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CEO PUBLICATION
G 02-7 (416)

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March 2002

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February, 2002

To appear in:

Managing Knowledge for Sustained Competitive Advantage: Designing Strategies for Effective Human Resource Management

Eds: S. Jackson, M. Hitt, & A. DeNisi

It is broadly accepted that we are in an era when knowledge-based resources have replaced financial capital, natural resources, and unskilled labor as the most important competitive resource (e.g., Drucker, 1993). Today's dominant strategic framework takes a resource-based approach, viewing competencies and capabilities as the most important strategic assets (Prahalad & Hamel, 1990; Stalk, Evans & Shulman, 1992), and the creation and sharing of knowledge as a source of organizational advantage (Nahapiet & Ghoshal, 1998). As is argued by DeNisi, Hitt and Jackson in the first chapter of this book, acquiring talented knowledge workers is not sufficient for deriving value from this human capital. Knowledge resides in the minds of employees, but it is also embedded in the processes and products of the organization (Leonard-Barton, 1995). Increasingly, strategic competencies lie in processes such as developing and delivering knowledge-based products that entail collaboration and complex interactions among many different disciplines and functions. Effective organization and management of knowledge workers is central to the success of the knowledge enterprise (Quinn, Anderson & Finkelstein, 1996), which relies on these employees' initiative, their willingness to contribute knowledge, and also on their collective work (Nonaka & Takeuchi, 1995; see Lepak & Snell, this volume). Work design defines and organizes the activities of knowledge workers in relationship to the work processes of the organization, the activities of others in the organization, and to external stakeholders.

This chapter examines the design of knowledge work. It argues that the dynamic and highly interdependent nature of knowledge work, the trend toward geographically dispersed work systems, the characteristics of knowledge workers, and the critical importance of learning in the knowledge system require changes in organizational forms and the design of work.

Modifications and extensions to traditional work design theory are proposed, and research directions are suggested.

HISTORICAL PERSPECTIVE ON WORK DESIGN

The prevailing academic paradigm of work design evolved along with the industrial economy. Early scientific management and bureaucratic theories emphasized simplified and specialized jobs, a clear division of labor, clear functional reporting lines, and reliance on rules and procedures and managerial control (Gilbreth, 1914; Taylor, 1911). Psychological expectancy based job design theory (e.g., Hackman & Lawler, 1971; Hackman & Oldham, 1975) combined a focus on employee outcomes and task effectiveness. Five task attributes--*task significance, variety, identity, autonomy, and feedback from the job*—were posited to lead to critical psychological states—*meaningfulness, responsibility, and knowledge of results*-- which in turn promote work motivation, performance, effectiveness, and satisfaction (Hackman, 1977). A number of job design approaches were suggested to enrich the job and increase the motivational potential of work: forming natural work groups, combining tasks, establishing relationships with clients, vertically loading the job with responsibilities such as planning and control, and opening feedback channels from the work itself (Dunnette, Campbell & Hakel, 1967; Hackman, 1983; Hulin & Blood, 1968;). Subsequent research introduced the notion that job design must fit with the nature of the workforce, the design of the organization, and the patterns of interdependence inherent in the work technology (Porter, Lawler & Hackman, 1975; Rousseau, 1977). The basic task attributes approach has been expanded to focus on work that is carried out by teams (e.g., Hackman, 1983; 1990). However, with a few exceptions, work design has been largely overlooked as a research topic in the past decade, during which organizational forms have been fundamentally transformed as part of the transition to the knowledge economy.

The early work design frameworks were fashioned uncritically of the prevailing organizational forms that fit the bureaucratic principle that the job is the fundamental unit of work and the Parsonian notion that there is a clear differentiation of responsibilities between levels of the bureaucracy: institutional and strategic responsibilities were viewed as executive work; control of operations was managerial work, and execution was the responsibility of front-line employees (Parsons, 1960). Work design theory dealt largely with the work of front-line employees. Technology was accepted as given, and work was defined to conform to it. These assumptions began to be challenged by the socio-technical systems (STS) theory and philosophically related work on high involvement systems (Lawler, 1986) and high commitment organizations (Walton, 1985). These frameworks were based on a belief that work could be purposefully designed to optimize the performance of both the technical and social sub-systems of the organization (Trist, 1981; Pasmore, 1988), and to more fully involve front-line employees in the success of the business. They built on the motivational principles of the job design literature, but generated explicit tenets that are in direct contradiction to the notion of bureaucratic control. Rather than minimize investment in people, for example, they advocated investing in people as a resource to be developed, and equipping them with multiple broad skills so they can do more tasks and be flexibly deployed. Rather than simplifying and breaking down work into small chunks, they advocated creating optimal task groupings and designing work around work processes that can be relatively self-contained and controlled, or self-regulated, by the employees in the group, and building adaptive capabilities into work units

In their willingness to challenge the bureaucratic form and their focus on designing work to fit with the technical work and other lateral processes of the organization and to enhance the ability of the organization to develop and benefit from the knowledge and skills of employees,

these approaches anticipated many work design issues that are emblematic of the knowledge economy. Although initially employed largely in industrial settings (e.g., Trist & Bamforth, 1951; Walton, 1982) the socio-technical framework has subsequently guided the design of knowledge work settings such as hospitals, banks, and technical organizations (e.g., Pava, 1983; 1986; Taylor, 1986; Pasmore, Petee & Bastian, 1987). Work design in contemporary knowledge work settings often has followed similar principles, setting up various kinds of process-defined lateral work structures such as teams to house work that cannot easily be partitioned into individual jobs (e.g., Mohrman, Cohen & Mohrman, 1995). The next section will deal specifically with the nature of knowledge work and the challenges of designing knowledge work.

