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An Integrative team learning model - New perspectives for manufacturing system design

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An Integrative Team Learning Model – New Perspectives for Manufacturing System Design

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ABSTRACT

Existing literature suggest that learning occur at three levels: individual, team and organizational. Although there have been theoretical models at all three levels, the research efforts to integrate them are limited. This paper proposes a team learning model that integrates previous learning theories at different levels. The model was then used to explain how to overcome learning barriers in various aspects of modern manufacturing system design.

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INTRODUTION

George Huber (1984) describes today's post-industrial society as more and increasing knowledge, more and increasing complexity, and more and increasing uncertainty. In order to survive and compete in this fast changing environment, organizational designs must incorporate mechanisms that facilitate rapid innovation and adaptation (Huber, 1984; Doll and Vonderembse, 1991). Besides customer-driven organization and time-based competition, one buzzword for such an adaptive mechanism is organizational learning (Garvin, 1993; Dodgson, 1993). Indeed, learning has been advocated as the only sustainable source of competitive advantage (Senge, 1990; Schein, 1993). Nonaka (1991) echoed that in an environment where the only certainty is uncertainty, one lasting source of competitive advantage is continuous learning and knowledge creation.

However, despite the wide spread of the notion of organizational learning, its definition has always been elusive (Fiol and Lyles, 1985; Garvin, 1993). Argyris and Schon (1978) define organizational learning as error detection and correction. Fiol and Lyles (1985) define organizational learning as the process of improving actions through better knowledge. Huber (1991) suggests that organizations learn if their behaviors change through information processing. Kim (1993) defines organizational learning as increased organizational capacity to take effective action. While Nevis et al. (1995) define organizational learning as the organizational processes to enhance performance through experience. These definitions suggest that organizational learning have two

major components: 1) Outcomes, such as improved performance, action or behavior and 2) Processes, which are the organizational processes that lead to those outcomes. Dodgson (1993) indicated that organizational behavior and psychology literature mostly focus on organizational learning processes, while management literature tends to emphasize outcomes such as business performance. But from practitioners' point of view, the outcome approach is not very useful because it does not provide enough practical guidelines. It is the research on the processes of organizational learning that guide businesses to get expected results. Thus my answer will focus on organizational learning processes. Moreover, several authors suggest that learning occur at three levels: individual, team and organizational (Senge, 1990; Dixon, 1994). It's generally argued that organizational learning is not simple accumulation of individual learning (Fiol and Lyles, 1985; Dodgson, 1993). But the learning literature mostly does not distinguish between the processes of team learning and organizational learning, since they both fall into the domain of collective learning. This paper will draw upon the literature of all three levels of learning.

INDIVIDUAL, TEAM AND ORGANIZATIONAL LEARNING

The process of individual learning has been studied by psychologists for a long time. One well-known approach is the experiential learning theory founded by Kurt Lewin. He proposed that an individual continuously cycles through a four stage learning process: having concrete *experiences*, making *reflections* on the experiences, forming *abstractions* and generalizations, and *testing* the new concepts in new concrete experiences (Kolb, 1984). The *testing* and *experience* stages are *operational learning* focusing on know-how, while the *reflection* and *abstraction* stages are referred to as

conceptual learning focusing on know-why (Kim, 1993). Using these two types of individual learning as a metaphor in organizational learning, we have similar categorizations, including Single loop learning vs. Double loop learning (Argyris and Schon, 1978), Adaptive learning vs. Generative learning (Senge, 1990), and Lower level learning vs. Higher level learning (Fiol and Lyles, 1985). One problem with Lewin's model is that the same experience may lead to rather different conceptions in different people. What makes the differences is each individual's "mental model" (Senge, 1990), or deeply ingrained assumptions that affect our understanding of the world. A similar conception can be found in the notion of "tacit knowledge" (Nonaka, 1991). The interaction between individual learning cycle and mental model results in each individual's unique learning. This interaction will later be integrated in my team learning model.

