An Exploratory Study of the Determinants and Outcomes of Shared Mental Models of Skill Use in Autonomous Work Teams

by

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(ABSTRACT)

This research investigated the determinants and outcomes of shared mental models of skill use in autonomous work teams. A model of the determinants and outcomes (team task behaviors) of shared mental models of skill use was tested. Three components of shared mental models of skill use were investigated: shared knowledge pertaining to skill use in task performance (i.e., knowledge about the task, equipment, team, and team interaction), shared expectations for skill use in task performance in both routine and non-routine situations, and shared attitudes relevant to skill use in task performance (i.e., collective orientation and collective efficacy). The model included the interdependence, uncertainty, and complexity of the technology; the degree to which the team is cross-trained and its membership stable; and the level of prior experience team members have had with teamwork as the determinants of overlap in a team's mental model of skill use. The beneficial outcomes of a high degree of overlap in the team's mental model of skill use were four team task behaviors: flexibility, quality, verbal communication, and time required in task planning. The flexibility construct was defined as the degree to which a team allocated and used the multiple competencies/skills of each of its members in pursuit of team goals. A model of the development of flexibility was developed as was a theory of the role of shared mental models in flexible skill use.

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I have also come to understand, in the course of this project, that I am blessed to have the best parents ever given a child. My husband's undying support and encouragement were matched only by that of my parents. Because "can't" was never a word that appeared in their vocabulary in reference to me, it never became part of my vocabulary in reference to myself. I believe this, along with their unconditional love, were two of the greatest gifts I have ever received. I was also blessed to receive from them a spirit of persistence and endurance which served me well during this degree program and this project.

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This experience has taught me many lessons. Most important among these is that all things are possible through God.

Do not look forward to what may happen tomorrow;
The same everlasting Father who cares for you today
will take care of you tomorrow and everyday.
Either He will shield you from suffering,
or He will give you unfailing strength to bear it.
Be at peace, then,
put aside all anxious thoughts and imaginations,
and say continually
"The Lord is my strength and my shield;
my heart has trusted in Him and I am helped.
He is not only with me
but in me and I in him"

St. Francis de Sales

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Chapter 1: Introduction

Team-Based Management Systems

In the face of increasing competitive pressure, many organizations are searching for ways to improve performance and productivity. Increasing numbers of organizations are using teams to achieve these ends. In fact, the use of team-based systems has steadily increased in recent years (Lawler, Mohrman, & Ledford, 1992 and 1995) and this growth is projected to continue (Lawler et al., 1995). Increased utilization is facilitated by two trends. First, employee involvement and participative management practices are becoming increasingly popular. Many organizations that have teams use them as a progressive step after success with such management practices. Second, technological advances increasingly require rapid and flexible responses. Advocates of teams believe they have the capability to function well in dynamic environments that are characterized by time pressure, tasks that require complex multicomponent decisions, and rapidly changing and sometimes ambiguous information. Successful performance in such turbulent environments requires continual monitoring of the situation, the coordinated efforts of employees to integrate information and resources, and adaptation to changing task demands (Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995; and Rouse, 1992). Team-based systems are naturally suited to meet these requirements (Goodman, Devada, & Hughson, 1988). Thus, teams have become an increasingly popular way to organize people and work as organizations search for ways to produce more of higher quality, faster and cheaper.

Many advantages have been touted for team-based job design. Primary among these is the potential for synergy or process gain. Teams are thought to have the capacity to accomplish more than individuals organized traditionally in a highly specialized division of labor. The performance and processes of teams are thought to be superior to those of individuals (Cannon-

Bowers, Oser, & Flannagan, 1992). The expanded knowledge of members is thought to improve the quality and creativity of decisions and increase the speed with which they are made. Members have the opportunity to observe and monitor each other's performance and to pool knowledge and observations. This exposure allows teammates to exchange alternative viewpoints and provide feedback to each other. Performance, quality, and effectiveness are thereby enhanced.

Teams can generally be defined as "two or more people with different tasks who work together adaptively to achieve specified and shared goals" (Brannick & Prince, 1997, p. 4). Further, they can be defined as " two or more interdependent individuals performing coordinated tasks toward achievement of specified task goals" (Fleishman & Zaccaro, 1992, p. 4). Both of these definitions recognize that teams have a shared task orientation and are involved in interdependent tasks. Organizations utilize a wide variety of teams ranging from project teams to multi-functional teams to autonomous teams. Some versions of teams are temporary while others are permanent. Autonomous and semi-autonomous teams (hereafter referred to collectively as autonomous teams) are both permanent types. Both are characterized by shifting responsibility, decision-making authority, and accountability from management to teams. In these systems, authority for making a wide variety of decisions, including task allocation and execution decisions, is delegated to the team. Members of autonomous teams are given responsibility for an entire production process or a major segment thereof. Members are interdependent and jointly responsible and accountable for team functioning and self-regulation (Cannon-Bowers, et al., 1992; and Oransanu & Salas, 1993). They share common valued goals.

Job design for autonomous teams differs from a traditional division of labor. It is centered around cross-trained members. The work is arranged to encourage cooperative interaction. The tasks require multiple skills so, members are cross-trained to do multiple tasks.

