TASK, KNOWLEDGE, AND COORDINATION

-- TRANSACTIVE MEMORY IN ACTION

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Abstract

The theory of transactive memory has been formulated and improved by Wegner over the years since its debut in 1987. However, previous research on transactive memory has overlooked knowledge differentiation and integration, the two core underlying processes in transactive memory formation. Moreover, Wegner's formulation of transactive memory theory does not take into account effects of task characteristics on levels of knowledge differentiation and integration nor the corresponding integrative tools that can be employed to coordinate knowledge integration. This paper used a contingency framework looking for the best fit between the contingency factor or factors (e.g., task) and the structural requirement of the environment (e.g., levels of knowledge differentiation and integration, coordination mechanisms compatible with disparate knowledge demands). The results of this analysis would generate important practical implications for organization design.

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Organizational knowledge is a critical asset for organizations especially in the present information age when knowledge-intensive industries thrive more than ever. How to effectively manage knowledge resources emerges to be an urgent and important issue facing contemporary organizations. Organizations have to deal with a large number of tasks varying in complexity and cognitive demands. How to design comparable coordination structures to match differential knowledge requirements is the key to effective management of organizational knowledge. This paper explored the relationship among task, knowledge, and coordination from the vantage of transactive memory, analyzed optimal knowledge structures determined by given tasks, and proposed corresponding coordination mechanisms to satisfy respective knowledge demands. The results generated by this analysis would provide valuable guidance for organization design from learning and knowledge management perspectives.

The theory of transactive memory describes the stages and benefits of cognitive divisions of labor. It has been formulated and improved by Wegner (1987, 1995) over the years since its debut in the mid 1980s. A transactive memory system consists of the knowledge stored in individual memory systems together with the communication links between individuals (Wegner, Giuliano, & Hertel, 1985). Wegner (1995) identified three processes in the formation of a transactive memory system: directory updating, information allocation, and retrieval coordination. Directory updating is a process of learning “who knows what” or “who knows who knows what” in the system. Information allocation is a process by which new incoming information is allocated to relevant experts for storage. Information retrieval is a process of bringing back individually stored information for task completion purposes. Organizations with well-functioning transactive memory systems reduce the information processing and storage load for each member and at the same time enlarge the knowledge resource pool that every member has access to.

Two observations have stimulated the design of this study. First, previous research on transactive memory has primarily focused on individually based variables such as encoding, retrieval, expertise recognition, and communication. Little research has examined system-wide processes such as knowledge differentiation and integration—the two driving forces in transactive memory formation. Knowledge differentiation and integration, the two focal constructs in this analysis, are construed in similar fashion to Lawrence and Lorsch's (1967) definitions. Knowledge differentiation is a process through which domain specific job-related expertise is distributed in individual memories to cope with the demand of a particular aspect of a task. An increasingly differentiated transactive memory system is a natural product of on-going interactions through which individual members assume, delegate, or negotiate knowledge processing and storage responsibilities based on formal delegations, situational demands or perceptions of one's own and others' expertise (Wegner, 1987). Knowledge integration is a process of recalling expertise from recognized experts to accomplish a common task. Knowledge integration occurs through two processes: (1) aggregating existing knowledge, and/or (2) creating new knowledge.

Second, Wegner's articulation of transactive memory theory does not take into account effects of task characteristics on levels of knowledge differentiation and integration, nor corresponding integrative apparatus that can be employed to coordinate knowledge integration activities. The need for a match between distribution of knowledge and features of tasks is reminiscent of an open systems view of work groups and organizations (Ancona & Caldwell, 1992a; Nonaka, 1994). This paper discussed the role of task in the functioning of transactive memory systems and placed transactive memory analysis in the open systems perspective to organization research.