KNOWLEDGE WORK IMPERATIVES

Knowledge work entails the application of knowledge, the processing of information, and the generation of new knowledge (Mohrman, Mohrman & Cohen, 1995). Routine knowledge work involves the application of existing and often codified knowledge to carry out recurring tasks and problems. Non-routine knowledge work entails uncertainty, either because problems are not fully analyzable or because there are many cases that are exceptions to routine approaches (Perrow, 1967). Such work entails judgment (Thompson & Tuden, 1959), the application of tacit knowledge, and often the generation of new knowledge. The core competencies of the knowledge firm lie not only in the knowledge held by its employees, but also in knowledge embedded in its processes and systems. In the knowledge economy, a competitive advantage can be derived if a firm excels at generating and leveraging knowledge and at developing social and intellectual capital. By viewing the organization as a knowledge enterprise we can identify the characteristics of work in the knowledge economy, and their implications for work design (see Table 1). These will be briefly discussed below.

Table 1 Goes About Here

Strategic Competencies

Knowledge is growing geometrically, and the knowledge economy is dynamic, with potential competitive threats coming from rapid technological advances that disrupt existing business models (Christiansen, 1997; Hitt, Keats, & DeMarie, 1998). Strategy guides the competencies that the organization must protect and enhance. It also guides the work activities, and consequently the work design, in the knowledge system. For example, consider the new competencies required when a large equipment maker changes its strategy to sell "hours of service" instead of simply selling equipment. Product development work has to be designed to bring together technologists, financial experts, and marketers with a deep understanding of usage patterns, failure modes, recovery times, and economic modeling of the customer's business situation. The selling process has to include the customization of equipment and the development of new economic and pricing models as new kinds of customers are secured. In this situation, the work design must ensure that the product development and selling processes are carried out in a coordinated manner by employees who understand their own company's business model and who are knowledgeable about the business model and needs of the customer. In a dynamic knowledge environment, work can't be fully specified—much must be left to employees' discretion and initiative, as the organization charts a path through a turbulent competitive environment. Employees are required to focus on the purposes and strategy of the larger system in order to know how to focus their work, and with whom to coordinate and collaborate. As they collaborate to solve problems, develop new processes, products, and services, and find new ways to deliver value to customers, employees may create new knowledge that in a sense defines the future directions of the organization.

Saturated Interdependence

Knowledge work does not fit the reductionist organizing approaches that stem from scientific management such as partitioning and segmenting work, because it often does not have linear work flows (Pava, 1983). It may consist of multiple, concurrent workflows that influence each other (see Figure 2). For example, Dougherty (2000) found that new product development organizations have simultaneous, interacting processes for technical, market, business, and knowledge aspects of the work. Pava described the "saturated" nature of interdependence in knowledge systems, where often "it seems as though everything totally depends on everything else (1983, p. 52). Work designs must enable integration of the work of multiple specialists, each with their unique discipline perspectives (Dougherty, 1992).

Competitively valuable knowledge includes firm-specific process and product knowledge, and often tacit industry and market knowledge that comes from dealing with problems and processes in particular contexts (Leonard-Barton, 1995). Much knowledge creation occurs at the intersection of multiple disciplines and functions, and at the intersection of deep knowledge bases with the world of applications (Boland & Tenkasi, 1995). Collaboration across boundaries in shared problem solving and knowledge creation is core to creating value from knowledge. The importance of such collaboration has grown as customers demand integrated solutions. Working at knowledge intersections requires T-shaped skills (Iansiti, 1995)—skill sets that include a deep technical knowledge base combined with broad knowledge that enables individuals to understand the systemic impact of their work and to be able to collaborate with co-workers from other disciplines. Work designs include forums, such as cross-functional teams, for the integration of the work of multiple contributors with different knowledge bases. For example, chemists, analytical mathematicians, microbiologists and

physicians may work together in teams that collaborate to turn promising compounds into viable drug therapies. Tax and estate specialists and several different investment specialists may collaborate to manage a wealthy client's investment portfolio. In professional services firms, diversification into new service areas allows the configuration of diverse project teams to capture knowledge synergies (Hitt, Bierman, Shimizu & Kochhar, 2001).

Process Orientation

The knowledge economy has emerged in concert with the recognition that value is delivered to the customer through work processes, not through a series of discrete, partitioned tasks. This awareness was raised by proponents of the total quality management (TQM) movement (e.g., Deming, 1982; Juran, 1989), who emphasized designing work processes to deliver value to internal and external customers. They argued that knowledge, information, and understanding are lost as work meanders through the organization. Increasing the value delivered to customers requires integration of the interdependent activities that constitute a process and of the various streams of activity that come together to yield outcomes. Optimal performance requires awareness of the whole process.

