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ORGANIZING KNOWLEDGE WORK SYSTEMS

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Abstract

The organization of knowledge work is increasingly the focus of redesign and reengineering efforts. Teams are one of the design approaches that are being advocated in response to pressures for increased competitive pressures for speed, quality, and efficiency, and in order to cope with the increased need to integrate complex organizations across a variety of dimensions (Galbraith, 1994). This chapter examines the more general question of organizing for knowledge work. It draws on the general literature underpinning organization theory and design, and more applied work on design for knowledge work. First, it addresses the issue of "what is knowledge work?" Second, it integrates several theoretical perspectives that are useful in conceptualizing the organizational challenges of designing for knowledge work. This section provides a series of propositions concerning design imperatives of knowledge work settings. Third, it presents a systematic model of knowledge work organizations, derived from the propositions. Finally, we identify areas where additional theory is required and where empirical testing is needed.

ORGANIZING KNOWLEDGE WORK SYSTEMS

Knowledge work has been the work of specialists--individuals trained in a way of understanding the world and possessing a set of methodologies for processing information and doing work. They produce knowledge, models, frameworks, decisions, evaluations, reports, diagnoses, treatments, product designs, plans, and systems. Traditional hierarchies have cubby-holed these groups in functional, specialty groups with a management structure expert in the same knowledge areas. They have often broken work down for the individual knowledge worker, with integration of work, where needed, being done by the managers. This traditional way of organizing knowledge work results in individual specialists having in-depth knowledge in relatively narrow areas. Because the goals of knowledge work are not easily measured, evaluation of knowledge workers is frequently done on a judgmental and comparative basis--through qualitative evaluation of individual knowledge worker expertise and contribution. Knowledge work settings frequently tout legends of individual heros--the individuals who are identified with actual breakthroughs, broke sales records, fought odds to prove a concept could work, solved the unfathomable puzzle, or regularly performed remarkable diagnoses.

The organization of knowledge work is increasingly the focus of redesign and reengineering efforts in organizations. Competitive pressures for speed, quality, efficiency and innovation are leading to the need to create faster, more responsive, more agile and better integrated organizations. As organizations deal in more complex environments, they are being required to integrate across many dimensions of functioning (Galbraith, 1994) such as global diversity, product proliferation, and customer requirements for customization and integrated products and services. The reengineering movement (Davenport, 1993; Hammer, 1993) is prompting organizations to look at themselves from the customer's viewpoint, and to find a way to integrate the work that constitutes an entire process of delivering value to the customer. The design of global organizations and those that compete in an increasingly differentiated market must include ways for people to flexibly and interactively process competing sources of complexity. The pressures are for organizations that execute well and integrate well. These pressures are evoking a new look at the way knowledge work is organized and the assumptions embedded in its traditional organization.

In the search for new ways of organizing and integrating knowledge work many organizations are looking at teams, in particular they are borrowing the team models as they have evolved in manufacturing settings. But the work found in production settings has a different logic than knowledge work. It is often routine and requires low to moderate level skills. Production workteams are designed so that members can rotate jobs and perform a variety of tasks leading to maximum flexibility and human development. Thus, production workteams create generalists of all team members. For production workers, learning multiple skills enriches the work and gives a greater sense of control. However the application of the workteam concept in settings housing deep specialties and non-routine work is relatively new, and cannot rely on making generalists of all team members. Learning multiple, deep skills may not even be possible. Further, in knowledge settings, integrating across skills may be viewed as a diminishing rather than an increasing of control. Transporting the team design solutions crafted on the factory floor becomes, at best, an iffy proposition.

At the very time that knowledge bases are becoming increasingly deep and specialized, organizations are being forced to integrate. Technical excellence and the ongoing evolution of technical capabilities depends, in part, on the application of ever deeper specialty knowledge. On the other hand, the success of the business in its environment depends on its systemic functioning, and its ability to integrate the different knowledge bases and perspectives required to deliver value to the customer. Squaring these conflicting pressures is the essence of the knowledge work design challenge.

This paper examines the organization of knowledge work systems. It begins with an overview of the nature of knowledge work and the challenges it poses for design. Second, it generates a number of propositions about organization design for knowledge work, based on the nature of the work and the organizational theory literature. Third, it presents a skeletal rendering of a systemic model for knowledge work organizations, derived from the propositions.

Non-Routine Knowledge Work: Challenges for Organization

This section deals with the nature of knowledge work, its organizational attributes, and the role of learning.

Knowledge Work

Knowledge work entails the *application of knowledge bases and the processing of information as its essence*. Although some knowledge work is routine and analyzable (eg., some accounting tasks), much knowledge work is *non-routine*. Non-routine work deals with much variety and many exceptions that have to be handled by the technological process, and these exceptions are not easily analyzed and consequently their solutions have not been preprogrammed (Perrow, 1968). Work can vary along the non-routine dimensions. Engineering tasks, for example, involve variety and exceptions but each case may be quite analyzable. Tasks of scientific discovery are not completely analyzable, because there is not complete cause-effect understanding. Non-routine work can be both *complex* and *uncertain*. Complexity stems from the variety of tasks that require adjustments in multi-faceted work processes; uncertainty comes from incomplete understanding which can lead to failure to apply the correct processes to attain the desired outcome.

The nature of the work affects the kinds of decisions that must be made in the organization (Thompson & Tuden, 1959). When work is not fully analyzable, and the cause and effect relations are not fully understood, judgment is required. When exceptions are common, a broader range of knowledge must be applied, and it is more difficult to fully program the work. When the nature of the work is to discover solutions in the absence of a full understanding of cause and effect relations, creativity is required. In non-routine work the conversion process is an interpretive transformation (Pava, 1983). On the other hand, when cause-effect is well understood and work is analyzable, it can be programmed. The decisions involved in performing such programmed work are primarily computational (Thompson, 1967)--they entail carrying out pre-specified steps.

Knowledge work is frequently carried out by people with highly developed and often *specialized knowledge sets*: accountants, chemists, surgeons, analysts, electrical engineers, marketers, and so forth. In many cases they have gone through extensive education during which they attained expertise in the content and methods of a knowledge domain. Specialists in a discipline are steeped in the "thought world" of that discipline (Dougherty, 1992). They have learned to attend to certain aspects of their environment, to value particular processes and outcomes, and to filter information to conform to their paradigms of understanding and action. Their work entails the application of their knowledge to the problems posed in the organization of which they are a part. The technical adequacy of knowledge, however, must be judged from within the paradigm of the discipline. For this reason, specialists are often housed in discipline groups, supervised by experts in the discipline, and interact with colleagues with a similar discipline expertise. These specialists often have expectations of being treated as "professionals". They expect to have a certain amount of autonomy based on their discipline's expertise, and to have standards maintained collegially with others in their discipline (Von Glinow, 1988). A large part of the challenge of managing these professionals is to induce them to be committed to the organization's goals and purpose, as well as to the internal logic of their profession.