This study employed a contingency framework aiming to look for, as Donaldson pointed out (1996), the best fit between the contingency factor or factors (e.g., task) and the structural requirement of the environment (e.g., levels of knowledge differentiation and integration, coordination mechanisms compatible with disparate knowledge demands). The reason why task complexity was chosen as the contingency variable was two fold. First, task complexity comprises a variety of task characteristics (e.g., task interdependence, task analyzability, task uncertainty) and is most comprehensive in describing a task. Second, task complexity is conceived as consisting of three dimensions: component complexity, coordinative complexity, and dynamic complexity (Wood, 1986), each of which has distinct effects on levels of knowledge differentiation and integration. For instance, component complexity largely determines the degree to which knowledge structures are differentiated. Coordinative complexity is closely associated with the need for knowledge integration. Since dynamic complexity is a result of the changes in component complexity, or coordinative complexity, or both, the complex combination of knowledge differentiation and integration requirements reflects dynamic interactions between component complexity and coordinative complexity.

To analyze the complex effects task complexity has on knowledge differentiation and integration, I divided tasks into four categories based on their levels of component complexity and coordinative complexity: tasks with (1) low levels of both component complexity and coordinative complexity, (2) high component complexity and low coordinative complexity, (3) low component complexity and high coordinative complexity, and (4) high levels of both component complexity and coordinative complexity. Knowledge requirements vary in degrees of differentiation and integration across the four categories of tasks and call for distinct coordination mechanisms for knowledge integration. As mentioned earlier, dynamic complexity is determined by changes in either component complexity, or coordinative complexity, or both (Wood, 1986). The effects of dynamic complexity on knowledge distribution, utilization, and coordination, thus, can be revealed through moving between task categories. By incorporating task characteristics into the analysis of knowledge and coordination, this paper helped to demonstrate how the nature of transactive processing ranging from most static to most dynamic varied with the type of task involved and provided practical implications for specific integrative tools organizations could adopt to meet the differential demands for knowledge differentiation and integration.

The Construct of Task Complexity

According to Wood (1986), task complexity consists of three dimensions: component complexity, coordinative complexity, and dynamic complexity. The component complexity of a task, as defined by Wood (1986), is determined by "the number of distinct acts" to be carried out and "the number of distinct information cues" to be processed in performing the task (p. 66). Suppose we need to invite ten benefactors of a non-profit organization to a Thank-you dinner. We want to make the invitation letters look personal. So we decide to include personal information such as how long they have contributed to this non-profit organization and how much donations they have made. To complete these letters, a number of acts have to be performed. For instance, a writer needs to do research on the guests' background, including how they get involved in this non-profit organization, why they contribute funds to this organization, how long they have contributed, how much money they have donated, and so on. Based on this information, a writer has to write a beautiful letter that reflects the unique contribution history of each guest. It is obvious that the amount of information that has to be processed in this task (i.e., writing ten letters) is greater than if there are only five guests (i.e., writing five letters). Furthermore, the level of component complexity of the task of writing ten different letters is also higher than that of the task of writing the same letter to each of the ten guests. In fact, the latter task is characterized by "component redundancy," a notion that describes the degree of redundancy in the acts to be performed and/or information cues to be processed (Naylor & Dickinson, 1969, cited in Wood, 1986).

Coordinative complexity is a feature of the interaction between task inputs and outputs. "The form and the strength of the relationship between information cues, acts, products, as well as the sequencing of inputs" (Wood, 1986, p. 68) constitute various dimensions of coordinative complexity. Take sequencing of inputs as an example. Thompson (1967) proposed three types of interdependence: *pooled interdependence*, *sequential interdependence*, and *reciprocal interdependence*. *Pooled interdependence* refers to two parties A and B having a shared resource pool, but contributing and retrieving resources relatively independent of one another. *Sequential interdependence* means that, in addition to sharing a resource pool, A has to act before B can act. *Reciprocal interdependence* characterizes situations where A acts before B does and B's output feeds back into A as A's input. Thompson (1967) argued that these three types of interdependence should match different levels of complexity in organizations with pooled interdependence suitable for organizations with lowest complexity and reciprocal interdependence appropriate for organizations with highest complexity. In similar fashion, coordinative complexity increases with the level of interdependence, with coordinative complexity being lowest in tasks characterized by pooled interdependence, intermediate in tasks with sequential interdependence, and highest in tasks with reciprocal interdependence. It is worth noting that tasks with the same level of component complexity can vary substantially on coordinative complexity depending on the type of interdependence they have.