Business process reengineering theorists (Hammer & Champy, 1993; Davenport, 1993) are quite explicit about the close relationship between knowledge and work processes. They stress the role that information technology can play in enabling effective value-delivering processes by ensuring that necessary information is available to inform the work of employees throughout the organization. I.T. is viewed as an integral part of the work design in the organization. Reengineering approaches include the automation of easily codified process steps that do not require human judgement, the elimination of steps that don't add value to the

customer, and the combination of tasks in the roles of individuals or units that have I.T.-enabled access to information that was previously located in organizational pockets.

Geographical Linkages

Knowledge travels easily between locations, enabling virtual work designs. Even services as personalized as health care can get delivered through work processes that link contributors across locations. Physicians send test data and electronic patient records to specialty labs in other cities and consult with experts in medical centers in different parts of the world in collaborative diagnostic processes. Similarly, centralized technical support teams for a control systems company have electronic access to the specifications and real-time performance data for heating and cooling systems in global locations of a customer's corporation. They can detect and in many cases solve problems from great distances, often working in concert with technicians on location.

Companies seek global markets in order to recoup their investments in new knowledge-based products, services, and processes. Increasingly having a global strategy and global markets means doing work in many countries (Galbraith, 2000). Designing work to link knowledge across locations is a key strategic competency for many knowledge firms. Companies seek talent wherever they can find it, service global customers, and locate various aspects of their operations close to the cutting edge technology and to talent concentrations and industry centers.

Learning: Improvement and Encoding

Continual improvement of work processes and work designs has become a competitive requirement. Process learning is now part of the core work of many firms. Employees are often expected to be part of a learning system by searching for the root causes of process quality

problems and finding process breakthroughs that enable improved performance. Companies such as British Petroleum and General Electric expect their managers to manage performance in their unit and also to participate in cross-unit learning processes. Process breakthroughs are frequently the product of cross-functional and cross-unit improvement teams that can look at workflows, intersections, and integration of the knowledge of different disciplines and functions. Process breakthroughs in one part of the organization can be encoded and shared with other parts of the organization, and thus become embedded in the functioning of the organization (Nonaka & Takeuchi, 1995). Iterations of process learning yield dynamic work processes that may require ongoing changes in the design of work.

Generating and Applying Knowledge

Knowledge generation and application are inherent in the conduct of knowledge work. Knowledge is contextual and relational—people construct social knowledge as they interact in a social context, and this knowledge in turn influences their behaviors, perceptions, and cognitions (Berger and Luckmann, 1966). Knowledge is "information combined with experience, context, interpretation and reflection" (Davenport, Delong & Beers, 1998), that becomes "anchored in the beliefs and commitments of its holder" (Nonaka & Takeuchi, 1995, p.58) through active involvement in its creation, and/or through collective sense-making and local learning (Orlikowski & Robey, 1991). For example, units that implement a new information technology are not the passive recipients of knowledge that has been developed elsewhere. They engage in local experimentation and sense-making, and learn how to use the new technology to increase their effectiveness. The knowledge-creating firm is characterized by a cycle of learning through which individuals' often tacit knowledge is shared through collaborative work, becomes explicit through such means as building models and articulating analogies, and eventually is made

available to the larger organization (Nonaka & Takeuchi, 1995; Liedtka et al, 1997). Interdependence is inherent in knowledge leverage and generation processes, and collaborative work is the source of the relationships that grow intellectual and social capital.

The diverse activities of a firm are held together by company's intent, or strategy (Nonaka & Takeuchi, 1995), but also by the shared meaning that develops as people work together toward desired outcomes for customers, for the company, and for each other (Liedtka et al, 1997). Learning is both a collective and individual process. Knowledge is embedded in knowledge communities and is developed as people participate together in the practices of a social community (Wenger, 1998). Knowing is deeply personal (Dixon, 2000), and willingness to share and learn from one another comes from connections between people, both within and across units and locations. Connection to these knowledge communities must be built into the work design of the organization. Creating knowledge connections and building geographically dispersed knowledge communities is a key competency in a global knowledge firm.

Summary: Implications for Knowledge Work Design

As depicted in Table 1, the six characteristics of knowledge work described above collectively point to a set of work design features that are hypothesized to underpin the ability of the firm to compete on knowledge. These work design features may provide the basis for strategic flexibility, the ability to flexibly apply resources in support of a dynamic strategy (Hitt, Keats & DeMarie, 1998). Each is briefly described below:

Work designs are dynamic. As strategies change and new knowledge is generated and built into processes and applications, the configuration of activity in the organization also changes to reflect new and evolving capabilities and competencies, and new ways of delivering

value. Knowledge is developed and value delivered through temporary work units with shifting membership.