This paper focuses on the organization of work systems that house non-routine knowledge work: work that entails the application of knowledge to interpret information, and judgment in the handling of uncertainty and variation. Knowledge work often creates new knowledge that advances the knowledge domain and therefore reduces uncertainty and increases analyzability. To some extent the distinction between routine and non-routine work is arbitrary and fuzzy. Most work organizations contain mixtures of the two. Furthermore, most types of work have routine and non-routine aspects. Production settings can no longer be characterized as entirely routine. As more and more aspects of production are automated, the work done by human beings is increasingly judgmental and interpretive in nature, often entailing learning that enables greater control over the production process. On the other hand, tasks that were once thought of as non-routine, including some engineering tasks, are increasingly being systematized and even automated, so that the work increasingly consists of the application of programs. The next section describes some of the organization-level attributes of knowledge work.

Organizational Attributes of Knowledge Work

Pava (1983) argues that non-routine knowledge work cannot be approached using reductionist approaches. A more integrative approach is required that understands knowledge work in its context. Knowledge work settings, he argues, are not characterized by a linear conversion flow that allows for organizing to optimize a piece of the flow. There tend to be multiple, concurrent conversion processes that influence each other. In a new product development project, for example, sub-processes may entail the development of software, hardware, marketing plans, manufacturing processes, and so forth. These processes are not independent of one another. Furthermore, since knowledge work is characterized by specialists who tend to see themselves as vocationally separate and who value individuality, taking an integrative approach requires attention to the formidable task of integrating across individuals with different thought worlds.

The work performed by knowledge workers has to be viewed within the context of the system of work of which it is a part. Pava describes the virtually saturated nature of the work interdependence in knowledge work settings, where "It seems as though everything totally depends on everything else" (1983, p. 52). In this kind of setting, even the concept of reciprocal interdependence between the work of different contributors fails to capture the *complexity of the interdependence* that pervades the organizational system, although reciprocal interdependence abounds. Here complexity refers to the number of activities that need to be coordinated. The increase in complexity is more than a mere additive effect of increased activities. If there are n activities, the activity pairs that may need to be coordinated are n(n-1)/2 and increase geometrically. The organizational costs of such coordination need to be assessed in light of desired benefit. Even small increases in the variety an organization can handle may lead to huge gains in flexibility, if the organization can develop ways to coordinate or decouple the variety of activities entailed (Pava, 1983).

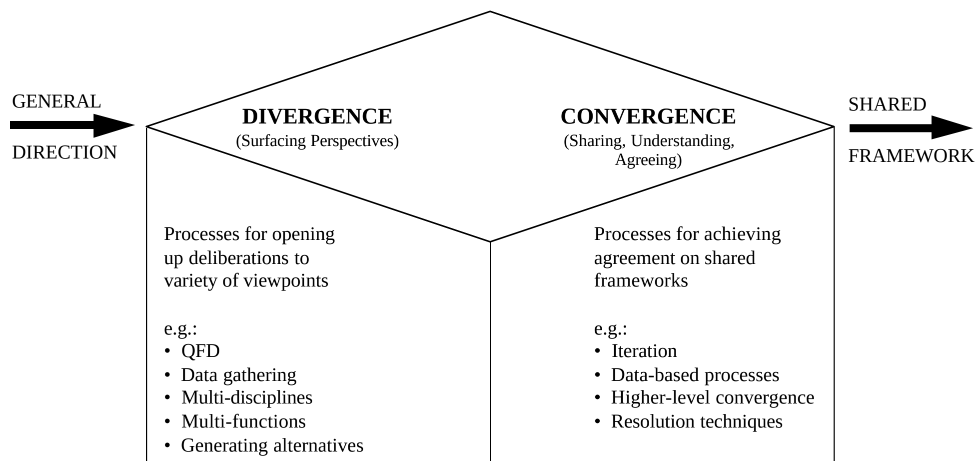
The environmental context for units that house knowledge work are often highly complex and dynamic. According to Duncan (1972), *environmental complexity and dynamic conditions both contribute to decision uncertainty*. Complexity stems from the number of specialized expertises and from the number of different elements that a business unit must deal with. Dynamic conditions cause uncertainty in decision-making because elements of the unit's environment keep changing. For example, in their study of high technology firms, Mohrman et al. (1990) found that technical learning, market developments and strategic redirections are sources of change that cause decisions to be uncertain and often require them to be revisited. Duncan (1972) has found that decision-making is uncertain if there is a lack of information concerning environmental factors, an inability to accurately assess environmental problems, and a lack of knowledge regarding the costs associated with an incorrect decision.

The proliferation of multiple specialties contributes to the difficulty of the decision-making task faced in knowledge work settings. Each specialty has its own discipline-based thought world, varying even on fundamental orientations such as time, interpersonal relations and formality of structure (Lawrence and Lorsch, 1967), and each focuses on different outcomes. For example, in new product development, Dougherty (1992) found that marketing focused on changing user needs, R&D on performance specification, and manufacturing on reliability, quality and manufacturability. Specialists evaluated environmental information through their unique lenses and concerns. Each group member holds a cognitive schema of the information domain of particular decision issues, that tells them not only what to see, but where to see it (Rummelhart, 1980). Furthermore, they *vary in preferred outcomes*, thereby creating an environment where decisions are often made by compromise or through establishing a dominant coalition (Thompson, 1967).

To understand such organizational contexts, we must picture a system with a host of concurrent processes, involving multiple specialists who understand a slice of the totality, and where, at the extreme, the work of everyone affects the work of everyone else. All this occurs in a dynamic environment where preferred outcomes are in contention to begin with.

Our studies of new product development projects have found that the activities associated with these projects can be conceptualized as an iterative cycle that begins with a number of players with divergent understandings and knowledge, and proceeds through a process of converging on an outcome (Figure 1).

Figure 1: Basic Divergence/Convergence Cycle



This *divergence/convergence cycle* occurs in each phase of the project, each of which has a "product" that has to be "signed off" by all parties. For example, the first phase may yield a concept, that defines high level product, market and manufacturing parameters. A later stage might yield a prototype. As the project proceeds through phases. the convergence/divergence cycles treat increasingly more detailed and less global issues, in general, since the earlier phases have provided the general parameters for the later stages. At the beginning of each phase, contributors bring their own lenses, knowledge, and preferences, and through a series of joint activities the network of contributors carries out activities designed to contribute not only to the product, but also to reducing the variability in the network's understanding of and preference for the product. This process entails specialists carrying out their technical tasks, but it is also a process of "gaining alignment between the major lines of contention" (Pava, 1983, p. 71) that involves a process of negotiating a collective belief structure from the disparate belief structures of contributors (Welsh et al., 1988). Based on studies of decision-making in uncertain conditions, Welsh et al. (1988) have argued that such tasks benefit from early divergence and breadth of representation of ideas, but that later stages depend on achieving consensus and narrower focus.

Pava calls the reflective and communicative process through which people interact to reduce the equivocality of an issue a deliberation, and he states that non-routine knowledge work is a series of interlocking deliberations. Ongoing interpersonal discussions that we observed in successful new product development projects included such deliberation processes as defining of the product, agreeing to work methods and processes, and learning. These were the dialogues that enabled the constellation of participants to interpret and integrate their divergent perspectives and to converge on an approach and a product. Interestingly, failure to converge could come from anywhere in the organization, illustrating Pava's concept of virtual saturation of interdependence. In one multi-divisional corporation, for example, decisions made in the marketing department of one division through a circuitous route, ultimately impacted and, in some cases, held up and undid the work in R&D labs of another division.