Team members frequently cross-train and certify each other as competent. Cross-training creates redundancy in skills across members making teams a unique form of job design. These teams have the necessary authority, materials, and equipment to perform their job. They are required to adaptively manage their internal resources including and most importantly, their skills. In redesigning the task and delegating authority to teams, the role of employees in task work is greatly expanded. This expanded role, however, requires expanded skills.

Unlike traditional job design, members of autonomous teams are expected to perform their tasks flexibly using their multiple skills by rotating or switching jobs. Coordinated use of an autonomous team's skills should be the most crucial factor in its successful task performance. Cross-training is paramount to positive synergy because it equips teams to perform their tasks flexibly (Gupta, Jenkins, Curington, Clements, Doty, Schweizer, & Teutsch, 1986; and Gupta, Ledford, Jenkins, & Doty, 1992; and Lawler, 1991). Practitioners (Gupta et al., 1986) and theorists (Lawler, 1991) alike clearly believe that cross-training should result in flexible skill use. Furthermore, both constituencies view flexible skill use as a key to increased productivity and enhanced team performance and effectiveness. Flexible skill use by teams is posited to improve productivity and performance in a number of ways. Cross-training should improve performance by enhancing deployment efficiencies. Team members who are cross-trained are essentially interchangeable. This facilitates ease of movement to high demand or problematic tasks as well as replacement of absent members. Cross-training also facilitates increased familiarity with the production process as a whole. Increased familiarity results in better and faster decision making and problem solving because members come to understand how tasks are interrelated and thereby how their performance is interrelated. Team members, therefore, make better decisions regarding methods of task performance. Cross-training also prevents boredom and fatigue by facilitating job rotation.

In order to operate successfully, teams develop two tracks of behavior over time, task work and team work. The task work track involves developing skills related to performing the team's tasks. In autonomous teams, the task work track develops through cross-training and on-the-job performance. The team work track involves behaviors that are required for each person to function effectively as a team member. Coordination and compensatory behavior are two team work behaviors that are required for successful team processes (Cannon-Bowers, Salas, & Converse, 1990). Coordination and compensatory behaviors are team competencies. Team competencies are not merely the aggregation of individual competencies. They transcend the competencies of individual members to provide a collective influence on team performance (Cannon-Bowers et al., 1995). The very nature of team tasks requires synchronized behavior. Behaviors summed or aggregated across individuals would not result in successful performance of the tasks. The lack of requisite abilities for task work is often not the cause of failure in task performance. Rather, it results from failure to coordinate member capabilities and contributions. Thus, coordination deficiencies are a significant source of negative synergy or process loss in teams (Fleishman & Zaccaro, 1992). Conversely, positive synergy or process gain requires coordination. In teams, the crucial aspect of coordination and compensatory behavior is the coordination of the team's multiple redundant skills in a compensatory fashion. Specifically, in order to compensate for teammate's needs, skills must be coordinated to shift team members where they are needed most.

Given the unique nature of their training and job design, compensation for these teams is also unique. It is usually based on the number of skills possessed by a member (i.e., the number of jobs or sets of tasks he is able to do), not upon the job a member performs at a given time. In skill-based pay systems, members are given an incremental pay increase for each additional set of skills acquired through cross-training. The individual pay received from the skill-based system is frequently supplemented with a gain-sharing system. The gain-sharing system is designed to be a team-level or organizational-level reward that reinforces group performance and discourages individual achievement at the team's expense (Gupta, et al., 1986; and Gupta, et al., 1992; and Lawler, 1982). Practically speaking, skill use by cross-trained autonomous teams is a key issue for organizations. Its importance is indicated by the organization's significant expenditure of resources (i.e., both time and money) for cross-training and skill-based pay systems.

Despite their widespread use and many touted advantages, little is actually known about the processes internal to teams that help deliver outcomes superior to those that would result were work performed by individuals (Brannick & Prince, 1997). Models of team performance and effectiveness abound. However, most focus on the impact of exogenous determinants on performance or its outcomes (see, for example, Gladstein, 1984; Pearce & Ravlin, 1987, Hackman, 1987; and Levine & Moreland, 1990). The majority do not address how groups perform synergistically. Some (e.g., Hackman, 1987) explicitly recognize the potential for group synergy, but fail to elucidate how synergy may be achieved. Others (e.g., Gladstein, 1984) try to carefully lay out group processes such as communication and supportiveness, but in doing so fail to capture the sources of synergy which may not be explicit or observable.

A central source of positive synergy in autonomous teams should be the multiple and redundant skills possessed by members (Fleishman & Zacarro, 1992). The key to positive synergy in task performance for these cross-trained teams should, then, be how they allocate and utilize their member's redundant skills in a coordinated fashion to accomplish their task. There is a large practitioner literature detailing the advantages and successes of team-based systems that clearly recognizes the potential for synergy and the necessity for coordination of team resources such as skills. The flexibility construct is widely utilized in both theoretical and practitioner literatures. However, the literature lacks both a theoretical framework and empirical investigations of the construct and skill use by teams in general. Although there is widespread recognition that cross-trained teams should rotate and switch tasks thereby performing flexibly, many authors simply presume that teams do allocate and utilize their redundant skills by switching or rotating jobs. The extent to which teams actually use the full range of their skills in task performance is currently an unaddressed issue. Furthermore, there is little information on the mechanisms by which teams achieve this coordination.

