT INFRASTRUCTURE

The need for an IT "infrastructure" has emerged slowly, but surely, in the four decades of computer use. The earliest applications were essentially built to support a single function. Among these were payroll and general ledger, order entry, and manufacturing control. Then applications were developed that served multiple organizations, such as the set of human resource systems -- payroll, benefits, personnel records, etc. Subsequently, network capabilities were added, followed by databases separate from individual applications. At this point the primary elements of the IT infrastructure were in place. The next major requirement for IT infrastructure services was the need to connect individual users to the network, whether they were PC users or users of sophisticated engineering workstations. Interconnection problems now have become very formidable. A "Fortune 100" company might need to connect upwards of 50,000 workstations to hundreds of computers and databases within the company, as well as to external suppliers and customers. The IT infrastructure of today must enable process-oriented systems to pass data between functions and across divisional and geographical boundaries, as companies "wire" themselves internally and externally.

IT Infrastructure Elements

The key differentiating element of the IT function is its infrastructure. This infrastructure supports individual line and staff functions, but also increasingly supports interfunctional and interorganizational process-oriented systems (Figure 1.). It is composed of a number of technology elements that have been well described in numerous papers and books. Management's challenge is to combine these elements into an organizational arrangement that will satisfy the cultural, economic, and integration needs of the

company A   company B

staff groups

finance	personnel

staff groups

finance	personnel

Value Chain

enginr'ng	manuf'ng	distribution	service	sales

Value Chain

enginr'ng	manuf'ng	...etc.

IT Infrastructure

IT Infrastructure

LEGEND:
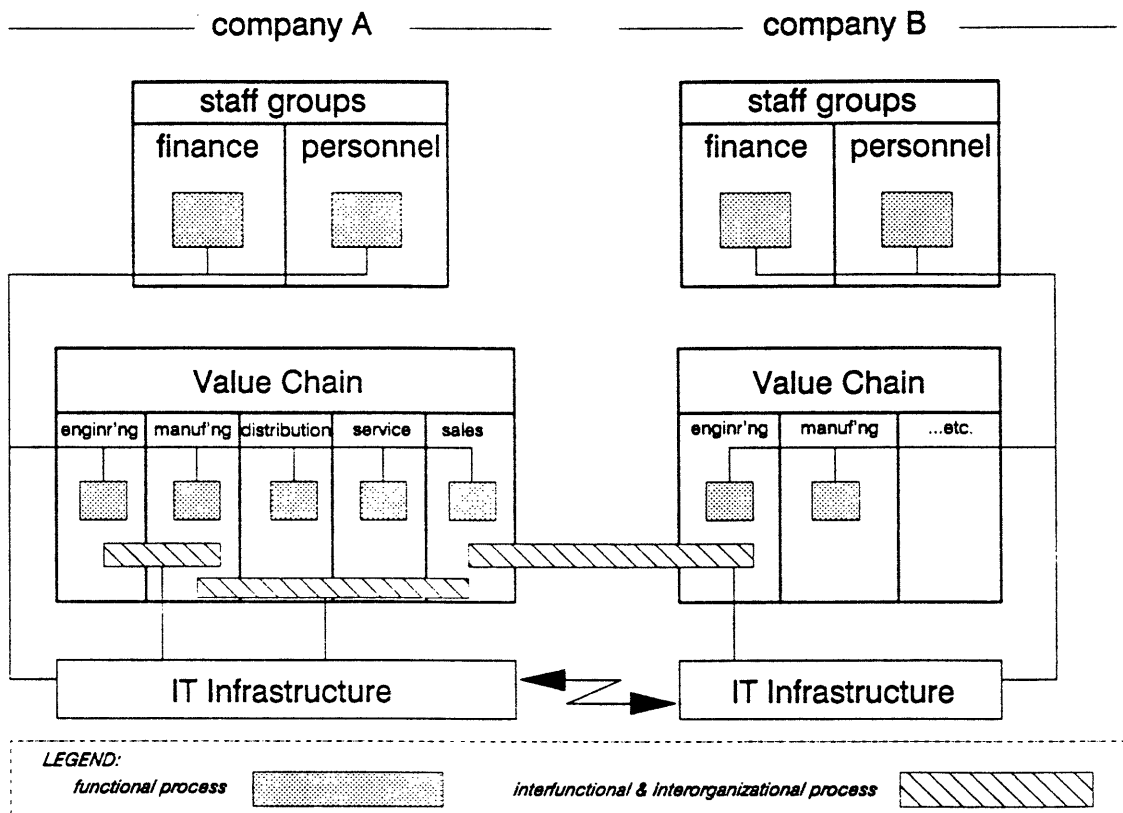functional process   interfunctional & interorganizational process