Learning

The learning aspect of knowledge work deserves special focus. Some knowledge work is primarily applying an extant knowledge base to process an organizational information flow and handle a workflow. This is routine application of knowledge. Other knowledge work entails solving work and organizational problems. This could entail the creation of new approaches and applications and of new knowledge. Scientists in R&D labs, for example, are knowledge creators working in the context of a corporation that hopes to apply the knowledge that is created. Tenkasi (1994) portrays this knowledge creation process as a "cognitively based evolutionary learning process that is embedded in, and influenced by the social context" (p.3). These scientists reduce uncertainty in their environment by creating new knowledge, perhaps using the scientific method, discovering new knowledge through environmental searches, and sharing knowledge with colleagues both within and across disciplines, perhaps engaging in a joint learning process.

Non-routine knowledge work operates at the edge of what is known and what is not known: of what can be programmed and what is in the process of being apprehended, perhaps for ultimate programming. It may operate in areas where the application of the knowledge involves complex cognitive processes that have not yet been systematically described and thus cannot yet be systematized. It's essence is uncertainty reduction. Much of codified knowledge is gathered within disciplines. More mature disciplines have more extensive knowledge bases. The frontiers of knowledge where uncertainty occurs in organizations are often at the interstices between disciplinary knowledge bases. Thus, uncertainty reduction often demands interdisciplinary processes.

This process of uncertainty reduction involves *direct learning processes by which people incorporate information and knowledge into their own understanding*. This can be both explicit, or formal knowledge that is systematic and abstract, and tacit knowledge, shaped by experience and action (Nonaka, 1994; Polyani, 1966). The importance of tacit, practice-based knowledge has been demonstrated in several knowledge work settings (Hutchins, 1991; Orr, 1980; and Wenger, 1991). Direct learning can occur through collaboration and dialogue when people share explicit knowledge and experience. Increasingly this learning occurs across disciplines, as the problems being addressed by organizations require interdisciplinary solutions, and the kinds of breakthroughs that come from joining different knowledge bases. The problem of becoming a low cost provider, for example, is best solved by joining the paradigms of production and design, rather than by solving problems within each function. Because formal knowledge is insufficient for understanding work and learning (Brown & Duguid, 1991), people from different disciplines engage in dialogue, sharing both formal and practice-based knowledge.

There are two focuses of uncertainty reduction that constitute the essence of non-routine knowledge work and by implication of organizational learning. One focus is the application of and creation of knowledge about the *content of work*. Developing deeper and broader understanding of the interaction between chemicals and the environment that enables the development of a safer pesticide is an example. Discovering the complex mixture of psycho-social and medical interventions required to treat a certain classification of people with a particular disease is another. A second focus is applying and creating knowledge about the *process of work*. How various specialties should integrate organizationally to deliver the complex of medical interventions or to develop and deliver the safer pesticide is in question here. Another aspect is how the organization should be designed to support that integration of activities. Senge (1990) argues that organizing should be viewed as a discipline, and organizational learning will occur when there are processes in place to develop a deeper understanding and application of the discipline. The learning processes advocated by various quality improvement paradigms (Deming, 1986; Juran, 1989) and organizational design approaches (eg., Mohrman and Cummings, 1989; Pasmore, 1988) are relevant to this process learning.

Both content and process learning only become organizational learning to the extent that they are codified and applied. Learning about treatment protocols that remains within the head and individual practice of a master physician does not lead to organizational learning, because it can't become embedded in the practices of the organization. Learning that occurs in one new product development project about techniques that promote or serve as barriers to interdisciplinary integration become lost, if they are not captured and shared in the organization. Thus, the uncertainty reduction that is the essence of knowledge work involves learning. The codification and sharing of such learning enables organizational learning. This is true of content and process learning. In both cases, the result will be an increase in analyzability/programmability of work. Extending the frontiers of knowledge creates the ability to develop programs for work. The learning organization is constantly extending the frontiers and capturing the learnings in work processes. Thus, the knowledge work setting will always be a mixture of routine and non-routine work.

Summary

This paper deals with the organizing for non-routine knowledge work. This work is characterized by variety and exceptions that require going beyond a programmed response. It often requires judgment in the application of knowledge to interpret information, because cause-effect relations are not fully understood. It is often performed by specialists, steeped in a deep and pervasive thought-world. Learning is integral to non-routine knowledge work. Organizational learning occurs when the learnings are codified in a way that impacts work processes.

When work of this nature is organized, the organizational context is characterized by some typical features. Interdependencies are complex, even saturated, and a maze of activities must be coordinated. The organization contains multiple, concurrent conversion processes. Decision uncertainty results from the complexity and dynamic nature of the environment as well as the degree of knowledge about the environment. The divergent preferences of various disciplines adds to the complexity of organizational decision-making, and results in compromise and/or coalitional decision-making. Organizational activities proceed through cycles of divergence and convergence required to take advantage of and integrate the perspectives of the many expert specialist groups that contribute to organizational performance. It is against the backdrop of this depiction of knowledge work that we will next proceed to examine the characteristics of the design that can organize such work.

Design for Knowledge Work: Frameworks and Propositions

This section develops some propositions concerning the parameters of organization that fit the requirements of knowledge work. It first presents several frameworks underpinning organization design, and then discusses the changes and extensions of those frameworks that are required to develop a model for effective knowledge work organization. It argues that the new models will incorporate many of the design principals that characterize existing organizational theory, but constitute a fundamental reconceptualization of some aspects of organization. A primary focus will be on the sub-units that have to be established to perform knowledge work, and the way they are integrated to compose an organizational system.

Design Frameworks

We first present a series of organizational frameworks that presently underpin organization design.

Broad Contours of Organization. The predominant model of organizational system stems from the work of Parsons (1960), who postulated three system levels of responsibility and control: technical, managerial and institutional. The technical sub-system is focused on the effective performance of the technical function. The managerial sub-system services the technical subsystem by mediating between it and its customers, procuring the resources, and controlling and directing it. The institutional level articulates the overall relationship of the organization to its environment, which Parsons saw as the institutions and agencies of the community. Building on the work of Parsons, Thompson (1967) postulated that organizational rationality is achieved when the technical core is buffered from as much uncertainty as possible.

When it is combined with the prevailing organizational structural notions that emanate in part from Weberian bureaucratic theory (Weber, 1947), this concept of system levels gets translated in practice to levels in a hierarchy. The top is responsible for institutional issues, the middle for control, and the bottom for technical functioning. Within that overall model, individuals are assigned to well-defined jobs for which they are qualified, and are supervised by managers expert in the job requirements. Rules, job descriptions, goals, and standard operating procedures help integrate and direct the work by providing common ways of doing things, clarifying who does what, and providing a common direction. Managers not only control, but they also manage the boundaries between the parts of the organization they manage.