Shared Mental Models as Knowledge Structures

One promising perspective on teamwork and performance clearly recognizes that teams have competencies that are distinct and separate from the competencies of individual members. In their model of team performance, Cannon-Bowers, Salas, and Converse (1993) indicated that team competencies provide a collective influence on performance which transcend the team members and, thereby, are a source of positive synergy. These authors posited that there are three team competencies: knowledge, principles, and concepts required for the team's effective task performance; a set of skills and behaviors required for effective task performance; and appropriate attitudes among team members regarding themselves and the team that facilitate effective performance. They viewed teamwork and team performance as a "function of the extent to which team members hold similar organized expectations surrounding the task or each other" (Cannon-Bowers, et al., 1990; and Kraiger & Wenzel, 1997, p. 65).

Cannon-Bowers et al. (1993) proposed that shared mental models are required team knowledge. Essentially this approach holds that team members build shared knowledge structures from which explanations of events are derived as are expectations for future behavior and system functioning. Teammates, according to this view, must have knowledge structures regarding the team and its task that are compatible so that they can adapt and respond appropriately to dynamic situations (Cannon-Bowers, et al., 1995; and Rouse, Cannon-Bowers, &

Salas 1992). Shared mental models are knowledge structures held in common by team members which contain information about the team, its objectives, team roles, behavior patterns, and/or interaction patterns. The shared mental model construct allows theorists and researchers to conceptualize and explain how teams can successfully perform in the absence of explicit strategizing (Cannon-Bowers et al., 1990). Shared mental models are thought to improve performance by enabling team members to form accurate explanations and expectations for a task, allowing members to coordinate actions, adapt behaviors to task demands, and facilitate the team's information processing (Kraiger & Wenzel, 1997).

Coordination is undeniably a central feature of teamwork. Coordination implies some form of adjustment by one or more team members to attain the team's goal (Brannick & Prince, 1997). Shared mental models facilitate coordination and thus, performance, by providing members with a common understanding of what their task requires as well as the coordination it requires (Kraiger & Wenzel, 1997). Since skill use is a key source of synergy in autonomous teams, shared mental models of skill use in task performance should be central to a team's potential for task performance. That is to say, the key to successfully utilizing and coordinating the team's multiple redundant skills is the ability of the team and its members to form appropriate expectations and explanations so that they may anticipate both the behavior and needs of fellow teammates. The greater the extent of overlap in the team's mental model of skill use, the better it should coordinate and utilize its skills in task performance.

The notion of teams sharing a cognitive structure is not new. In fact, the idea that groups of people can retain information by sharing it and do so in such a way that it transcends the cognitive facilities of individuals is quite old. While there is consensus regarding the existence of knowledge structures in the literature, there is little clarity in their definition or theoretical base. Historically, the theoretical framework for knowledge structures is twofold. This notion finds its earliest roots in the study of manual controls. More recently, it has been developed in the area of cognitive science from which organizational researchers have adopted it. The shared mental model construct is given various names in the literature and frequently lacks explicit definition. While the popularity of this construct as an explanatory mechanism is on the rise, it is most frequently used in a post hoc fashion rather than as an a priori component in models of team performance (Klimoski & Mohammed, 1994) (with the notable exception of Cannon-Bowers et al., 1993). Furthermore, the literature is scant regarding the determinants and outcomes of shared mental models and is essentially void of empirical work.

In response to gaps in the team literature, this research built and tested a theory of the factors that facilitate the formation of shared mental models for coordinated and flexible use of a team's key resource: multiple redundant skills. This research into the determinants of mental model overlap can provide insight into the methods (e.g., cross-training) by which organizations could intentionally influence the development of appropriate shared models. Furthermore, this research investigated the impact of shared mental models of skill use on team task behaviors in an effort to discover whether shared mental models of skill use improved team performance. In testing the model, this research began building a nomological net for the construct of shared mental models and thereby began the process of construct validation. Specifically, this research addressed two key questions:

- Which of the factors included in the model affected the extent of overlap in a team's mental model of skill use?
- Did the extent of overlap in a team's mental model of skill use affect team behavior in task performance?

The Role of Shared Mental Models of Skill Use in Team Performance

The central construct of this research, then, is shared mental models. Many authors have addressed the question of what exactly is "shared" in mental models. Consensus exists that there are three types of shared components in mental models: knowledge, behavioral expectations, and attitudes (Kraiger & Wenzel, 1997). This consensus is in keeping with Cannon-Bowers et al.'s (1993) team performance model that indicates that the three team competencies necessary for effective team performance are knowledge, skills and behaviors, and attitudes. This research operationalized shared mental models in terms of these three components.