Figure 1. Schematic of IT Infrastructure

organization (as discussed later in this paper). The technology elements that must be combined are:

- computers,

- telecommunications services,

- workstations,

- technology architecture and standards, and

- applications and databases that serve the entire organization.

Key Differences in Infrastructures

Examining the nature of the IT infrastructure, we note several key differences between the IT and the finance and personnel infrastructures.

- The primary motivation for the growth of the finance and personnel infrastructures has been to support external governmental reporting as well as internal post-operations monitoring. The primary motivation for the IT infrastructure, however, is to support the daily operational needs of the internal organization. Only secondarily does it support post-operations monitoring.

- The form of the finance and personnel infrastructures is *conceptual* and *procedural*, e.g., chart of accounts and affirmative action reporting procedures. The form of the IT infrastructure is that of a highly technical *physical* operation, encompassing computers, networks, and workstations.

- Because of its high technology component, the IT infrastructure is always changing. Consequently the investment is large and requires multi-year funding, while the finance and personnel infrastructures change more slowly and require minimum funding to maintain.

- The IT infrastructure is a direct enabler of necessary business processes. It is embedded within each function's business processes and in many cross functional business processes, making it very difficult to separate information tasks from the physical or service tasks performed in the business process. To illustrate, an ATM transaction is inseparable from a bank's retail business process. In a similar manner, in a manufacturing firm, a CAD workstation

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which provides design capabilities as well as access to information concerning drawings, cost data, failure data, etc., is an integral part of the design, engineering, manufacturing, and procurement functions.

- The finance and personnel infrastructures primarily serve only the organization itself, while the IT infrastructure has a key role as a linking element to business relationships with other organizations, as typified by Electronic Data Integration (EDI) applications.

- The finance and personnel infrastructures are valuable to management as key measurement vehicles for evaluating strategy. The IT infrastructure, on the other hand, has come to be recognized as a key enabler of strategy.

These differences between the IT, finance, and personnel infrastructures are summarized in Figure 2.

The Design of the IT Infrastructure

The role of the IT function in each company is highly dependent on the nature of the IT infrastructure which has to be managed. In order for the IT infrastructure to fit the specific needs of the firm, its design requires an appropriate balance of three key variables:

1) The level of interdependence or integration of process required by the organization for effective operation;

2) Economies of scale required by cost pressures in the industry; and

3) The corporate culture.

The second and third of these variables are straightforward. With regard to the second, a highly centralized infrastructure is *probably* most economical for certain components (networks, mainframe computers, many databases) if designed and operated well. Allowing suborganizations to implement their own infrastructures, while possibly more effective in serving the particular suborganization(s), will most often lead to greater costs.

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CHARACTERISTICS	FINANCE/PERSONNEL	INFORMATION TECHNOLOGY
primary motivation	external	internal
form	conceptual/procedural	physical (computers/networks)
primary usage	reporting	operations and reporting
relationship to business process	abstracts data from	embedded within
scope	within organization	within organization, but also to customers and suppliers
change dynamics	low to moderate	very high
relation to strategy	measures results/strategy	enables strategy
capital requirements	minimal	large -- multi-year

Figure 2. Infrastructure Differences

And culture can lead to decisions about infrastructure which ignore, or tend to override, costs and logically appropriate business integration needs.