As organizations grow, increased layers of management are put in place to break the span and permit ongoing managerial control. In addition, as they grow and become more complex, it becomes clear that the organization needs to house a variety of capabilities that requires diverse ways of functioning, and that the organization has to be broken into more manageable sub-systems. Design approaches emerged for breaking up the organization into units. Although some organizations grew as monolithic function-based organizations, others created a divisional structure to accommodate the need to have different business focuses in different parts of the organization and the need to break the organization into manageable units.

Contingency Models of Organization. Studies of organization have found evidence that organizational forms differ in different task environments. Although the broad contours outlined above (differentiation of systems levels, hierarchy and bureaucracy, and the creation of manageable sub-systems) may remain essentially in place, they play out differently in different task environments. Less predictable technologies, for example, appear better managed by shorter hierarchies with less centralized decision-making and less formalized coordination (Woodward, 1953). Faster rates of change in the environment and need for internal innovation to respond correlates with "organic" organizational forms (Burns and Stalker, 1961) that rely less on breaking tasks down into specialist roles with a clear hierarchy, and more on individuals performing their tasks in light of their knowledge of the firm as a whole, informal job definitions, and lateral interaction and decision-making. Mechanistic organizational forms that rely on breakdowns into specialties, hierarchical decision-making, and standard procedures fit better with stable environments.

Lawrence and Lorsch (1969) further developed the contingency model of organizational design by examining the extent of differentiation and integration found in organizations existing in different environmental conditions. Organizations tend to elaborate and subdivide their parts that deal with a great deal of variety and uncertainty in their environments. Thus, differentiation (the difference in orientation between parts of the organization) goes up in uncertain environments, such as are created when the market changes quickly, demanding organizational innovation. Organizations in all environments need to achieve a certain level of integration of activities (collaboration/ coordination among departments that are required to achieve unity of effort by their environment); however, where there is a high degree of differentiation, the organization must utilize many more approaches to integration.

Based on the mechanistic/organic breakdown of Burns and Stalker, one would predict that knowledge work would best be done in an organizational setting characterized by loosely defined jobs, and a minimum of hierarchical decision-making. However, Lawrence and Lorsch's study finds that far from needing less integration, firms that have to process large amounts of uncertainty actually differentiate more and need more integrating mechanisms. They don't abandon the traditional factors of integration through the hierarchy and rules, but they supplement it with other approaches.

In a similar vein, in their multiple year study of high technology firms, Schoonhoven and Jelinek (1990) have found that organizational functioning requires clear lines of authority and a clearly delineated organizational structure and roles to deal with the complexity and the uncertainty being faced. On the other hand, the structure, although clear, changes frequently. The managements in these organizations are continually bringing the structure into alignment with their strategy, which itself tends to be in dynamic alignment with a rapidly changing task and market environment. Furthermore, in these organizations, formal hierarchical structure is supplemented by what Schoonhoven and Jelinek refer to as "quasi-structure"--task forces, teams, and committees that are formally prescribed and used in conjunction with the formal structure.

Studies of strategic decision-making by Eisenhardt and Bourgeois (1990) have discovered the value of decisive, hierarchical decision-making in high technology organizations that exist in an uncertain environment. They find that those firms that are able to lead in rapidly changing environments are able to gather input quickly, make quick decisions, and have the various organizational units adapt their activities to fit with these decisions. Thus, in high technology organizations, which are full of knowledge workers, it appears that clear delineation of structure and decision-making are required to integrate the activities of the organization.

Information Processing. Galbraith (1973) provided a design model based on the view that organizations are essentially information-processing systems and that the key design challenge is to craft an organization that is capable of processing equivocal information effectively to meet organizational performance objectives. By this definition, knowledge work becomes the essence of the organization's ability to adapt to its changing environment. As organizations grow, he argued, and as their environments become increasingly complex, uncertainty increases as does the amount of information they have to process in order to reduce it. Organizations then need to go beyond the core of integrating mechanisms: hierarchy, rules, and goals.

One approach to deal with this increasing information processing requirement is to increase the capacity to process information in one of two ways: by investing in information systems that can aggregate and integrate more information to inform management decision makers, or by developing lateral approaches so that individuals can exchange information and integrate laterally without going through hierarchical channels. Galbraith (1973) spells out various approaches to create lateral mechanisms to integrate the organization. He recommends that companies start with the "least costly" informal approaches. The organization should then adopt more costly approaches if required to meet the integration challenge. These more costly approaches, in order of increasing investment are various kinds of formal groups, and then formal roles and integrating departments. Many of these mechanisms resemble the "quasi-structure" that was described by Schoonhoven and Jelinek. Alternatively, organizations might choose to reduce the need for information processing by creating self-contained units; i.e., by more loosely coupling the parts of the organization (Weick, 1979). One approach is to create organizational units with all the capabilities necessary to do well-specified jobs and consequently minimize the need for operational coordination among units. The ultimate of this might be the network organization, where there is an assortment of single purpose units that essentially operate as independent businesses, and are governed by a focal unit whose job is to integrate the contributions of all the others (Miles and Snow, 1986; Galbraith, 1993). The network of relatively independent units obviates much of the need to coordinate operations because there is no intent to create vertical integration.

Perhaps the most common, but certainly the most insidious way that organizations can reduce the need for information processing is to create slack resources: buffers, time delays, extra coordination expenses, and so forth, to deal with the problems that arise when uncertainty is not handled and the organization does not function optimally (Galbraith, 1973). Current performance pressures are forcing organizations to realize that they cannot afford to deal with the inadequacies of their designs by adding expense. Many current organizational improvement processes are designed to ferret out slack resources and in their place put designs that can handle the information processing tasks more efficiently.

Galbraith (1973) makes the assumption in his framework that the supplemental information processing approaches are just that: supplemental to the core hierarchical mechanisms of control by rule and hierarchy. Nevertheless, in his latest work (1993; 1994), he describes organizations that are increasingly dependent on lateral integrating mechanisms because of the complexity of operating in today's complex business environment. The complexity of information that has to be processed to deal with the competing focuses in the organization (country, product, function, customer set, etc.) outstrips the capacity for hierarchical decision-making and demands teams, councils, and other mechanisms to carry out the deliberations that end up making trade-offs and accommodations across organizational boundaries. The management processes in these firms are comprised to a large extent of complex, cross-functional decision-making.

Galbraith (1973) stresses the need for all aspects of the organization's design (structure, processes, people, rewards and tasks) to be aligned with the strategic requirements for integration and differentiation. For lateral integration to be effective, he emphasizes the need to create the capability for lateral decision-making. One way to build such capability is through careful career development of generalist knowledge sufficient for integration purposes. Carefully designed cross-functional planning systems and reward systems that reinforce action that takes the big picture into account are other key aspects of lateral capability. Lateral integration is most likely to happen, if the organization has ways to make the big picture salient to people and give them the processes and motivation to influence it and act within it.