Since mental models are viewed as forms of knowledge structures, it stands to reason that knowledge is a central shared component of mental models. Thus, how team members organize or structure knowledge about their skills is a critical element of the team's mental model. Without this shared knowledge, coordinated action would be impossible because members would not have corresponding declarative, procedural and explanatory knowledge driving their skill use in task performance. Members would not share common perceptions regarding what to do, how to do it, or why to do it. Shared knowledge regarding skills enables each team member to execute his role in both a timely and coordinated fashion. This behavior helps the team successfully function as a unit without having to continually negotiate the details of task performance. Shared knowledge provides a context in which members can interpret commands and information requests. It also allows members to volunteer information or actions at appropriate times. Furthermore, it provides team members with a basis for predicting the behavior or needs of teammates (Oransanu & Salas, 1993). Knowledge contained in mental models may be described in terms of its focus: team, task, equipment and/or interaction among team members (Cannon-Bowers et al., 1993). In order to coordinate skill use for effective task performance, members must share knowledge regarding the nature of the team, its task, its equipment, and the interaction among teammates.

Shared knowledge alone is insufficient, however, to facilitate team performance. Shared knowledge must be acted upon. Shared mental models contain shared expectations for behaviors of team members (Canon-Bowers et al., 1993; and Kraiger & Wenzel, 1997). Thus, in addition to operationalizing the construct of shared mental models in terms of knowledge, this research also operationalized the construct of shared mental models in terms of the team's shared expectations for skill use in task performance. These shared expectations allow team members to: allocate resources (such as skills), perform complimentary task behaviors, provide back up support to each other, coordinate actions to accomplish team goals, adapt behavior to task demands, sequence tasks, and communicate in a manner that enables acceptable performance (Cannon-Bowers et al., 1993; Kraiger & Wenzel, 1997; and Rouse et al., 1992). These authors believe that the formation of expectations is likely to be a central element in team coordination and performance. Cannon-Bowers et al., (1993) argue that shared expectations are the most critical component of mental models.

Finally, the team's attitudes may have a direct impact on the way the team interacts and performs. Thus, shared attitudes are also an important component of mental models. The attitudinal components of shared mental models of skill use should be those attitudes that enable team members to coordinate skill use and perform their task successfully. Two such attitudes have received attention in the literature: collective orientation and collective efficacy. Collective orientation is the "shared capacity to take others' behavior into account during team interactions or a belief in the team approach" (Kraiger & Wenzel, 1997, p.70). Collective efficacy is the "team members' assessment of his team's collective ability to perform required tasks" (Kraiger & Wenzel, 1997, p. 70). High levels of overlap for these two attitudes would likely facilitate compensatory behavior and skill use in team performance.

The Model

The model tested is presented in Figure 1. The team was the level of analysis. The left hand portion of the model addressed the first research question regarding factors that affect the extent of overlap in a team's mental model of skill use. Theoretically anything that improves the degree to which a team's mental model is shared should improve the utilization of its skills in task performance and thereby contribute to successful task performance. Likewise, anything that increases team member's exposure to each other or teamwork should increase the degree of overlap. Thus, this research investigated the impact of two classes of variables, those in the technological context and those at the team level, on the extent of overlap in team models of skill use. The degree of interdependence required by the technology, cross-training, team membership stability, and experience with teamwork were hypothesized to have a positive effect on the extent of overlap in models of skill use. Interdependence, cross-training, and team membership stability should all have a positive impact on overlap because each increases the exposure of the team's members to each other. In doing so, they increase the likelihood either that mental models will be jointly formed or that mental models formed individually will be shared. Experience with teamwork should have a positive impact on overlap because it should facilitate the formation of shared mental models. Individuals with experience can import previous mental models for the team's adoption. Or, members with previous experience may be predisposed to team processes and thereby form shared mental models easier and faster than those without experience. The technology's degree of uncertainty and complexity were hypothesized to have a negative effect on the extent of overlap in models of skill use (Klimoski & Mohammed, 1994; and Kraiger & Wenzel, 1997; Oransanu & Salas, 1993). This negative impact was hypothesized because both uncertainty and complexity precipitate increasingly complex mental models that should be more difficult to jointly form and share among team members.

The right hand portion of the model addresses the second research question regarding the effect of the extent of overlap in a team's model of skill use on team behavior in task performance. One view is that greater overlap of shared mental models facilitates performance by leading to better use of team resources including skill and time. Specifically, the degree of