Work is designed for cross boundary collaboration. The optimal application of knowledge resources requires lateral linkages across boundaries, including those between functions and disciplines, geographies, business units, and companies. Many of the core competencies of a knowledge firm entail interdependent contributions from multiple knowledge bases in carrying out and improving the processes of the organizational system, generating and leveraging new knowledge, and delivering value to customers. In this laterally linked organization, individuals may simultaneously belong to multiple organizational units, or may work across them. Coordination and control are no longer the sole domain of hierarchical managers. Lateral linkage is part of the work of many front-line knowledge workers, and may occur through formal lateral linkage roles such as liaisons, project leaders, expert consultants, and matrix and dual membership roles.

As knowledge rather than capital becomes the currency of the organization and powerful I.T. tools enable easy exchange of information and coordination across distances, the location of work is no longer constrained by the location of capital equipment. Work processes can be designed across geographies and time zones, taking advantage of expertise no matter where located. I.T. systems are no longer simply tools for doing work: the design of work and of I.T. systems are inextricably linked.

Work designs provide focus on the larger system as well as on local performance. Saturated interdependencies, interweaving processes that deliver value to customers, and the need to achieve competitive advantage through the ongoing leverage of knowledge dictate that local mission and goals be viewed contextually--within the mission and goals of the larger

system that is itself continually changing. In the knowledge economy, change occurs too quickly for the sub-systems of the organization to be fully aligned from the top. Self-regulation is of necessity systemic in nature, with individuals and units within the system mutually adapting and re-forming with reference to one another and to the larger system purposes and strategies (Mohrman, Mohrman & Cohen, 1995).

Work is designed for learning. Changes in strategy and the rapid growth of basic discipline knowledge and advanced analytic tools drive the need for new knowledge and competencies. A key competitive capability is leveraging the initially tacit knowledge that is gained through the experiences of front-line workers dealing with concrete problems. Training and development activities are only one of many ways that learning is facilitated and intellectual capital is developed (see Chapter 8). Organizational learning and knowledge leverage is everyone's concern and much of it occurs on the job.

These work design features represent a fundamental change from traditional work design principles. Very little rigorous work has been done to ascertain their prevalence, and their impact on employee and firm effectiveness.

WORK DESIGN AND MOTIVATION IN THE KNOWLEDGE FIRM

Work design has so far been discussed with little consideration of the attributes of the knowledge worker. One of the most striking attributes of knowledge workers is that they are in short supply. Despite sharp economic fluctuations, demographic trends such as the retirement of the baby-boomer generation and its replacement by a much smaller cohort suggest that labor markets for knowledge workers are likely to remain tight for several decades (Russell, 1993). To a great extent, firms "rent" the knowledge of these scarce employees, but they also contribute to its development. This knowledge and the company's investment in it can easily walk out the

door. Today's technical workers are mobile--willing to change firms for advancement opportunities and increased pay (Finegold, Mohrman & Spreitzer, forthcoming)—making it imperative to find approaches to build attachment to the company (Coff, 1997). Work design relates to performance motivation and to commitment and retention. It also provides the context for the effective utilization of scarce and potentially temporary knowledge work talent (Quinn, Anderson & Finkelstein, 1996). This section examines work design, motivation, and the knowledge worker. It proposes testable refinements, reinterpretations, and additions to the traditional job characteristics model.

Attributes of Knowledge Workers

Knowledge workers enter the workforce with skills and knowledge that they have generally obtained through formal education. Through their experience they develop deeper expertise, and/or broad practice-based knowledge—by applying their knowledge in multiple contexts and to solve diverse problems. Knowledge workers who perform non-routine tasks may continually expand their knowledge competencies through experience and additional formal education, and become increasingly valuable as employees.

There is not a clear line between managerial and knowledge work. Managers are knowledge workers, and non-management knowledge workers perform functions, such as planning, integration, coordination, invention, and innovation, that were considered managerial in the industrial organization (Mohrman, Cohen, & Mohrman, 1995). Based on their expertise, they expect autonomy (Von Glinow, 1988)—to be able to carry out their work free from close supervision. Whereas front line workers in the industrial economy were viewed as having jobs while managers had careers, knowledge workers enter the workforce seeking careers. Their loyalty is to their careers and their professional identity rather than to their firm (Von Glinow,

1989). Career growth and competency development are built into their expectations of work. Given the flatter structures that have emerged as organizations increasingly work laterally (Galbraith, 1994), career growth may be within the technical/professional ranks rather than through a succession of managerial positions. An increasing number of knowledge workers are operating as independent contractors, being hired by companies solely because of their knowledge competencies to perform particular tasks in particular projects.

Knowledge workers operate through personal networks (Adler & Kwan, 2002). Networks are built through and facilitate work performance and collaborative learning in the highly interdependent and distributed knowledge firm. Additionally, professional networks are essential to career building. It is through such networks that knowledge workers become aware of opportunities both within and outside of the firm. In fact, in technical firms young knowledge workers report being closely linked electronically to their professional networks, and keep each other abreast of job opportunities, salary trends, and qualitative information about different firms (Mohrman & Finegold, 2000). They also use their networks to stay aware of emerging trends and competencies so that they can direct their personal growth and development and seek opportunities that will maintain their employability.