Teams. One mechanism that Galbraith (1973) put forth to manage complex information processing is the creation of self-contained units: units that are minimally dependent on the rest of the organization. The socio-technical systems literature has dealt extensively with the use of such self-contained units, sometimes referred to as self-regulating workteams. These teams are established to completely manage a portion of the conversion process. A technical design process enables the firm to delineate the portion of work that a team will operate in order to optimize both technical and social outcomes. Technical outcomes are optimized when the team is configured in such a way that it is able to deal with the typical variances in the workflow, because it has control over the factors that contribute. Social outcomes are optimized when the team is responsible for a "whole" task, rather than an artificially prescribed slice of work. Self-regulating teams perform optimally when they have boundary and task control (Cummings, 1978).

Pasmore (1988) has pointed out that self-regulating teams operate best when they are stable, contain routine tasks, and contain relatively equal levels of skill and skills that can be acquired from one another so that members can gain mastery over all aspects of task performance. Temporary task teams or project teams, for example, would not be good candidates for self-regulation given the requirement of stability and common programmed knowledge.

Pava (1983) has advocated a modification of the socio-technical design process to fit non-routine knowledge work. The analysis focuses on the key deliberations that have to go on in the organization to resolve trade-offs, establish direction, and enable people to operate in a more coordinated way. Both he and Savage (1990) portray an organization with loose, dynamic decision making forums, coalitions, and project teams with cross-functional members that come together for the task at hand. Pava (1983) focuses more on the need for deliberation of contentious views. Savage (1990) focuses more on the identification and assembling of the various expertises required to take advantage of an opportunity or perform a task that moves the organization ahead. In knowledge organizations, neither of them portray an organization with stable teams and lasting structures.

Ancona & Caldwell (1992; 1990; 1988) have studied new product development teams, groups characterized by high uncertainty, complexity, and multiple forms of dependence with other groups and individuals. They found that appropriate boundary spanning activities are positively associated with project success (Ancona & Caldwell, 1992). Their work builds on the earlier findings by Katz and Tushman (1979) and Allen (1977). They argue that the greater the task uncertainty, the higher the information processing requirements, and the more that boundary spanning roles need to be multiple and dispersed. In general, this perspective suggests that project teams do not exist in isolation and their performance depends upon their external linkages.

A great deal of the current literature on organizing for speed, customer responsiveness and innovation stresses the need for cross-functional capability and advocates teams as a way to accomplish this. Teams are advocated as agents of organizational learning. Quality improvement teams (Deming, 1986; Juran, 1989), reengineering teams (Hammer & Champy, 1993), and design teams (Mohrman and Cummings, 1989; Pasmore, 1988) are examples of cross-functional teams established to conduct organizational learning in order to introduce changes in the way the organization operates. Teams are also advocated to perform the work.

Project teams (Hayes, Wheelwright, & Clark, 1988; Myer, 1993) and customer-service teams are examples of teams that perform the conversion work of the organization, and are organized cross-functionally. Often these teams are being utilized in knowledge work settings, precisely because of the complexity of the knowledge specialties that have to be integrated.

Teams in knowledge work organizations are neither stable, permanent, nor self-contained. The fluidity of their structures, differences in the expertise of their members, and external connectedness makes self-regulation exceedingly difficult. These teams cannot self-regulate their behaviors in isolation from the other parts of the organization with which they are interdependent. Systemic regulation replaces self-regulation as the modus operandi.

Although the classical workteam model does not appear to be suited for non-routine knowledge work, integration is required, and teams are being used. Conceptualizing and designing these teams properly is a key challenge, and one for which there are not ready-made models. The next section will draw on the nature of knowledge work and identify the design imperatives in knowledge work, which will be a step toward an organization model for the integration and systemic regulation of knowledge work.

Knowledge Work Design Imperatives

This section presents a series of propositions about knowledge work design. Its format is as follows. First, we present the organizing challenge that is faced, based on the nature of knowledge work and heuristics provided by the organization design and theory frameworks presented above. Then we present a proposition about the design attribute that is suitable to address the challenge.

Knowledge work entails the application of specialized knowledge bases. Organizations must contain requisite variety in their skill sets to accomplish the task variety required to perform the work (Ashby, 1956). Non-routine knowledge work involves the reduction of uncertainty in the process of doing work, which entails learning that may advance the knowledge base itself. It also entails learning across knowledge bases. The challenge of designing for knowledge work is to create an organization where specialists can operate effectively within an organized system. Therefore:

> Proposition 1: Effective knowledge work organizations are able to maintain and further develop specialized knowledge capabilities as well as find ways to integrate work that applies a variety of specialized knowledge to meet organizational objectives.

Non-routine knowledge work requires participants to incorporate information into their knowledge through a direct learning process. This may entail joining one's knowledge with that of others in the organization or incorporating the knowledge and perspective of the customer. This learning cannot be mediated or integrated by managers, but requires the various contributors to have the responsibility for integration and coordination of their work. Therefore:

> Proposition 2: In knowledge work organizations, responsibility for task related integration is the responsibility of the participants rather than being the special purview of managers.

Organizational performance in a knowledge work setting involves cycles of divergence and convergence. The divergence stage of each cycle requires forums that bring together the pertinent specialized knowledge bases for deliberation and resolution of contention. Achieving convergence requires consensual learning and common knowledge production to reduce the uncertainty and arrive at an agreed-to direction. This requires direct exposure of specialists to one another and a learning process through which they can incorporate each other's knowledge. Therefore:

> Proposition 3: Effective knowledge work organizations will have forums where contributors with different knowledge engage in the cycles of divergence and convergence that constitute the conversion processes in knowledge work.

Knowledge work is characterized by saturated interdependence, especially with the broader system level, not simply among the specialty elements of the system. Thus, everything does depend on everything else, and uncertainty reduction requires multi-directional learning across system levels as well as sub-systems. Lateral learning is required between the various technical contributors. Vertical systemic learning is required across levels, (i.e., between issues at the technical core and those at the managerial and institutional systems levels that deal with the strategic and operational business requirements). Since organizations are open systems (i.e., they exist in an environment that provides feedback that impacts their operation), rapid response to environmental demands requires learning that couples the knowledge of all systems levels with environmental knowledge. Thus, the picture is not one of a clear delineation of the technical core, managerial, and institutional concerns of the organization, nor of a technical core that is buffered from uncertainty. Rather, these focuses are conjoint throughout the organizational system, with all participants achieving enough knowledge of the perspectives of each to act within the overall requirements of the organization. Therefore:

> Proposition 4: Knowledge work organizations establish overlapping domains of concern and direct learning among their technical, managerial and institutional systemic levels.

Saturated interdependence means that it will be impossible to fully self-contain performing units so that they contain all the relevant knowledge and interdependent parties and can be fully self-regulating. Knowledge work organizations will require continual crossing of boundaries, both organizational and disciplinary, in order to achieve requisite integration of work. A key challenge will be the integration of the purposes throughout the organization so that cross boundary collaboration can occur. Therefore:

> Proposition 5: No matter what core structural elements are established in a knowledge work setting, the organization design must also provide for the crossing of these boundaries in a goal-directed manner.