Component complexity and coordinative complexity, according to Wood (1986), refer to stationary complexity of task inputs. The “nonstationary” complexity is defined as dynamic complexity, which results from changes in either component complexity or coordinative complexity, or both (Wood, 1986, p. 71). According to Wood (1986), tasks can be dynamically complex with an increase in component complexity but not coordinative complexity. He also argues that although the three components of task complexity are not completely independent of one another, “the level of each complexity can vary quite considerably without affecting the levels of the other two complexities” (p. 73). He further explains that “high levels of component complexity may make a task more complex in an overall sense than low to moderate levels of coordinative complexity, or that moderate to high levels of coordinative complexity may result in greater overall task complexity than low levels of dynamic complexity” (Wood, 1986, p. 74).

Knowledge Differentiation and Integration

Modern economic organizations are becoming more and more knowledge intensive with specialized knowledge residing in discrete individuals and work units, and thus, there inevitably emerges a greater need for knowledge integration to cope with an increasingly turbulent environment (Boland & Tenkasi, 1995). Grant (1996) goes further by conceptualizing an organization as “an institution for integrating knowledge” (p. 109).

Although knowledge differentiation and integration is becoming increasingly important in organizations, the dynamic process through which it occurs remains largely untangled. The theory of transactive memory provides a useful tool to examine this relationship by detailing the processes that lead to progressive knowledge differentiation and integration in a collective memory system. As mentioned at the outset of the paper, Wegner (1995) identified three processes in the formation of a transactive memory system: directory updating, information allocation, and retrieval coordination. Once individuals accept responsibilities for storing the knowledge relevant to particular domains either due to situational demands or official delegations, others in the system will pass new information to the experts for processing and storage and these experts are expected to recall the information whenever there is a need. On-going allocation will lead to greater knowledge differentiation over time. As a transactive memory system gets more differentiated, knowledge stored in a greater number of discrete individual memories may be retrieved and integrated to complete a task. The level of knowledge integration varies with the level of knowledge differentiation.

Knowledge differentiation and integration can be illustrated in two extreme memory structures proposed by Wegner (1987): differentiated transactive memory and integrated transactive memory. A differentiated transactive memory system is characterized by the storage of unique knowledge in different individual memories. The only redundant information in such a system is the common labels for various pieces of knowledge and expertise directories that are indispensable to knowledge allocation and retrieval. An integrated transcative memory system is one in which all members share the same knowledge and are aware of such redundancy in the collective memory system. Strictly speaking, a completely integrated memory system is not "transactive" in nature because the absence of knowledge differentiation makes knowledge allocation and retrieval unnecessary.

The two memory structures occupy the two ends of the transactive memory spectrum. Each has weaknesses of its own. The absence of an optimal level of shared knowledge in a differentiated transactive memory system may impede effective communication among its members that is critical to knowledge integration. An integrated transactive memory system, on the other hand, provides a much smaller knowledge resource pool. It is thus important to match memory structure with task demand. There often exists an optimal combination of differentiation and integration for a given task. In the course of performing a task, if knowledge differentiation exceeds the optimal level, it may impede knowledge integration. This is because as knowledge differentiation increases, task-related expertise may be embedded in a greater number of individual memories. Coordination costs for retrieving and integrating discretely stored individual expertise increase. There may also be more conflicts about how to perform the task because individuals with diverse expertise may view the task through different lenses and harbor different priorities. The amount of disagreement may go up as a task gets more complex or obscure (Hughes & Young, 1990). Increases in both coordination costs and conflicts will bring about greater impediments to knowledge integration.

> *Proposition 1*: For a given level of task complexity, the greater the increase in knowledge differentiation beyond the optimal level, the less effective is knowledge integration.