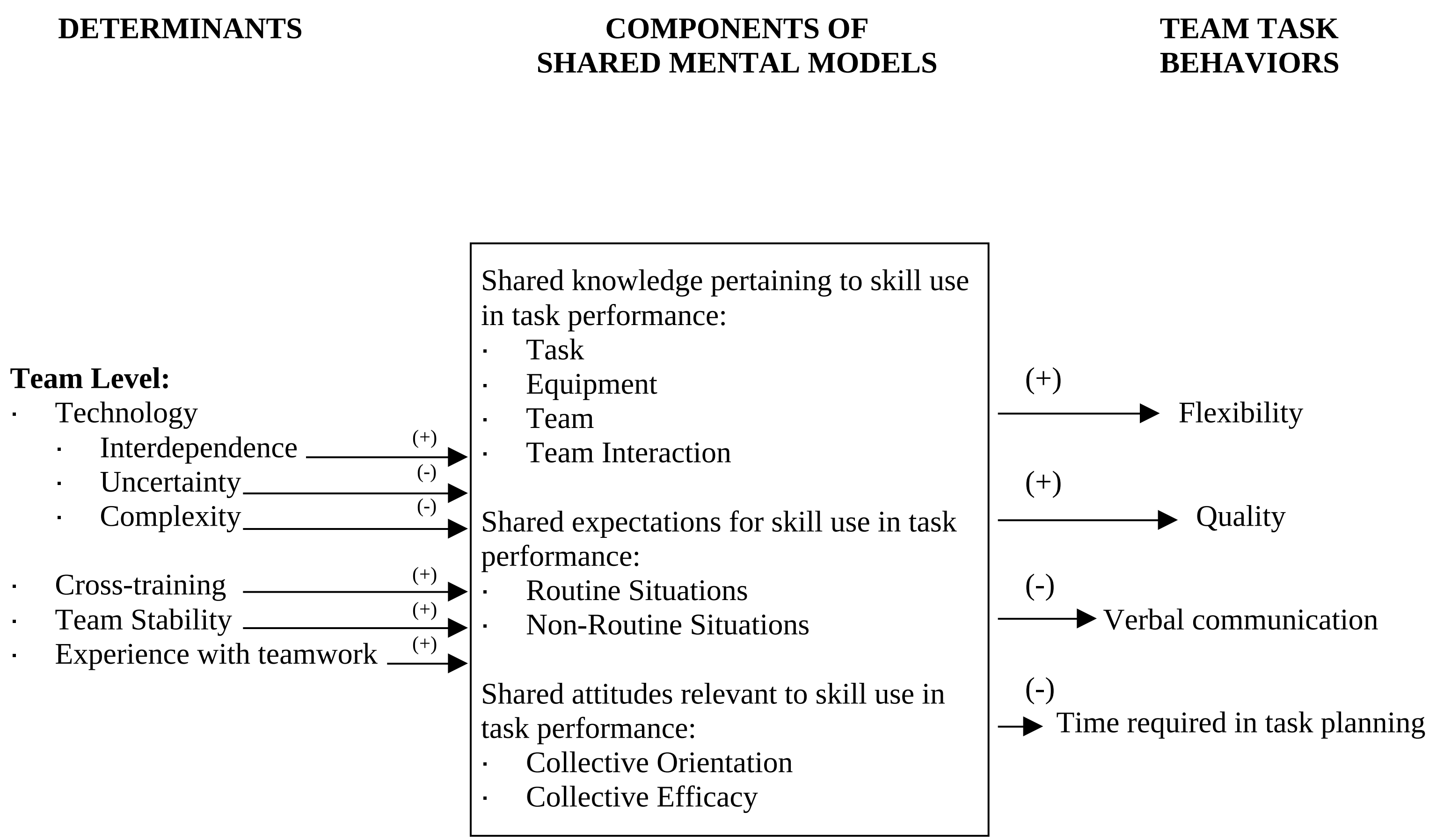

Figure 1: Proposed Model

overlap in mental models of skill use was hypothesized to enhance flexibility in task performance. The current effort sought to develop theory regarding the flexibility construct. A construct definition was developed and a theory of the development of flexible skill use was proposed. Flexibility was defined as the degree to which the team allocates and uses the multiple redundant skills of each of its members in pursuit of team goals. The more shared the team's mental model of skill use, the more likely that it would allocate and utilize its skills flexibly because members would understand the talents, preferences, and responsibilities of teammates. Furthermore, the greater the sharing of the team's mental model of skill use, the higher quality its performance because its skill use should be improved. The extent of overlap in models of skill use was also hypothesized to decrease amount of verbal communication and time required in task planning thereby improving team performance (Rouse et al., 1992). The more shared the model, the less teammates would have to communicate and plan because these processes would be redundant.

The theoretical and empirical literature relevant to these research questions and the investigation of the model guiding this research is reviewed in Chapter 2.

Chapter 2: Literature Review

This chapter presents the literature relevant to the proposed model. Thus, the literature regarding shared knowledge structures including shared mental models, shared problem models, performance strategies, and habitual routines is reviewed. This information is then applied to skill use in teams and results in a model of shared mental models of skill use in teams. Next, a model of the development of flexible skill use in teams is presented. The chapter culminates in a discussion of the determinants and outcomes of shared mental models of skill use in teams, the model that guides the current research.

Shared Mental Models

As aforementioned, Cannon-Bowers et al. (1995) provided a unique perspective on team performance which recognized, in part, the role of shared mental models. To reiterate, they recognized that specific team competencies are required for effective team performance. Specifically, Cannon-Bowers et al. (1995) indicated that team competencies fall into three categories:

> (1) the requisite knowledge, principles, and concepts underlying the team's effective task performance; (2) the repertoire of required skills and behaviors necessary to perform the team task effectively; and (3) the appropriate attitudes on the part of team members (about themselves and the team; i.e., collective efficacy and collective orientation, respectively) that foster effective performance (Cannon-Bowers et al., 1995; page 336 - 337).