Knowledge work organizations will house a diversity of work, including routine knowledge application, non-routine knowledge application, and the development of knowledge. The latter two include learning as essential components of the work. To handle the variety of work that is performed, a variety of kinds of work structures and forums will have to coexist in the organization, in order to optimize both linear and non-linear work, and individual and collective activities. They cannot be built around an organizational model that is repeated in all parts of the organization. Various parts of the organization will be idiosyncratically constructed to perform the work that they house. Therefore:

> Proposition 6: Effective knowledge work organizations consist of a variety of organizational forms, with differing units, levels, and organizing concepts in order to optimize the large variety of work that is done within the organization.

Much non-routine knowledge work occurs at the frontier of knowledge. It is involved with reducing uncertainty, and to do so it must generate knowledge. This is true for process improvement activities and research and development activities, where learning and developing are the express purposes. It is more generally true in any setting where people organize themselves to perform a new task, or deal with a new problem. Organizational learning only occurs when the generated knowledge becomes codified, accessible and used, so that future performance incorporates it. This also means that knowledge organizations are in a continual process of building programs for accomplishing work that incorporate past learning. This includes improvement and development of systematic processes for making decisions. Therefore:

> Proposition 7: Effective knowledge work organizations organize to incorporate learning into the ongoing work of the organization. They have forums and processes for making learning accessible and for introducing changes and systematizing work as learning unfolds.

Knowledge work organizations contain a number of different kinds of teams that meet the broad definition that a team is a "collective of individuals whose work is interdependent and who share a common goal." Where work is routine and can be placed in groups that are self-contained, the self-regulating team model where individuals learn the various skills to perform the work may be applicable. However, a large assortment of teams may exist that are composed of people with deep, specialized knowledge bases. In this case a different model of team is required, one that stresses the ability of the team to integrate across specialties in pursuit of a common goal and to achieve a common focus. These teams may perform work, integrate work, or improve work. The logic, internal dynamics, and management challenges of these teams will differ. Therefore:

> Proposition 8: Knowledge work organizations establish different kinds of teams for different purposes. These different kinds of teams will have different design parameters and be managed in different ways.

Knowledge work organizations exist in dynamic environments because of continual market, competitor and technological change. Furthermore, knowledge work is frequently characterized by cycles that pose different work and organizing challenges. As a result of both external and internal dynamic features, the configuration of organizational activities will be very dynamic. Organizations may have to change their mix of activities because of their strategy in a changing market, or because of their overall business picture or the stage of various internal projects and sub-systems. Therefore:

> Proposition 9: Knowledge work organizations will be composed of a dynamic set of activities and structures. They must have mechanisms for configuring and reconfiguring their design to accommodate the activities that are required to enact the strategy in a dynamic environment.

To respond to the dynamic requirements of the environment in a timely manner, the organization must have a mechanism for authoritatively making decisions at a broad scope that provide the framework within which the dynamic configuration of performing units can operate. These broad scope decisions will have to reflect the complexity of the organization, and join the perspectives in the organization. A managerial, hierarchical mechanism cannot make all authoritative broad-scope decisions, because it does not necessarily have all pertinent knowledge, but also because it would then become a bottleneck in the functioning of the organization. Consequently, the organization must vest authority in cross-functional groups that are not defined by levels in management. Therefore:

> Proposition 10: Knowledge work organizations must find mechanisms other than managerial rank to enable authoritative cross-functional decision-making for broad-scope issues.

Organizing is one of the key processes of knowledge work in a knowledge work setting. Units at all levels must be self-organizing, not only because this is part of the learning about process that is required for performance to improve, but also because the dynamic nature of the work precludes an orderly top-down process. On the other hand, in a dynamic environment, structural clarity is key. Management is responsible for the overall organization and its configuration of activities and performing units. The charter, purpose and authority of performing units vis-a-vis one another must be clarified, in order to facilitate the resolution of contention within the organization. Therefore:

> Proposition 11: Dynamic organizational structures need self-organizing capabilities, but this can happen only within a context where management takes responsibility for ensuring that the array of structural mechanisms fits the strategy of the organization and provides structural clarity, including ensuring that the charter of each structural unit and its authority are clearly delineated.

Formal structure is inadequate to shape all the behavior of the organization. Interdependencies go well beyond boundaries and systemic or saturated interdependency prevails. The myriad of multi-directional interactions that have to occur to process the uncertainty and thereby perform the knowledge work require an overarching integration that is shaped by strategy and common goals. This can be influenced from the sub-systems of the organization, but it must emanate from the institutional level. A key top management role is the formulation and communication of a strategy that provides an umbrella within which many diverse teams and individuals can carry out countless formally prescribed and informally emerging transactions in order to apply the variety of knowledge in the organization in an integrated and goal-directed manner. Therefore:

> Proposition 12: Knowledge work organizations require a clear and well communicated strategy and direction to provide a shared template for integrating the work of many people with diverse thought-worlds.

The essence of non-routine knowledge work is the learning that occurs when people incorporate new information into their knowledge sets. Since this frequently occurs in forums where people work across boundaries and disciplines, the ability to communicate across these bounds to join knowledge determines the effectiveness of knowledge work. Knowledge work organizations need to develop this capacity in many ways, including the development of people with generalist exposure, who can serve as translators across different thought-worlds, the development and introduction of models that incorporate multiple thought-worlds, and the introduction of skills, tools, and methods (systematic processes) that enable people to explore and determine the fit among thought-worlds. Therefore:

> Proposition 13: Development in knowledge work settings must include a focus on the capabilities for people with different paradigms and experiences to work collaboratively.

Knowledge work organizations are high on both differentiation and uncertainty, making the integration task formidable. Because of the learning imperative, integrating and doing the work are at times indistinguishable. However, it is also true that there must be ample time for specialists to apply their knowledge bases in carrying out the work. Both the effectiveness and the efficiency of the integration are paramount: insufficient integration and inefficient integration can have overwhelming costs. The management of performance in this kind of setting consists in large part of managing the structures established to integrate. *They are the new performing units of the organization*. The work of the contributing specialists frequently occurs in the context of a team goal. Performance management practices such as goal-setting, feedback and appraisal and rewards can no longer be thought of as primarily the management of individual performance. Managing the performance of teams becomes a key management responsibility in knowledge work organizations. Individual performance must be managed in the context of the teams to which they contribute. Therefore:

> Proposition 14: The performing units in many knowledge work settings include teams and much individual performance occurs in the context of teams. Collective performance must be managed in order to manage the process of organizational integration.

Summary

This section traced some of the strands of the organizational theory and design literatures that shed light on organizing for knowledge work. The backdrop or starting point comes from the Parsonian (1960) systems view of the three organizational subsystems (technical core, managerial, and institutional) and their imposition on the Weberian (1947) bureaucratic form. Contingency theorists (Lawrence & Lorsch, 1967) found evidence that the organization becomes more "organic" when it faces a dynamic and uncertain environment that requires innovation, but recent studies of high technology organizations reestablish the importance of some of the linchpins of classical theory: clear structure and hierarchical decision-making.