Many knowledge workers are highly dependent on advanced analysis, modeling, and communication tools. Tools that embody knowledge have become extensions of the knowledge worker and the knowledge work team. Knowledge workers, tools, and tasks are linked together to deliver value (Argote & Ingram, 2000). For example, insurance actuaries create powerful tools for modeling risk and determining net present value. 3-D models and system simulation tools embody sophisticated engineering knowledge and serve as powerful productivity enhancers. Having the opportunity to master up-to-date tools is critical to the professional

identity and employability of knowledge workers. Knowledge workers depend on their tools to be able to tap into knowledge communities, work teams and projects from remote locations and with a shifting group of co-workers; these tools have also made it possible for knowledge workers to physically locate anywhere in the world, and still work interdependently with teammates in other locations.

Job Design for Knowledge Work

Job characteristics theory and the expectancy theory of motivation stress designing work in a way that is psychologically rewarding to employees, enables effective performance, and yields desired employee outcomes as a consequence of good performance. Although there is no reason to believe that the fundamental psychological mechanisms of motivation have changed, the knowledge economy has resulted in changes in the organizational and technical contexts for work. Increasingly, instead of holding clearly defined and stable jobs, individuals are flexibly deployed to a sequence of assignments and roles that require their competencies. In addition to being held accountable solely for how well they play their individual roles, they may be held accountable for how well they contribute to the needs of the larger knowledge system. Defining work design principles that fit this context and result in high levels of motivation is a challenging research focus.

Earlier research found very few individual differences in the receptiveness of employees to the five key task attributes of classic job design theory (Griffin, Moorhead & Welsh, 1981). Given the high growth needs that can be expected to characterize knowledge workers, these job characteristics are expected to be important to them. However, we may need new images of how to achieve these job attributes in systemic and interdependent knowledge work with its inherent learning requirements (see Table 2). The remainder of this section suggests ways that our

understandings of these job characteristics may need to change to fit the knowledge enterprise. It is also argued that two new job attributes should be considered. Growth and development and network building opportunities are expected to contribute to employee motivation and outcomes, and to performance in knowledge work settings. This discussion is intended to provide a rich menu of testable propositions.

Table 2 Goes About here

Task Identity. The saturated interdependence and collaborative nature of knowledge work make it difficult for individuals to perform "whole" tasks, as would be called for by the traditional job attributes framework. Products and services are often delivered through complex processes that involve the collective outputs of a wide variety of interacting teams. Teams established for such purposes as new product development or customer service may go through phases in which composition changes through time as the required competencies change, making it difficult for any one team member to feel responsible for the ultimate team output. "Virtual" work involves individuals and teams in multiple locations coordinating electronically and working synchronously and asynchronously on the same problem or model, resulting in a product where it is difficult for members to see, let alone identify personal contributions. Knowledge emerges through a juxtaposition of ideas from many sources, and ideas generated by individuals in one team may end up reaching fruition in another team.

We know little about how task identity is achieved in knowledge settings, and whether it is important. It may exist primarily at the collective level—through the missions and objectives of different temporary teams and networks and through individuals' often shifting understanding of their roles and expected contribution in these work structures. Rather than having a clearly

defined job in a stable work unit, many knowledge workers have a succession of assignments. Short term, identity may stem from clear individual assignments and/or being a member of one or more teams with well-defined outputs. But individuals may also be tasked with linking between teams or being part of coordinating teams—where success is measurable only at the higher system level. Perhaps through time, a sense of identity comes from clarity about the knowledge and competencies a person contributes to the system and from developing a deeper understanding of how these contributions impact the larger system. It is proposed that task identity can be achieved by designing work so that the tasks of all performing elements—individuals, teams, and business units-- have a clearly articulated relationship to the effectiveness of the larger knowledge system and to other performing units, and by designing the sequence of assignments so that individuals develop a greater understanding of the overall system through time.

Task Variety. The traditional view was that task variety was achieved by constituting a job of multiple horizontal and vertical tasks rather than defining narrowly specialized jobs. Designing work for the knowledge economy requires understanding how specialized knowledge and knowledge workers add value in particular organizational contexts, and what kinds of adjacent knowledge need to be coordinated to increase knowledge contribution (Quinn, Anderson & Finkelstein, 1996). In some situations, such as the performance of neurosurgery, a deep specialist delivers the central value, and work designs that promote the ability of this critical specialist to perform effectively by aligning other knowledge specialists in support roles are the most appropriate. Allowing neurosurgeons to concentrate on neurosurgery makes more sense than increasing the variety of the surgeons' tasks by requiring them to prepare their own instruments, conduct their own CT-Scans, or do their own billing. Variety for the neurosurgeon