Of particular importance is the degree of business integration which is logically present in the organization. A highly integrated company requires an infrastructure sufficiently large and complex to serve the overall integration needs of the business. Companies such as computer and aerospace manufacturers (Digital Equipment Corporation and North American Rockwell, for example) fall into this category. Companies that serve separate definable sets of customers, and therefore are organized by business groups or sections (such as Sara Lee or Johnson & Johnson, for example), on the other hand, generally do not require a high degree of integration at the corporate level, and consequently do not require a complex *corporate-wide* infrastructure. Some pure conglomerates such as Transamerica have eliminated all corporate infrastructure and staff oversight as well. The importance of organizational interdependence in shaping the infrastructure cannot be overemphasized.

AN EVOLVING MODEL OF THE IT ORGANIZATION

The IT organization is today in transition. It is moving from polarized, centralized, and decentralized models to an organization characterized by more complex, more organic, and more appropriate staff *and* line roles. We suggest that the most appropriate lens to view the IT organization is through Mintzberg's formulation. Elements of the IT functions are found in both staff groups (support staff and technostructure) to support, guide, and evaluate the effective use of the technology throughout the organization. More importantly, elements of the IT organization provide a vital, cross-functional embedded *line* service in operating the infrastructure of the firm. The IT executive, therefore, has a role unique in organizational history -- having in one function the responsibility for managing the vastly differing roles of staff and line managers.

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The uniqueness of this role, and the diversity of it, has led to much of the uncertainty cited at the beginning of this paper. What is more, the role is becoming more complex. In addition to management of the ongoing major line and staff functions, the IT executive has a growing involvement in two significant staff roles which are emerging as vital to the success of the IT function and, we believe, to the organization itself. These are:

- IT advocacy as a member of the executive management team; and,

- the development of partnerships with key users.

Executive Management Role

With increasing frequency, decisions vital to a firm's future are significantly influenced by information technology. Senior management in a number of companies has realized the importance of having an insider able to interpret and translate IT's capabilities and implementation risks included in executive management discussions and processes. The promotion of Ray Cairns of DuPont, and his inclusion in the senior management group of the company is illustrative of this. Significantly, electronic integration and the re-engineering of the firm are becoming so compelling today that the IT executive who understands the business and is viewed as part of executive management can act as a powerful advocate for effective change.

Partnership Role

The movement away from the domination of all IT activities by the IT organization has been going on for fifteen years. It was, and is, inevitable. As IT invades all parts of the business, line management must take responsibility for the effective business use and implementation of technology. But the IT organization will still provide expertise, educate, build many systems, and manage the infrastructure. To enable this divided responsibility to work effectively, partnerships between IT and the line must be developed. As Dixon and John (1989), see it, "IT manages the technology, and line executives manage the use of the technology through partnerships with IT." Thus for the IT executive, a key critical success

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EXECUTIVE MANAGEMENT — The IT Executive

STAFF ROLES

LINE ROLE

Technostructure
▲ Key traditional roles
  – Standards, policies
  – Appraisal
▲ Emerging roles
  – Executive participation
  – Partnership with line
Support staff
▲ Systems development
▲ "Help desks"