Performance pressures facing organizations in today's highly competitive world have caused organizations to adopt a more lateral framework that finds ways to integrate rather than rely on hierarchical integrating mechanisms. Galbraith's (1973) information processing model of organization design provides a starting point to conceptualize how that might be done. Again, he uses as his back-drop the classical model of organization with rules, hierarchy and functional groupings as the core framework.

The socio-technical systems literature (eg., Cummings, 1978) has taken a bottom up approach to design, concentrating on the work that is done. In routine settings this has often led to self-regulating teams that have responsibility for a portion of the conversion process. The conditions where such teams are appropriate differ fundamentally from the conditions that prevail in non-routine knowledge settings, prompting a need to recast the issue in terms of organizing to house the deliberations that must occur to reduce uncertainty.

The second half of this section provided a foundation for knowledge work organization by spelling out a number of propositions to guide it. These propositions describe attributes, but do not depict the organizational system. The next section presents a general depiction of a knowledge work system.

The Knowledge Work System

The knowledge work framework briefly described in this section is based on a conceptualization of the organization as a system: an organized, cohesive complex of elements standing in interaction (Von Bertalanffy, 1955). A system is characterized by interdependencies among components and processes that involve discernible regularities in the relationships. Similarly, there is an interdependency between the system and its environment (Evered, 1980). Massarik has stressed the portrayal of the system as the link between the system and the human "phenomenology" (1980). Behavior is guided by people's perceptual understanding of the system. If a system is to operate differently, people's mental images of the system need to change. Consequently, we advocate depicting the knowledge work system in a way that reflects how it is intended to operate. This needs to be different than the way we have traditionally depicted organizational systems.

Massarik (1980) argues that the system involves purposeful differentiation related to its desired operation, and that people's perceptual highlighting and subordination of particular variables and interaction patterns is key to the meaning that the system has for them and the way they enact their roles. We propose that the visual depiction of the organization be based on how the system is intended to *operate*, rather than on a set of conventions drawn from an era when regularity and system stability were the paramount operational characteristics, and depicting the organization as a chain of command made sense. For example, if the knowledge work organization needs to operate through a dynamic series of coalitions, or teams, rather than through a series of isolated jobs with fixed responsibilities, the organization should be depicted as the former rather than the latter. If authority and accountability are to be vested in organizational elements based on their scope of operation rather than based on their level in the hierarchy, the depiction of the organization should match this operational characteristic.

This argument is more than a plea for eliminating the bureaucratic depiction of organization. It is an argument for aligning the portrayal of the organization with its operating characteristics and with the phenomenological understandings that are required to enact roles in a way that carry out the purpose and underlying intention of the design of the system. In the case of knowledge organizations, it argues for a potential flip in figure and ground, by focusing on the operational interdependencies. Many current models begin with the discipline-based structure as the core structure of the organization. The cross-functional structures are often "overlays" or "quasi-structures". We argue that if the organization is intended to operate through a series of cross-functional units, these, rather than the discipline-based knowledge structure, should become the primary focal structures, with the discipline structure as the overlay. We do not argue that this is the correct solution in all cases, rather, that such a depiction be used when work is done through integrated units rather than through the chain of command.

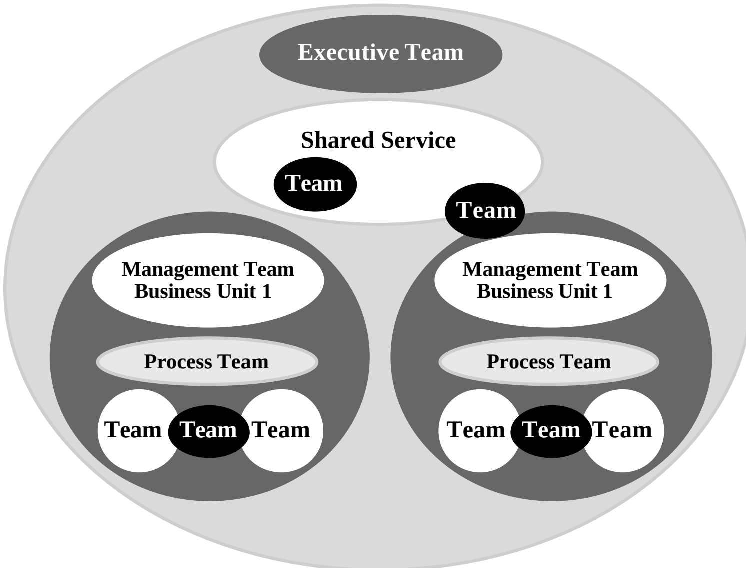
More generally, this is not an argument for either a functional or a cross-functional organization. Rather, it is an argument for identifying the *performing units* of the organization, and designing to support their operation and the management of the interdependencies between them. This section provides a first step toward reconceptualizing the organization in terms of its performing units, and toward designing the organization accordingly. It first presents a visual depiction and then discusses the processes and role features that are required.

The Organization as a System of Performing Units

Figure 2 depicts the organization as a series of embedded performing units. It portrays three systems levels, although by implication there are actually four, since the individual level is not depicted in the diagram. The three levels depicted on the chart are the team, the business unit, and the organization as a whole. These groupings reflect patterns of organized activity required to deliver value. Clustering activities in this way enables contributors to determine, from the vast array of potentially valuable activities, where their focus should be.

Performing Units. In this example organization, the overall set of activities is divided into two major business units that provide value to the customer. These units might be product lines in an electronics firm, programs in aerospace, or customer sets in a service industry. Arrayed within each business unit are the performing units, or teams, that deliver products or services that are identifiable sub-parts of the business unit's performance. At the organization level, there are some units that represent shared services; units that provide a service to both business units. These are support groups that are more efficiently or effectively provided centrally.

Figure 2: Team-Based Organization



This depiction says nothing about the composition of the teams. They may be cross-functional, or uni-functional. They may have members with multiple skills or single skills, many years of experience or fledgling, management experience or only team experience. They are the assortment of contributors required to:

1. Conduct a set of activities that deliver value to the customer.
2. Work interdependently in the accomplishment of the goal.
3. Carry out the deliberations involved with accomplishing the goal.

Integrating Mechanisms. In a knowledge work setting, interdependencies cannot normally be completely bounded. The cross-team teams depicted within each business unit illustrate one way that interactions to work out interdependencies can be formalized. These integrating teams would have as their product a process, the integration of the two teams. Cross-team teams can also link a shared service to a business unit. In addition to the team relations that are depicted, there may be a number of other integrating mechanisms, ranging from informal interaction to the designation of particular contributors to play integrating roles.

Another type of performing unit that is portrayed is the process team. This team has responsibility for improving a process. In a sense, the process team is also an integrating team, in that it is developing improvements and processes that will become common operating methods in the organization, thus providing a foundation for the integration of work at the systemic level. The process teams depicted in this diagram are operating at the business unit level of the system: i.e., they are improving business unit processes. It would also be possible to have a process team at the organization-wide level, improving, for example, the financial information sharing processes in the company.

When the performing units of the organization are cross-functional, the functional or discipline capabilities of the organization are maintained by units that have accountability for maintaining these capabilities. These are special examples of process teams. They may house experts who lead efforts to improve methods and skills and to provide mentoring and technical oversight.