may come from the individual differences inherent in multiple cases; such variety contributes to the development of deeper and perhaps tacit expertise. Where multiple specialties come together to develop a system or systemic approach, such as when internists, dieticians, cardiologists, internists, and physical therapists collaborate to develop an overall treatment plan for a chronically ill patient, variety may be introduced not only through the variance in individual cases, but also in the range of considerations that members in the group are exposed to and responsible for. These specialists develop skills at working together and combining their knowledge to yield a plan, but they only minimally develop overlapping knowledge. When related specialists such as electrical engineers, software engineers, biologists, chemists, and medical doctors form a team to develop an electro-chemical medical device, variety may stem not only from the range of technical considerations, but also from the overlap of tasks and working collaboratively on the same problem, leading often to a broadening and perhaps even redefining of knowledge that enables specialists to contribute in more general ways. When it is understood that a new product development team contributes to company success not only by inventing the latest gadget, but also by doing it in a way that it is economically and reliably manufactured and easily serviced, the variety of considerations and responsibilities of that team is greatly enhanced. "T-shaped" skills are developed in the new product development teams where contributors develop overlapping knowledge that enables more effective combination of knowledge.

Thus, variety may best be defined in relationship to the knowledge structure inherent in the technical and business requirements of the organization. It may be achieved through the application of deep skills in multiple contexts over time. Alternatively, it may be achieved by developing broad skills through diverse assignments, performing more aspects of the process,

and/or through focusing on the integration of the system. Research might fruitfully examine the impact of different kinds of variety on knowledge worker outcomes, on the enhancement of knowledge-based competitiveness, and on system performance.

Significance. Significance refers to the belief that one's work makes a difference or has an impact, such as for customers or some larger mission. Just as was true with identity, the complexity of processes may make it difficult for knowledge workers to identify how their personal work is significant. Clarity about the organizational processes that deliver value through the integrated activities of multiple contributors in a potentially diffuse work system may be accompanied by an increased sense of significance of one's individual contribution to the overall process. Perceptions of significance can be enhanced by creating direct links to the customer that make it possible for all involved in the process to understand customer need and see how value is perceived by the customer. Some companies routinely find a time early in a person's career to give them at least one assignment where they have direct customer contact. Others may hold customer focus groups and/or celebrations to provide employee visibility to customer impact. Feedback systems that enable knowledge workers to see the impact of their teams' and unit's work on business performance can increase the perception of significance to the company. In today's economy, where knowledge work is often housed in organizations with strong strategic and financial orientations, balanced score-cards with measures that force a systemic focus and that are broken down into appropriate measures for various teams and units may provide awareness of the significance of work to the organization. The same work design approaches that are required because of the interdependency of work--creating cross-functional teams to address more systemic problems, and building links across interdependent parts of the organization—may create an awareness of how one's contribution is significant for the larger

system. Significance may also be enhanced by sequencing work assignments so that individuals get experience in multiple units and can see how various units depend on one another. Given the extensive literature documenting the gap between the orientation of professional employees toward furthering their discipline and their employers' orientation toward business outcomes, it is critical to develop a better understanding about how to better align these two concerns and the significance that knowledge workers attach to each.

Feedback. Traditional job design theory emphasized intrinsic satisfaction and receiving feedback from doing the job rather than external feedback from management. Software programmers, for example, receive feedback if their piece of the code runs with or without error messages. A software program team gets feedback when the members combine their code and run their module. Feedback about the systemic aspects of performance stems from collective work : How much does it cost to run the code? Does it fit with the larger software system or does it have to be modified? Are "bugs" encountered in the field? Does the application fit the customer's requirements? Ultimately, how much revenue does the company receive from this software package, and how much market share is gained or lost? Personally relevant feedback, like significance and identity, may operate at multiple systems levels.

Building the tracking of team and project level success into the work process itself may be a way to achieve meaningful work-based feedback in a highly interdependent knowledge work system. Because knowledge workers tend to work in a variety of networks and teams and collaboration across boundaries is inherent in the work, feedback from multiple sources is relevant. Peer and customer project reviews that are integrated with milestones and process flows maintain the principle that feedback comes from the work itself. Such approaches are consistent with integral relationship of learning as part of knowledge work. Through multiple

source project reviews, knowledge workers individually and collectively find out how other knowledge workers experience their contribution, and get feedback about how to improve their contribution. For example, software companies such as Microsoft build regular "time-outs" into the software development process. Code may be temporarily frozen and different teams examine each other's products and codes for integrity, reliability, and system compatibility. This provides periodic feedback from the work, and it enhances the likelihood of a successful project by facilitating learning and enabling mid-course fixes to prevent errors. Again, we know little about the characteristics of work-related feedback systems in complex knowledge work and about how to create a personal line of sight.

Autonomy. It may be especially important to understand the role of autonomy in dynamic and highly interdependent knowledge systems that cannot be fully "programmed" from the top. Autonomy has been found to be a key issue for professional knowledge workers. Autonomy has traditionally meant that individuals or teams have the responsibility and authority to carry out their work without close supervision. Professional autonomy has been viewed as independence in applying sound professional knowledge using accepted standards and methodologies. Self-regulating work teams have been viewed as "autonomous" in determining how they organize their resources and the strategies they apply to accomplish the outputs required by the larger organization. These traditional views depend on the ability to segment work so people "own" a piece of it and can manage their own activities.