Effects of Task Complexity on Knowledge Differentiation and Integration

The nature of a task may have a direct effect on how knowledge is utilized in organizations. Task complexity may exert significant performance effects by changing the amount of knowledge required for each task performer (Wood, 1986). The degree of task complexity is determined by such attributes as “information load, diversity, or rate of change” (Campbell, 1988, p. 43). Zigurs and Buckland (1998) argued that an aggregate of the levels of these three components in information processing could serve as an index to the knowledge demand on task performers. Complex tasks, therefore, may exert more cognitive load on task performers (Zigurs & Buckland, 1998) and require more diverse expertise and knowledge creation. Simple tasks, on the other hand, are standardized with specific course to follow, and thus place comparatively low demand on task-related knowledge (Brown and Miller, 2000), and may have a low requirement for knowledge differentiation and/or integration as well.

Effects of component complexity on knowledge differentiation

According to Wood (1986), the inputs of a task have three levels: subtask, act, and information cue. Component complexity is measured by unique task inputs. As component complexity increases, these task inputs increase accordingly (Wood, 1986). No single person may have a broad enough knowledge and skill base needed to perform every subset of the task and process every information cue. The required expertise has to be recalled from recognized experts in respective knowledge domains in order to get things done. Information pertinent to a knowledge area may be allocated to an expert rather than a non-expert for memory storage. Every member in a transactive memory system is responsible for gathering information in a substantive domain, and thus is likely to develop a unique set of expertise that nobody else in the collective memory system has. Knowledge redundancy may be reduced. Component complexity may contribute to the evolution of differentiated knowledge structures in transactive memory systems.

Let's take sales as an example. Compared with selling large production lines, selling cosmetics is a task with relatively low component complexity. The sales people in a cosmetics sales team may share the same knowledge about the products that range from skincare to make-up because the component complexity involved in this task is so low that one person is capable of processing all the information concerning the features of a variety of products. There is not much need for information allocation or retrieval coordination in performing these tasks. There won't be much differentiation in individuals' knowledge structures in cosmetics sales teams.

The picture may be quite different for a sales team responsible for selling complex production systems such as ice cream production lines. Such sales teams may consist of sales people who have superb sales skills and general knowledge about the product, designers who are well acquainted with the specific features of the product, and engineers who specialize in troubleshooting and maintaining the production system. Organizations have to develop separate training programs for these people because the amount of information required for performing these tasks goes beyond the cognitive ability of any single individual. When the members from different functional areas work together as a team, a differentiated transactive memory system is likely to evolve. Sales people may pass clients' questions about specific features of the production lines to engineers. Engineers may keep sales persons informed of clients' concerns about price and let sales people handle bargaining tasks. Engineers may develop a directory among themselves on who is good at solving what technical problems and turn to recognized experts for knowledge in respective domains. The high component complexity characterizing complex production lines sales may lead to high knowledge differentiation among task performers.

Proposition 2: Component complexity is positively associated with knowledge differentiation.

Effects of coordinative complexity on knowledge integration

Coordinative complexity is closely associated with the need for knowledge integration. The level of coordinative complexity is determined by three factors: the order in which task inputs to be arranged, the type (e.g., linear or non-linear function) and strength (i.e., the frequency of associating a specific task input with an output) of the relationship between acts, information cues, and outputs (Wood, 1986). The first two factors are related to task interdependence and the third factor concerns task uncertainty. As coordinative complexity increases, organizations face a higher demand for designing the acts (e.g., timing, frequency, sequence) of each member in performing the task (Wood, 1986). In this design process, diverse expertise is called for to plan on how to carry out the task. In the execution process, task performers may encounter a greater number of exceptions given higher task uncertainty and a greater need for retrieving relevant expertise from more sources, integrate expert knowledge, and search for unique solutions to each exception. When a task is low in coordinative complexity, the decisions to be made in performing the task are routine and repetitive and/or involve few performers. Such decision-making activities can be guided by routines (Simon, 1965) and require little knowledge integration across individuals. The degree to which knowledge in a variety of domains is integrated may increase proportionally with coordinative complexity.