Direct support
through
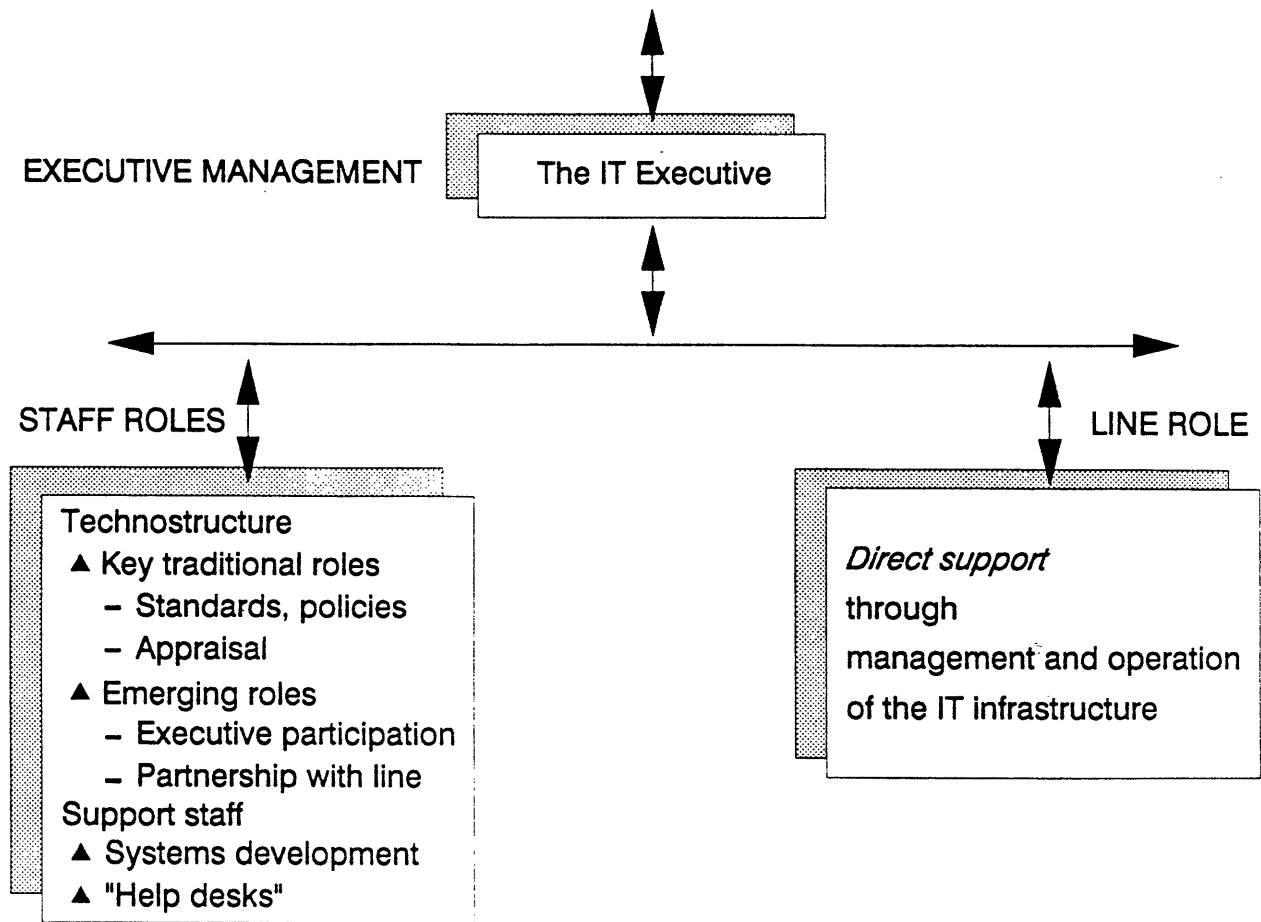management and operation
of the IT infrastructure

Figure 3. The 1990s IT Organization

factor is to ensure partnerships between the producers of technology and managers of the business processes at all levels in the organization.

WILL THE MODEL HOLD UP?

The emergence and evolution of the IT function's dual line/staff role described above is well recognized. What we have done is attempt to clarify this very unique set of organizational roles which exists today in almost all major companies. This model is shown in skeleton form in Figure 3. We also need to examine those forces that could reshape the model.

There are two primary arguments to be dispensed with if the model of the IT function presented is to last through the 1990s. They are: a) claims by those such as Dearden (1987), that the economics of IT and software productivity will make the centralized IT organization obsolete; and b) that the partnerships required by this model can not be made to work.

Dearden's Argument Analyzed

Dearden's primary argument is that the economics and ease of software production as manifested in the plethora of packages now available is rapidly bringing IT to the point where line management can totally own it. Thus, the need for an IT function will vanish. The major point that Dearden misses is the rate at which process integration is taking place within and across functions and business units of a company, and the implications of this for IT.