In the dynamic and highly interdependent knowledge system, autonomy may be best understood as individual and/or collective self-regulation in continual interaction with the other elements of the system and in relationship to the shifting purposes of the larger context. Self-regulation occurs both in response to top down direction, and through awareness, connection,

and accountability to the other elements of the system. Mutual adjustment is a fundamental process enabling autonomy; it depends on shared understandings and norms within the system. Reconfiguring resources to pursue a dynamic strategy is enabled by an organization design that includes common processes and systems, and talent strategies that facilitate the movement of knowledge resources from one project or venture to another without the need to rebuild understandings from scratch (Galbraith, 1997). Achieving value from knowledge and learning requires that what is learned quickly becomes accessible to other parts of the organization and embedded in processes. The autonomy of various elements of the knowledge system, such as individuals and teams, is constrained by the need to adjust dynamically to a changing context, and where collaboration and flexibility are enabled by adhering to shared principles of interaction. At the same time, each element is responsible for figuring out *how* to carry out its role to support the larger system and operate synergistically with its other elements. The organization changes too quickly for control from the top, yet it needs to continually adjust itself in response to system-wide direction. There is a need to better understand the nature of autonomy that enables optimum application of and advancing of knowledge while facilitating system self-regulation.

Growth and Development. Although it has been found that performance is highest if tasks are performed by the people the most qualified individuals (Argote and Ingram, 2000), designing work to take advantage of people's current competencies may not be the best approach in fast-paced knowledge settings. There are both social and technical reasons why growth and development should be considered a work design characteristic in the knowledge economy. Personal growth and development are of key importance to knowledge workers, and organizations that compete on knowledge have demanding requirements for organizational

learning and improvement. The growth and development activities in the firm are building blocks for the establishment of shared understanding and system awareness that underpin the ability to work effectively in a dynamic, interdependent system, and to derive value from knowledge (Mohrman, Finegold, & Mohrman, 2002). We can therefore hypothesize that building growth and development requirements into work will contribute to employee satisfaction and commitment as well as to performance.

As was the case with variety, designing work for growth and development must occur within the framework of the various competencies required in the system, and their implications for the needed mix of deep and broad knowledge. Designing for growth and development is not solely or even primarily a matter of planning training activities. Experience is critical to the development of explicit and tacit knowledge (See Chapters 1 and 8, this volume). Job assignments are a way not only to utilize talent, but also to develop it. Careful composition of work groups and design of work processes enable members to learn from each other, and to explicitly transfer practice from one part of the organization to another. Cross-functional process-oriented teams present the opportunity to develop broader knowledge; communities of practice present opportunities to develop deeper knowledge. Research is needed to discover the mix of approaches suitable in different knowledge contexts and for different knowledge bases.

Increasing the overlap of learning and doing by embedding growth and development in the way work is designed and in the sequence of assignments and roles knowledge workers assume is expected to be highly motivating. Tying the broadening and/or deepening of skills not only to the company's need for competencies, but also to the individual's personal needs for career growth strengthens the motivational expectancy cycle. Competency-based human resource practices enable this alignment (Lawler & Ledford, 1998). Development plans can be

set up for individuals and teams and their work can be defined to include learning required to carry out the organization's strategy and meet its competency requirements. Other human resource practices such as assessments, career paths, and rewards can also be defined to include a focus on learning. Given that learning is part of the work of the knowledge firms, carrying out these development plans can be included in the system's metrics. Process improvement, dissemination, and adoption of innovation can be built into the objectives and plans of each element of the system: individuals, teams, projects and business units. Although human resource competency based systems have been described and studied, these studies have typically not included a focus on the design of individual and collective work, nor on their performance impact in enabling knowledge based competition.

Network Building. There are both social and technical reasons why network building should be an explicit work design characteristic in the knowledge firm. Networks are the basis for increasing social capital through the resources derived from the relationships in the organization (See chapter 8, this volume). Benefiting from the knowledge of the many specialists in the organization requires that people are aware of who knows what (Argote and Ingram, 2000). The organization relies on its dispersed elements to collaborate with and adjust to one another. Such behavior depends on the existence of interpersonal networks built on a foundation of trust, familiarity, and shared understandings (See chapter 3, this volume). Knowledge workers rely on their personal networks for many purposes -- for development of their competencies, personal visibility in the organization, and awareness of opportunities, and for their ability to operate effectively in the interdependent knowledge system. They derive a sense of professional identity and peer support from their knowledge communities.

Networks can be formally established by building them into the work design of the organization. Technical councils and communities of practice can be established as formal work units. Networks are also built in and among the core work units of the organization. When people serve on the same temporary and possibly emergent teams or assume liaison roles vis-a-vis other parts of the organization, they remain part of each others' personal network long after the project has been completed and the team disbanded. Through a sequence of assignments and team memberships, a network of contacts is developed based on experience working with each other and becoming aware of each other's knowledge competencies. More informally, I.T. systems such as expert lists and readily accessible project and knowledge files can extend the reach of all employees to each other's knowledge and experience, and can enable connections throughout the organization. Organizations can plan development activities such as training sessions, business processes such as planning meetings, and collective work activities such as peer project reviews and customer visits to expose people to one another and build networks.