For instance, in a factory that manufactures pens, some workers may be responsible for matching the pen cap with the right pen. There is a linear relationship between task inputs (e.g., pen cap, pen, knowledge about which pen cap should match which pen) and outputs (e.g., assembled pen). The outcome increases in a linear fashion with the intensity of labor and the frequency of acts. As long as task performers know which pen cap goes with which pen, the level of productivity depends primarily on one’s own efficiency and is relatively independent of others’ performance. Coordinative complexity is low in this task and not much knowledge integration is needed.

An example with greater coordinative complexity would be writing a research paper that involves faculty members and students from several universities. The relationship between task inputs and products is much less certain due to complex coordination and the highly creative process involved in research. The project members have to be aware of what everybody else is doing, coordinate the sequence and content of one another's acts, and make sure that their individual pieces can be integrated into a coherent paper. Greater knowledge integration is needed to determine what type of expertise to include, when to involve which expertise, and how frequently a particular expertise is needed. The certainty in performing this task is substantially reduced. Increasing task uncertainty is associated with a greater amount of task-related knowledge processed with the exception that the task is so novel that it is beyond a task performer's cognitive ability (Daft & Macintosh, 1981). Knowledge integration is especially important to tasks that are uncertain (e.g., product development) and/or require collaboration among individuals or teams with different functional skills (Brown & Eisenhardt, 1995).

Proposition 3: Coordinative complexity is positively associated with knowledge integration.

Effects of dynamic complexity on knowledge differentiation and integration

Since dynamic complexity is a result of the changes in component complexity, or coordinative complexity, or both, the complex combination of the requirements for knowledge differentiation and integration reflects dynamic interactions between component complexity and coordinative complexity. When the levels of both component complexity and coordinative complexity are low in a given task, the amount of knowledge and skills required to complete the task is relatively small. One single person may be able to possess all the expertise and perform the task independently. There is little need for transactive processing. When component complexity increases and coordinative complexity remains low, the number of information cues to be processed and the number of acts to be performed increase. New knowledge is continuously allocated to relevant experts for storage to improve knowledge processing efficiency and effectiveness, which leads to an increasingly differentiated memory structure over time. In this task environment, the primary mode for transactive processing is knowledge allocation. Knowledge integration occurs minimally.

When coordinative complexity increases and component complexity remains low, the relationship between task inputs and outcomes becomes more complex. Although task performers have a relatively small amount of information to process and a small number of acts to perform, it is much harder to coordinate the cognitive effort and program the acts to bring out individually stored unique expertise. There emerges a greater demand for knowledge integration. Transactive processing mainly takes place in the form of retrieval. When both component complexity and coordinative complexity increase, task performers have to process a greater amount of information and perform more acts, and at the same time, experience greater complexity in coordinating individual acts, the requirements for both knowledge differentiation and integration increase. Both knowledge allocation and retrieval are demanded for the successful completion of these tasks. Transactive processing takes on its most dynamic form.

The needs for transactive processing are predicted to differ for tasks with varying degrees of component complexity and coordinative complexity, ranging from most static (Proposition 4a) to most dynamic (Proposition 4d).

Proposition 4a: Tasks with low component complexity and coordinative complexity require low knowledge differentiation and integration;

Proposition 4b: Tasks with high component complexity and low coordinative complexity require high knowledge differentiation and low integration;

Proposition 4c: Tasks with low component complexity and high coordinative complexity require low knowledge differentiation and high integration;

Proposition 4d: Tasks with high component complexity and high coordinative complexity require high knowledge differentiation and integration.

Coordination

Labor, either cognitive or physical, is necessarily distributed in organizations (Boland & Tenkasi, 1995). Integrative tools are indispensable to coordinating distributed cognition. Designing an integrative mechanism that fits knowledge demands is critical to positive performance outcomes. This is because both “process loss” and “process gain” may occur in knowledge integration processes (Hill, 1982). Whether process loss weighs over process gain or vice versa is dependent on the match between the integrative device adopted and the knowledge requirement determined by specific task characteristics. The various levels of knowledge differentiation place different demands on knowledge integration, and hence call for distinct coordinative tools for knowledge integration.