According to Cannon-Bowers et al. (1995), specific team knowledge requirements recognized in the literature as fundamental to effective team performance included: shared mental models; an understanding of the nature of team work and teamwork skills; knowledge of overall team goals, objectives, and missions; knowledge about boundary spanning; knowledge about fellow team members' roles and responsibilities; and cue-strategy associations that are environmental signals to the team indicating which coordination strategy is appropriate. Several of these knowledge requirements are directly associated with the allocation and use of a team's skills. Specifically, shared mental models, knowledge about fellow team member's roles and responsibilities, and cue-strategy associations should influence the way teams allocate and utilize their task skills.

The role of shared mental models as a prerequisite for effective team performance is receiving increased attention in the literature as they have long been recognized as precursors to team performance (Klimoski & Mohammed, 1994). The most widely accepted definition views shared mental models as:

> a mechanism whereby humans generate descriptions of system purpose and form, explanations of system functioning and observed system states, and predictions of future system states (Cannon-Bowers, Salas, & Converse, 1993; page 226).

Simply put, team mental models are: "…psychological representations of the environment and its expected behavior" (Klimoski & Mohammed, 1994; page 405). Mental models shared by team members are thought to help individuals understand their surroundings and make inferences regarding their situation by culling important information necessary for decision making (see Figure 2). Furthermore, the extent to which team members share the mental model is thought to help increase efficiency in decision-making and team performance. Thus, the greater the commonality of the model among team members, the greater the likelihood that team members will similarly predict the needs of both task and team and adapt to changing demands. In relation to the team's flexible skill use, the greater the degree of overlap of mental models of skill use, the more successfully members will coordinate activity with each other (Klimoski & Mohammed, 1994).

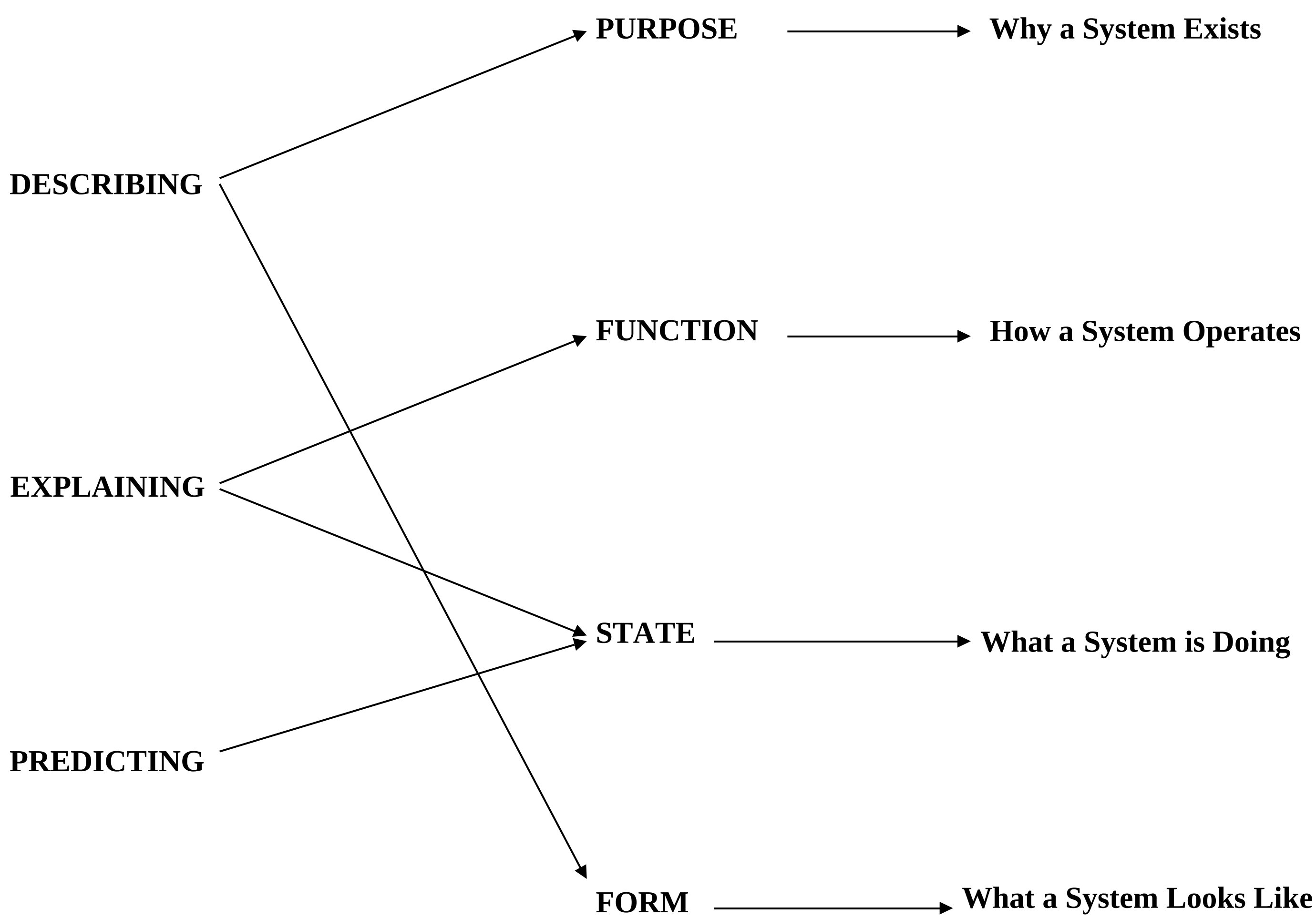

Figure 2: Nature of Mental Models (Cannon-Bowers et al., 1993; page 1300)