Authority. This depiction does more than illustrate the performing units and how they are clustered into groupings that deliver value. It also implies scope of operation and of authority. For example, a team has a scope, defined by its charter, that is smaller than that of the business unit, and an authority that is defined by its scope. In order to influence issues at a broader scope, it must operate across the involved teams or influence decisions made by a business-unit-wide decision-making body such as a management team or a process team. Business unit-wide decision-making forums such as process teams would be constituted of members who carry the necessary perspectives or knowledge bases to make decisions that bind the unit. They may be composed of representatives from the various performing units. The same is true at a higher systemic level of forums that have organization-wide scope. Again, the scope of the decision-making forum does not dictate particular rank, status, or formal position among its members. It is vested with authority at a particular scope for a particular domain of decisions, and composed of the knowledge bases to make those decisions. These same principles are true throughout the system.

Management. Two levels of management are illustrated in this organizational system: at the business unit level and the organization level. These are management teams, illustrating that they are composed of a set of individuals who have the necessary knowledge bases to make management decisions. They are cross-disciplinary in nature, enabling the team to make decisions that can direct all the disciplines in the business unit or organization. The particular responsibility of a management team is to make authoritative decisions about the strategy of the business unit or organization, the design to accomplish that strategy, and the allocation of resources in support of the strategy. It is also responsible for orchestrating goal-setting, feedback, and reward systems; the performance management systems that align the components of the system in pursuit of the strategy. The management team will tend to be composed of individuals who occupy formal positions of higher rank than others in the performing units it manages, but even this is not a requirement of this systems conceptualization.

Leadership roles are not illustrated on this diagram, but must be specified. The traditional management tasks of boundary management, task management and performance management have to be accomplished. However, this conceptualization makes no assumption that those tasks must be accomplished by people in supervisory positions. For each task, it makes sense to determine how it is best done, and where. To the greatest extent possible, performing units should handle their own management tasks. Decisions need to be made about whether to spread these tasks among different members, cluster them in one leadership role, vest that leadership role with authority over others in the performing unit, rotate responsibilities and so forth. These decisions should be made based on an analysis of the work and the members and a determination of how best to get management tasks accomplished. Different units may accomplish these leadership roles in different ways. Members of the performing units are accountable for its performance. Individuals are accountable to the performing unit for their role in it. In this respect, leaders are no exception.

Integrating Processes

Invisible in this diagram, and yet equally important from a systemic perspective are the processes that bind the organization together. These also need to be consciously designed. Four processes that are particularly critical are the goal-setting processes, planning, communication, decision-making, and performance management (For some, goal-setting is considered a sub-process of performance management. We list it separately here to indicate its linchpin role in the knowledge work system). These processes assume a heightened importance in the knowledge work organization because of its dynamic nature, and because the essence of the work is uncertainty reduction and learning. To meet the needs of such an organization these processes must be multi-directional. For example, goal-setting must be done laterally and vertically, to make sure that the goals of each performing unit are nested in the goals of the larger systemic unit, and to make sure that the goals of laterally interdependent units fit with each other so that collaboration is possible. Performing units must have routes to influence decisions made elsewhere in the organization that impact their ability to perform. Communication must be open, involve shared data sets and languages, and enable multi-directional connection.

Although the processes must be dynamic and multi-directional, this requirement does not imply that they are haphazard. Quite the opposite is true. Paradoxically, knowledge work, characterized by highly uncertain environments and work, requires highly systematic processes, precisely because these processes, not hierarchical control, are the glue that holds the organization together. Decision making authority and involvement need to be clearly delineated. Systematic processes facilitate providing input, communicating across specialties, and making trade-offs.

Performance management of performing units also has to be highly systematic. The essence of performance management is the feedback system that "controls" the system and enables it to be goal-directed (Lundberg, 1980). The traditional depiction of the organization places responsibility for feedback in the chain of command. Knowledge work systems, characterized by multi-directional interdependencies, also require multi-directional influence. This calls for a performance management system where feedback is channeled in many directions, giving interdependent performers and performing units the opportunity to influence each other's performance.

Relationship to Propositions

Although this conceptualization of the knowledge work organization is preliminary, it does address many of the propositions derived from organizational theory. By defining four systemic levels and delineating the scope of authority of the performing units at each systemic level, structural clarity is achieved (Proposition 11). The need for integrating mechanisms other than managerial rank to enable cross-functional decision-making for broad scope issues is illustrated by the use of cross-team teams (Proposition 10). The need for forums to enhance organizational learning and implement organizational changes is illustrated by the use of process teams (Proposition 7). Multiple types of teams are part of the organizational system including management teams, process teams, shared service teams, cross-team teams, and work teams (Proposition 6). It is clear that this system of teams enables participants to do task related integration (Proposition 2). This system of embedded performing units enables the workteams to define their goals in alignment with the mission and goals established by the business unit and organizational levels (Proposition 11 and 12). The mechanisms for integration go beyond structural elements and involve key organizational processes. The processes of goal-setting, communication, decision-making, and performance management enable goal clarity and alignment, multi-directional influence and connection, and agreed-upon and disciplined decision-making approaches (Propositions 3, 5, 11, 12, 13, and 14).

Summary

This section has outlined a model of conceptualizing and designing organizations for knowledge work. The model is based on the assumption that both differentiation and integration are required. It advocates depicting the units of the organization based on how the organization is intended to operate, and building in the relationships among performing units. The model does not automatically link together systemic operating levels with organizational hierarchy, or people with particular boxes in a chain of command. It does, however, maintain the notion of clear structure and authority. The model offers some beginning concepts to underpin a dialogue about knowledge work design.

Conclusion

Knowledge work embodies the application of specialty knowledge bases to the performing of work and the solving of problems. Non-routine knowledge work entails the reduction of uncertainty. High levels of uncertainty, dynamic conditions, and multi-level and multi-directional interdependencies pose particular challenges for organizing. These challenges are exacerbated by the need to link different knowledge bases to address complex problems. Most formal designs of organizations are "out of sync" with the operating modes necessitated by these challenges.

We have argued that the figure and ground used in traditional models of organization need to be modified to foster highly effective knowledge work systems. The new figure should be the organization's performing units, dynamic though they may be. Control should be thought of as laterally exercised as well as exercised across different systems levels. Hierarchy of control must be thought of as mirroring the hierarchy of nested systems at different levels. Making decisions at each increasing level of the system's hierarchy is equivalent to making authoritative decisions of different scope. However, a hierarchy of systems' levels does not necessarily mirror job and career hierarchies.

To some extent, the model we depict reflects the reality of how many organizations are beginning to operate. We have merely begun to craft a model to fit practice. This framework raises many theoretical and pragmatic issues. For example, vesting authority in a group instead of an individual is a new concept, and its theoretical, as well as practical, viability need to be explored. Embedding human beings in this kind of system raises all kinds of questions about human resource systems such as job responsibilities, careers, and rewards. To the extent that organizations in the future will have to operate differently, it is worth the effort to find organizational models that fit.

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