By attending to the network building aspects of work design, an organization can create a web of formal and informal connectivity that matches the saturated interdependency of the system. This approach also meets the needs of professional workers to have networks for various career and work effectiveness purposes. Although much research has described how networks are formed and maintained, there are many unanswered questions. What kinds and density of networks contribute to work effectiveness and employee outcomes in different kinds of knowledge settings? How many active linkages can employees maintain without losing performance productivity?

CONCLUSION: A FRAMEWORK FOR KNOWLEDGE WORK DESIGN

Designing work for the knowledge organization requires that the nature of the knowledge system be understood and that new principles of work design be followed that address its dynamic and highly interdependent nature. Because knowledge work assumes a variety of forms, each knowledge enterprise needs to be individually designed. Although we do not expect the basic underlying psychological mechanisms of motivation to change because people are knowledge workers, technical, contextual and environmental forces dictate a change in the assumptions underlying work design and the mechanisms for achieving employee motivation. Based on the framework that has been presented in this chapter, the following principles are proposed to guide knowledge work design:

1) Design for systemic performance. Knowledge work designs attend both to connecting the elements of a system to one another, and to differentiating and clarifying accountability and responsibility of the piece parts. Employees will be asked to operate wearing two hats: one that focuses on local objectives and performance, and the other that focuses on the contribution of the local unit to the system as a whole. The latter requires making adjustments required for the whole system to perform optimally.

2) Create dynamic designs. Work designs are not intended to be, nor portrayed as, permanent. Rather, work design is a strategic and operational tool that changes as the strategy and mix of activities in the system changes.

3) Focus on sequences of assignments, not on jobs. The organization cannot be conceptualized as consisting of individuals with stable jobs. Rather it is composed of dynamic knowledge processes and tasks to which people with various skills and knowledge are deployed.

The sequence of assignments determines the experiential learning of the employee, and the knowledge brought to subsequent tasks.

4) Blur the distinction between managerial and knowledge work. Managerial and leadership work is simply one form of knowledge work, often best carried out within and across performing units. Self-regulation and mutual adaptation is the responsibility of all elements of the organization. Linking to other parts of the organization and to elements external to the organization for interdependent task performance and for learning is built into the performance expectations for many employees.

5) Design work to enable processes that cut across boundaries. Dynamic knowledge work processes cut across disciplines and functions, geographies, product and service groupings and customer sets. No matter what the core structural units of the organization, leveraging and generating knowledge, and applying it for diverse purposes requires the organizational capability to assemble and connect dispersed resources (virtually or physically through co-location) to achieve focus on common outcomes. The design of work is independent of people's "home base" in the organization.

6) Design work to develop talent. Development can no longer be seen as something external to work. Rather, learning is part of the work itself. Development is facilitated by sequences of job assignments, tasks, and experiences, as much as by formal development events and the creation of learning networks

7) Focus on the employment relationship. Motivation to perform and commitment to contribute are the result of the expectancies built into the system. These are related to the organization's expectations for employee performance and contribution and the outcomes employees experience as a result of performing and contributing. Work design is integrally

related to these expectations and underpins the employment relationship. Clarifying how this relationship changes in the knowledge economy, and ensuring a viable set of mutual expectations is critical to the ability to attract, effectively utilize, and retain talent. Aligning work designs with the knowledge requirements of the system may require simultaneous focus on redefining human resource practices such as career progression, rewards, development, and performance management to fit with the knowledge and competency needs of the system and its work design approaches.

These principles, taken in full, represent some very fundamental changes from the status quo as represented in the academic literature. Although much has been written about changing organizational forms, we know little about the more micro-work design approaches that are effective and sustainable in these new forms. As important, we know very little about how employees respond to these new forms and to the new work relationships and structures that they imply. In the evolution of the knowledge economy, practice has preceded research. It is critical that academics catch up with these new directions, and generate theory and empirical evidence to underpin new ways of organizing work.

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Table 1

Implications for Work Design

Characteristics of Knowledge Work	Dynamic	Cross Boundary Collaboration	System Focus & Integration	Learning
Strategic Competencies	X	X	X	X
Saturated Interdependency		X	X	X
Process Orientation		X	X	X
Geographical Linkages		X	X	
Improvement and Encoding	X	X		X
Generating and Leveraging Knowledge	X	X	X	X

Table 2	
Motivating Work Design Characteristics	**Proposed Knowledge Work Forms**
Task Identity	Sequence of assignments to well-defined tasks and projects
Variety	Application of deep skills in multiple contexts over time; Development of broad skills through diverse assignments and performing more aspects of the process and/or systems integrating tasks
Significance	Knowing contribution to larger business context and success and/or to external customer and/or knowledge community
Feedback	Knowledge of performance of team, project and larger performing units; Individual feedback from job and from multiple sources
Autonomy	Collective and/or individual self-regulation with relationship to larger context
Growth and Development*	Enhancing personal competency through work assignments
Network Building*	Connections to knowledge community; Task connections Customer connections

*Not included in original Hackman and Oldham (1977) task attributes framework