While the degree of overlap in member's mental models is important, so too is the content of the models shared. Cannon-Bowers et al., (1993) indicated that team knowledge consisted of several mental model facets such as the team's equipment, task, and interactions (see Tables 1, 2, and 3 for a more detailed presentation). These authors believe that team knowledge consists of three types: declarative knowledge, procedural knowledge, and explanatory knowledge. Declarative team knowledge consists of understanding the roles of team members, the relationships among them, and the temporal patterns of team performance. Procedural team knowledge consists of understanding how team members perform their functions and how they function together as well as the overall mechanisms of team performance by which the their task is accomplished. Explanatory team knowledge consists of understanding why and how each member is needed and why the team performs and functions as it does to accomplish its task. Thus, these types of team knowledge represent different types of knowledge that could be shared by team members in their mental models (Cannon-Bowers et al., 1995).

Table 1: Types of Equipment Knowledge

Level	"What"	"How"	"Why"
Detailed/ Specific/ Concrete	Characteristics of Equipment Elements (What element is)	Functioning of Equipment Elements (How element works)	Requirements Fulfilled (Why element is needed)
↓	Relationships Among Equipment Elements (What connects to what)	Co-Functioning of Equipment Elements (How elements work together)	Objectives Supported (Why equipment is needed)
Global/ General/ Abstract	Temporal Patterns of Equipment Response (What typically happens)	Overall Mechanisms of Equipment Response (How response is generated)	Physical Principles/Theories (Why: physics, chemistry etc.)

(Cannon-Bowers et al., 1993; page 1300)

Table 2: Types of Task Knowledge

Level	"What"	"How"	"Why"
Detailed/ Specific/ Concrete	Situations (What might happen)	Procedures (How to deal with specific situations)	Operational Basis (Why procedure is acceptable)
↓	Criteria (What is important)	Strategies (How to deal with general situations)	Logical Basis (Why strategy is consistent)
Global/ General/ Abstract	Analogies (What similarities exist)	Methodologies (How to synthesize and evaluate alternatives)	Mathematical Principles/Theories (Why: statistics, logic)

(Cannon-Bowers et al., 1993; page 1301)

Table 3: Types of Team Knowledge

Level	"What"	"How"	"Why"
Detailed/ Specific/ Concrete	Roles of Team Members (Who member is)	Functioning of Team Members (How member performs)	Requirements Fulfilled (Why member is needed)
↓	Relationships among Team Members (Who relates to who)	Co-Functioning of Team Members (How members perform together)	Objectives Supported (Why team is needed)
Global/ General/ Abstract	Temporal Patterns of Team Performance (What typically happens)	Overall Mechanism of Team Performance (How performance is accomplished)	Behavioral Principle/Theories (Why: psychology, management, etc.)

(Cannon-Bowers et al., 1993; page 1301)

More specifically, Cannon-Bowers et al. (1993 and 1995) asserted that team members share models of how their roles interact and are related to each other, the importance of information sources, and the appropriateness of communication channels and information flow patterns. Together, knowledge of these things forms the basis of the members' expectations in a task situation. This information, then, is specific to the team and its task. Specific role information would include things such as knowledge about the skills, abilities, preferences, experiences, and tendencies of each team member (Cannon-Bowers et al., 1993; and Cannon-Bowers et al., 1995). The implication of this type of shared information for flexible skill allocation and use is clear.

Shared Problem Models

Some authors such as Oransanu and Salas (1993) have carried the concept of shared mental models further by suggesting that teams dynamically form shared problem models. They approach shared problem models as specific models of the situation and corresponding strategies for coping with task demands. Whereas shared mental models are preexisting structures of knowledge which evolve overtime and can be generalized to a variety of situations, shared problem models involve the development of skills by team members which allow them to apply task and team knowledge (i.e., shared mental models) to specific task situations. Thus, shared problem models may be developed and shared by team members when facing new or novel situations (Cannon-Bowers et al., 1995; and Oransanu & Salas, 1993).

Performance Strategies

In addition to shared models, performance strategies have been proposed as a mechanism guiding skill allocation, coordination, and use. According to Hackman (1987), the overall effectiveness of a team is a joint function of three things: the level of effort collectively exerted by team members in performing task work, the amount of knowledge and skill utilized by members in performance of the team's task, and the appropriateness of the performance strategy selected by the team for use in task execution. Thus, Hackman clearly indicated that teams actively select a strategy to guide task performance. Hackman and Morris (1975) defined task performance strategies as:

> The collective choices made by group members about how they will go about performing the task. Included are choices group members make about desirable performance outcomes and choices about how the group will go about trying to obtain those outcomes (i.e., how the group will allocate and utilize its skills) (Hackman & Morris, 1975; page 65).