Systems supporting independent functional units of the "stovepipe" organization are being replaced by "process-oriented" systems which cut across functions and divisions. "Subject" databases are being built to allow data to be shared by many organizational units. Packages to handle this well are not yet available. More importantly, whether a company buys and customizes packages or builds its own systems, an organization-wide IT

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infrastructure will still be needed to connect them and to manage the data -- and the infrastructure must be managed. The technology today is far from seamless and requires "professional" management. A strong IT organization is required, even if many IT development people are dispersed to line organizations, to accomplish this. In addition, many central IT staff functions (e.g., technical scanning) are necessary in a world in which the technology, and therefore its potential, is rapidly evolving.

Others believe the development of new systems development and "open systems" technology, and increasing user organization understanding of IT, will ultimately allow the transfer of all IT functions to the line? One *might* make a case for this sometime after the year 2000. But not within the 1990s -- the planning horizon of this paper.

Making Partnership Work

Research in MIT's Management in the 1990s program notes that the management of organizational change will continue to be the most difficult inhibitor to successful IT implementation (Scott Morton, et. al., 1991). Rockart (1988) connects successful IT implementation with line leadership and suggests the necessity for an implementation model consisting of a partnership between IT and the line executive. Henderson (1989) presents a model that describes the characteristics of effective partnership.

Partnership is a mechanism to provide the line with influence and control over the usage of a key element (the IT resource) in accomplishing its bottom line commitment without direct control over all aspects of it. Although in conflict with traditional organizational models, the IT/line partnership model is consistent with the movement to the "team-based" or "networked" organization. It is difficult to picture another approach that would provide the elements for successful implementation that the partnership model does. Recently, Cooprider and Henderson (1991) have provided empirical evidence of the presence of, and extremely positive results from, IT/line partnerships.

IMPLICATIONS FOR MANAGEMENT

There are a number of prescriptive conclusions indicated by this analysis to be considered by senior management, IT executives, and educators. They are:

1. The IT function in its hybrid form will be around for a long time, certainly for the decade of the 90s. Therefore, organizations should explicitly plan for an appropriate long term structuring of IT in the organization.

2. Significant senior management attention needs to be paid to understanding and transforming the role of the IT executive. The IT executive now has two key staff roles which are of growing importance. The first is as a senior executive providing insight and advice on the application of IT technology to other members of senior management, and the second is as the creator of partnerships with key users in the planning and implementation of the technology. The IT executive also has a key line role of managing the critical technology infrastructure of the firm.

   This role is extremely complex and poses multiple daunting management challenges. It demands the skills of a manufacturing executive in selecting and implementing appropriate technology while balancing factors such as efficiency, effectiveness, and absorbable rate of change. It requires the management of a creative staff organization charged with, for example, technology scanning and the innovative application of emerging technologies. And, it needs an effective salesperson and educator. If the role is not well-filled, the organization stands to suffer from redundant or ill-designed infrastructure elements -- and thus increased costs. Alternatively, opportunities presented by the technology may pass unobserved, not understood, or neglected through lack of insight or advocacy.

3. Significant senior management attention should be paid to the design of the IT infrastructure whose effective operation is now a critical "direct support" activity for line management to be successful. This infrastructure will need to be modified continually, taking into account changing business requirements, and the three key design variables of interdependence, economies of scale, and organizational culture.

4. The IT infrastructure needs to be viewed as a long term investment. Mechanisms to fund it supportive of, but separate from, the funding of applications, need to be developed.

5.   Emphasis will also have to be placed on making line and IT partnerships work.

6.   Educators will need to broaden the focus of IT education.   Current IT curriculum in many leading business schools tends to focus on applications, the underlying technologies, and their application to strategic business problems. There is insufficient focus on the design and management of the IT infrastructure.   If the complex IT infrastructures of the 1990s are to be developed and maintained adequately, increasing emphasis is needed in this area.

In summary, the IT function is evolving along a unique trajectory given its hybrid staff and line roles and the role its infrastructure plays in the "operating core" of the firm. The model and principles presented here can be used to develop an appropriate fit for the IT function within an organization.