Impersonal modes of integration

Van de Ven, Delbecq, and Koenig (1976) have found that impersonal modes of coordination are often employed in tasks with high certainty and low interdependence. Tasks with low component complexity and low coordinative complexity are least ambiguous and require minimal knowledge differentiation and integration. Such tasks can be performed with high certainty and can be easily programmed and formalized, and thus reduce the frequency of expertise retrieval and allocation. Codified, standardized knowledge resource pools such as company rule books, work manuals, and written guidelines with abundant information readily available may serve as primary repositories where the information germane to various knowledge domains is retrieved and new information is directed and stored. Such highly reliable knowledge resource repositories are most cost effective at coordinating tasks with low component complexity and coordinative complexity. The adoption of routines also reduces ambiguity and improves efficiency in coping with relatively stable task environments.

Let's take cashier's job at a supermarket as an example. This job does not require hard-to-master skills (low component complexity) and cashiers usually work independently of one another (low coordinative complexity). The most effective way to train new employees and guide the work of old ones is to compose a work manual describing in detail procedures of operating cash registers and handling special cases (e.g., process returned items). Since checking out is a relatively simple task, cashiers will find answers to most of their questions in the work manual. Besides, written guidelines are easily available, clearly stated, and relatively stable over time. They are superb at coordinating cashier's work, a task characterized by low component complexity and low coordinative complexity.

> *Proposition 5*: Impersonal modes (e.g., manuals, guidelines) are effective at coordinating tasks with low component complexity and low coordinative complexity.

Leaders in hierarchical structures

If a task has high component complexity and low coordinative complexity, leaders in hierarchical structures may serve the integrative function. This is because the nature of the relationship between task inputs and outputs is relatively certain--that is, there exists a well-defined procedure through which a specific task input leads to a highly predictable outcome. The course of integration is largely known to task performers. The need for flexible, circumstantial integration is low. The high level of component complexity, on the other hand, requires individuals with diverse expertise to work together on the task. The key to effective integration here is to help task performers acquire information on individual expertise. This may be achieved through effective communication flow in a decentralized network (Rulke & Galaskiewicz, 2000). However, if component complexity increases substantially, the increase in the size of the network would make it more and more difficult for the members to update their expertise directories with the most current and accurate information through direct communication with one another. The leaders in a hierarchical structure, by serving as the "central nervous system" (Maier, 1967, p. 239) and a special "cognitive apparatus" (Hutchins, 1991, p. 301) in a transactive memory system, may be highly effective at gathering such "meta-knowledge" (Larson & Christensen, 1993) or expertise "location information" (Wegner et al., 1985). Furthermore, the leaders' authoritative power may also facilitate the coordination of task assignments for each individual.

Take car making as an example. The leader of the manufacturing team knows who are experienced at making which part (e.g., engine, window, body) and who are good at assembly. Different groups of workers may work relatively independent of one another. The leader may decide on who does what based on individual expertise. The leader may also make decisions on how many parts to make, specific models for the parts to ensure they match with one another and can be assembled into a car, set up the work schedule, and so on.

Proposition 6: Leaders in hierarchical structures are effective at coordinating tasks with high component complexity and low coordinative complexity.

Communities of practice

If a task has low component complexity and high coordinative complexity, it does not require a group of experts with differentiated expertise to collaborate on the task. However, high coordinative complexity, either due to complex interdependence among subtasks or high uncertainty in the relationship between task inputs and outputs, places a strong demand on knowledge integration. A community of practice is an effective mechanism to meet this demand. The members in a community communicate regularly either face-to-face or electronically (Wenger & Snyder, 2000) to maintain flexible and continual exchange of task-related knowledge, generate new knowledge, and produce innovative solutions to novel problems. Communities have a positive effect on efficiency, effectiveness, and innovation through sharing specialized knowledge, modifying existing knowledge, and creating new knowledge (Cross, 2000).