Team learning is one of the major components of Senge's five disciplines. Senge (1990) defines team learning as the process of developing team's capacity to achieve desired results, which is very similar to Kim's (1993) definition of organizational learning. Senge argued that teaming learning is critical because teams are the basic learning unit in most organizations today. He further suggested that effective team learning involve moving between two distinctive processes: Dialogue and Discussion. In dialogue, team members suspend their assumptions to explore all relevant information. In discussion, different views are presented and defended, and a commonly preferred view is reached as team action guidance. Thus dialogue is divergent but discussion is convergent. They are complementary processes for team learning (Isaacs, 1993).

There are several conceptual models of organizational learning. Dixon (1994) proposed an organizational learning cycle based on Lewin's model. It consists of four stages: 1) Widespread generation of information; 2) Integration of information into organizational context; 3) Interpretation of information; and 4) Take actions based on the interpretation. Huber (1991) also describes four processes of organizational learning: knowledge acquisition, information distribution, information interpretation, and organizational memory. Organizational memory is actually shared mental model, which is missing in Dixon's (1994) model, while Huber (1991) failed to address knowledge utilization. Daft and Weick (1984) conceptualize organizational learning as a three-step process: Data gathering, Data interpretation, and Action. More recently, DiBella and Nevis (1998) improved upon the above models and proposed a concise three-stage organizational learning cycle: 1) Knowledge acquisition and creation; 2) Knowledge dissemination and interpretation; 3) Knowledge utilization and testing. In fact, the first two stages of this model are very much the same in nature as Senge's view of Dialogue and Discussion in team learning.

AN INTEGRATIVE MODEL OF TEAM LEARNING

Although there have been theoretical models at all three levels, the research efforts to integrate them are limited. March and Olsen (1975) attempted to link individual action directly with organizational action, but their over-simplified model failed to address the underlying mechanism of this transition. Kim (1993) did an excellent job by integrating Lewin's individual learning cycle and Senge's mental model into March and Olsen's model and identifying seven learning disconnects. My team learning model is a similar integration effort, but uses DiBella and Nevis (1998) three-stage organizational

learning cycle as the basic framework. I will borrow Kim's (1993) naming of learning disconnects, but may give some of them a little different meaning. The model is illustrated in Figure 1.

Stage 1 - Knowledge Acquisition/Dialogue: Team members learn through their own individual learning cycle while interacting with individual mental models. The team acquires information from each individual member through dialogue.

Stage 2 – Knowledge Dissemination/Discussion: Acquired information are distributed and discussed among team members, and become team memory or shared mental model that guides team action.

Stage 3 – Knowledge Utilization and Action: Shared team knowledge are used and tested in the environment, and the experiences lead to new learning of team members.

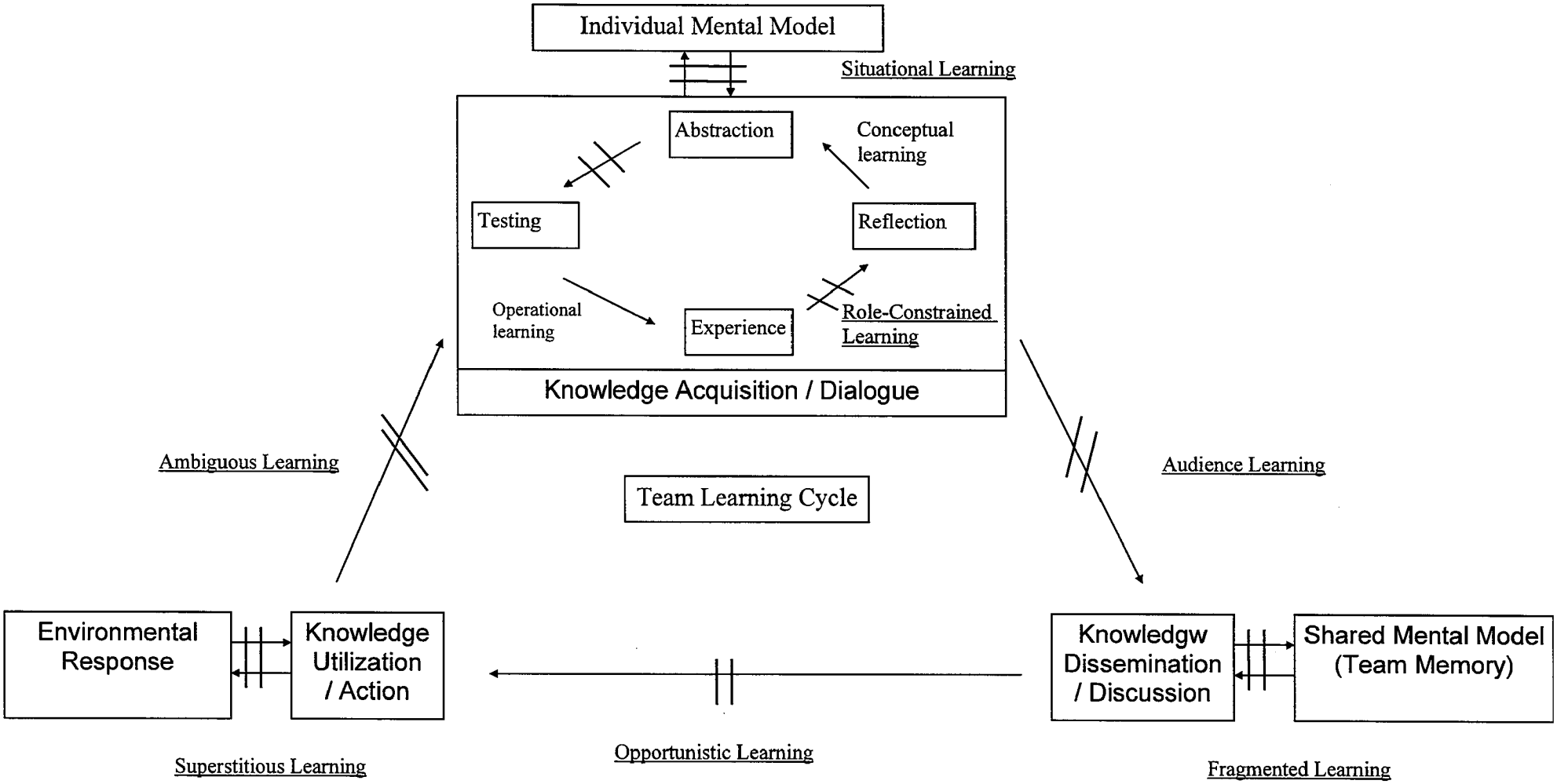
This model also reflects Nonaka's (1991) theory of knowledge spiral. In stage 1, individual tacit knowledge in the mental model is made explicit by presenting them to the team. The explicit knowledge is then distributed among team members. In stage 2, the individual explicit knowledge is assimilated by other team members and becomes shared tacit knowledge in the team mental model.

The major learning disconnects in the model include:

- *Role-constrained learning*: incomplete individual learning cycle due to constraints of individual roles.
- *Situational learning*: disconnect between individual learning and individual mental model because individual forgets or does not codify the learning for later use.

Figure 1

An Integrative Model of Team Learning



- *Audience learning*: individual explicit knowledge can not be distributed due to lack of communication or involvement.
- *Fragmented learning*: disconnect between distributed explicit knowledge and shared mental model because of ineffective discussion process or lack of systematic retention of knowledge.
- *Opportunistic learning*: team action is not based on team mental model because of resource limitations.
- *Superstitious learning*: team action cannot cause expected environment response due to lack of theories or framework.
- *Ambiguous learning*: team action experiences don't influence individual learning due to lack of communication and feedback.

These team learning disconnects are barriers to effective team learning process. Thus business practices should focus on overcoming these learning barriers.

IMPLICATIONS ON MANUFACTURING SYSTEM DESIGN

Manufacturing system design involves both structural and infrastructural issues. Some of the important issues include facilities layout, technology usage, production planning and control, workforce management, quality management, new product development, and performance evaluation (Leong et al., 1990). Next, I will discuss how appropriate design can help overcoming team learning barriers.

1.Ce llular Facility Layout

Cellular layout is a product-oriented rather than traditional process-oriented layout. A group of functionally different machines are placed together for the production of a family of parts. Cell workers work in teams that are responsible for a wide range of

operations. Thus each cell worker may have to perform tasks on a variety of machines. Huber and Hyer (1985) regard cell teams as an effective job enrichment tool. Therefore, cellular layout can help team members overcome the problem of role-constrained learning and complete their individual learning cycle. Cellular teams also provide workers with more chances of communication, thus facilitating the distribution of individual explicit knowledge and overcoming the problem of audience learning.