The Eureka story at Xerox is an example of community of practice (Bobrow & Whalen, 2002). Eureka is an expert system where the technicians responsible for repairing and adjusting photocopiers share the tips they have learned from their experience. Photocopiers are extremely sensitive to environmental conditions such as temperature, humidity, and dirt. This makes it difficult for technicians to locate the source of the problem. The symptom of a problem may be similar to the one that appears in the manual, but the cause of the problem may be quite different depending on the environment. The same solution may work differently across conditions as well. Fixing a specific problem may not require a technician to process a substantial amount of information. However, the relationship between the cause of a problem and the solution to it is highly uncertain. Coordinative complexity is relatively high. Eureka provides a platform where technicians can share their tips that will prove useful to others in the system. These tips have been learned from personal experience and cannot be found anywhere in the repair manual.

Proposition 7: Communities of practice are effective at coordinating tasks with low component complexity and high coordinative complexity.

<u>Cross-functional teams</u>

If a task has high levels of both component complexity and coordinative complexity, individuals with unique expertise need to be brought together for task completion purposes. The diverse functional backgrounds of the members in cross-functional teams allow them an easy access to a large knowledge storage repository (Ancona & Caldwell, 1992b; Uhl-Bien & Graen, 1998). Moreover, in the course of performing these tasks, a greater amount of knowledge needs to be processed and integrated. To satisfy the high knowledge processing demand, new knowledge needs to be passed to the experts for storage that can be retrieved later. Expertise recognition is critical to knowledge allocation and retrieval. On-going interactions may help members learn about who knows what (Anand, Manz, & Glick, 1998). Through working together, cross-functional teams also help to break communication barriers and routines, come up with innovative solutions (Brown & Eisenhardt, 1995), and access task-related expertise more easily by means of flexible membership (Grant, 1996).

Product design is a task high in both component complexity and coordinative complexity. Product design teams are usually consisted of members from different functional areas. These cross-functional teams have diverse knowledge resource pools that help to cope with the high component complexity of a design task. The regular interactions among the team members facilitate knowledge integration and help to deal with the high coordinative complexity of a task.

Proposition 8: Cross-functional teams are effective at coordinating tasks with high component complexity and high coordinative complexity.

Conclusion

By incorporating task complexity into analyses of knowledge and coordination, this paper demonstrated how the nature of transactive processing ranging from most static (e.g., in the case of least complex tasks) to most dynamic (e.g., in tasks with high component complexity and high coordinative complexity) varied with the type of tasks involved and provided practical implications for specific integrative tools organizations should adopt to meet the differential demands for knowledge differentiation and integration. This paper searched for the best fit among task, knowledge, and coordination and produced important implications for organization design.

The analysis on the effects of dynamic complexity on knowledge differentiation and integration was particularly useful to organizations for two reasons. First, a large number of tasks in organizations have a duration that covers more than one single period of time. Tasks that have longer durations are much more likely to be dynamically complex than the ones that have short durations (Simon, 1965). Second, dynamic complexity may result from constant shifts in the changes of component complexity and coordinative complexity (Wood, 1986). Sometimes such changes can be predicted and sometimes they are much less predictable. In less predictable situations, decomposing the effects of the interactions between the two static complexities on levels of knowledge differentiation and integration will help task performers quickly adjust their knowledge structures and coordination devices by moving from cell to cell in either direction in Table 1 to meet the shifting knowledge requirements caused by unstable task characteristics. The contingent relationships among task, knowledge, and coordination may help task performers quickly respond to and effectively adapt to fluid task environments that challenge many modern organizations.

Table 1. Task, knowledge, and coordination

		Coordinative Complexity: Low	Coordinative Complexity: High
Component Complexity	Low	Knowledge requirement Low knowledge differentiation Low knowledge integration Coordination mechanism Impersonal modes (e.g., work manuals, rule books)	Knowledge requirement Low knowledge differentiation High knowledge integration Coordination mechanism Communities of practice
	High	Knowledge requirement High knowledge differentiation Low knowledge integration Coordination mechanism Leaders in hierarchical structures	Knowledge requirement High knowledge differentiation High knowledge integration Coordination mechanism Cross-functional teams

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