2.Use of computer-based technology

The use of computer-based advanced manufacturing technology (AMT) has become a strategic investment for most firms (Naik and Chakravarty, 1992). However, many firms did not realize the full advantage of strategic flexibility offered by AMT (Jaikumar, 1986). The problem lies in lack of careful strategic justification. From learning point of view, this is the problems of superstitious learning and opportunistic learning. That is, teams do not know how to effectively use the new technology due to lack of framework or shared mental models, thus they cannot obtain expected results.

Moreover, when used effectively, computer-based technology can help organize, codify and retain existing knowledge, thus overcome the problems of fragmented learning and situational learning. Huber (1996) regards information technology as a major component of organizational memory.

3.K anban pull production control

Unlike traditional push production system that is buffered by excess inventories, Kanban pull production system minimizes buffers. Thus problems and bottlenecks in the process will be highly visible and solved immediately. Kanbans bring the critical production information around in a timely manner, so that production teams can readily

know their current status, avoiding the problem of ambiguous learning. Ohno(1982) described the Kanbans at Toyota as the nervous system of production process. I believe such a system can also serve as the nervous system of team learning process.

4.Em ployee involvement

There has been an increasing interest in employee involvement programs (Conger and Kanungo, 1988), such as employee suggestions, quality circles, and participation in work decisions. The expected benefits include increased productivity, innovation and job satisfaction (Cotton et al., 1988). By participating in such programs, workers are given the opportunity to present and distribute their individual knowledge, thus overcoming the problem of audience learning. Further, employee involvement fosters an experimental mind-set that facilitates individual learning and a climate of openness that enhances communication and information sharing, which are critical to the development of shared mental models (Nevis et al., 1995).

5.Total qu ality management

TQM programs have been around for quite a long time. Researchers have started to investigate the relationship between TQM and organizational learning (Sohal and Morrison, 1995). Garvin (1993) indicated that the failure of most continuous improvement programs was due to the lack of commitment to continuous learning. Sitkin et al. (1994) also argued that the traditional emphasis on control in TQM is no longer appropriate for today's highly uncertain production environment. A learning-oriented perspective on TQM is required for successful implementation. In fact, many basic TQM practices, such as benchmarking, customer focus, statistical process control, employee empowerment, and teamwork can be related to common organizational learning

practices, such as learning from best practices and experiences, systematic problem solving, experimental mind-set, and transferring knowledge (Garvin, 1993). Thus TQM practices can greatly help overcoming team learning barriers at various stages.

6.Cr oss-functional product development

As product life cycle get shorter, fast new product development becomes key to firm survival (Zirger and Maidique, 1990). One frequently used approach is cross-functional teams or even cross-organizational teams by involving suppliers and customers in the developing process. Takuchi and Nonaka (1986) pointed out the multilevel and multifunctional learning effects in such project teams due to the divers knowledge and skill background of team members. Meyers and Wilemon (1989) further empirically verified that effective communication and knowledge transfer mechanism is the most important factor for new product team learning. It solves the problems of audience learning and ambiguous learning.

7.Tim ely performance feedback system

Mai (1996) studied the learning practices of leading American companies and verified the importance of learning from feedback. People adjust behaviors according to environmental response and feedback. The problem of ambiguous learning occurs when team action results cannot be feedback to individual members. Thus a timely performance feedback systems is important to team learning. We emphasize timely, because as feedback time gets longer, learning effects decreases. Adler and Cole (1993) compared the learning practices of two automakers: Toyota-GM's NUMMI and Volvo's Uddevalla. The work cycle at NUMMI is one minute, while at Uddevalla is about two hours. Thus NUMMI workers could quickly identify their problems and have more

learning opportunities. While Uddevalla workers suffered from ambiguous learning. The result was decreased productivity and final close down of Uddevalla. From this example, we can also see the significance of cycle time reduction to learning.

In conclusion, as teams increasingly become the basic operating unit in modern manufacturing firms, the issue of team learning becomes very prominent. The model I proposed here will provide some practical guidelines for improving learning in manufacturing systems design.

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