These authors clearly indicated that the appropriateness of a strategy depends on the task and its contingencies. They also explicitly recognized several ways performance strategies may be utilized by teams. They indicated that groups may implement preexisting strategies that are shared by members. In this case, members simply implement strategies that are implicitly agreed upon because they have been used previously. This eliminates the need for explicit discussion. Or, teams may reformulate existing performance strategies in an attempt to tailor them to the specific task contingencies they face. When faced with new or unique task contingencies, teams may also formulate totally new performance strategies (Hackman & Morris, 1975). Like those endorsing shared mental models, Hackman indicates that the appropriateness of a strategy for a given team is a function of the task, the performance situation, and the resources allocated to the team. Thus, no "one best" strategy may be specified a priori (Hackman, 1987).

Hackman (1987) also clearly stated that team members reach agreement regarding methods of task performance relatively early in their tenure together. So, consensus about how the team will perform its work is arrived at fairly quickly in the life of the team. Furthermore, for familiar tasks, members are unlikely to explicitly discuss their strategy because they share an understanding of what that strategy is. Thus, strategy formulation may be an implicit or an explicit process. Once formed, however, the strategy fosters behavior in accordance with it and is, in fact, enforced by team members. Hackman resolutely states, "Performance strategies thus become part of the fabric of the group, a 'given' that is no more open to question than the task of the group or who is in the group" (Hackman, 1987; page 328). Therefore, task performance strategies often become well-codified group norms that guide member behavior. As such, performance strategies should contribute to the effectiveness of the team in task performance because they minimize the time spent in managing members' behavior and thereby, increase time spent in task performance (Hackman & Morris, 1975).

Several factors are hypothesized to increase the likelihood that teams will employ task appropriate performance strategies. Performance strategies are more likely to be used when the team has norms that support explicit assessment of the performance situation and facilitate active consideration of alternative methods of task performance. Thus, norms that support the team's self-regulation by increasing consensus and compliance foster orderly implementation of a chosen performance strategy. Furthermore, norms that support situation scanning and planning strategy foster development of appropriate performance strategies (Hackman, 1987).

Strategies are also more likely to be used when team members can access the data (via the organization's information system) necessary to assess the situation and evaluate alternative strategies. Inappropriate performance strategies may be developed by teams that do not have access to clear information regarding the performance situation or that do not have access to information regarding the likely outcomes of alternatives. A clear map of the performance situation is required in order for teams to develop an appropriate performance strategy. Specifically, this requires information about the requirements of the task as well as constraints that may limit alternatives from which the team may chose. Information about the availability of material resources is also important as is access to the standards which will be used to evaluate the team's output (Hackman, 1987).

Last, appropriate strategies are likely to be used in task performance when the team's interaction results in minimal "slippage" during performance plan execution. Minimal slippage or implementation which capitalizes on group synergy helps the team take advantage of highly favorable performance situations. This, in turn, encourages formation of innovative alternative ideas about how to proceed with task performance (Hackman, 1987).

Habitual Routines

In addition to shared models and performance strategies, habitual routines have been proposed as a mechanism guiding skill allocation and use by teams. Cannon-Bowers et al. (1993) and others such as Hackman and Morris (1975), Gersick and Hackman (1990), and Weiss and Ilgen (1985) have suggested that as a team practices and gains experience over time, rules emerge regarding performance which allow that performance to become habit or routine. Essentially, these authors recognized that individuals respond automatically to familiar situations rather than actively processing information about an already familiar environment. Furthermore, Gersick and Hackman (1990) asserted that a large percentage of group behavior and activity is governed by routines. Many authors appear to agree with Gersick and Hackman (1990) that habitual routines exist in teams. They define a habitual routine as "…exist(ing) when a group repeatedly exhibits a functionally similar pattern of behavior in a given stimulus situation without explicitly selecting it over alternative ways of behaving" (Gersick & Hackman, 1990; page 69). Habitual routines are recognized as varying in strength such that a behavior does not necessarily have to occur each time a situation arises. Nor do exact behavioral patterns have to repeatedly occur. Only functional similarity of behaviors is required for a team's activity to be considered a habitual routine (Weiss & Ilgen, 1985).

Habitual routines serve several functional purposes for teams. Teams using habitual routines save time and energy because they do not have to actively assess a situation and engage in a cognitive process of evaluating alternatives. They can, therefore, respond to situations more rapidly. Habitual behavior flows directly from a habitual routine, parts of which recognize and categorize stimuli in familiar situations. Thus, the group does not need to spend time selecting a behavioral strategy for task execution. The behavioral strategy flows directly from the habitual routine. Furthermore, activation of a habitual routine and its resultant habitual behavior minimizes explicit coordination required among team members. Since habitual routines are generally well practiced, group members gain the added advantage of increased comfort, decreased uncertainty, and increased confidence in their role as a member. Habitual routines also minimize overt competition and disagreement (Gersick & Hackman, 1990; and Weiss & Ilgen, 1985).

Habitual routines are also clearly recognized as having potentially dysfunctional consequences. As a means of quickly coding stimuli present in a situation (for categorization of the situation), habitual routines by definition result in reduced levels of active cognitive activity. This may, in turn, result in miscoding of performance situations. Miscoding is likely to occur in several situations. It is likely to occur if a team altogether fails to recognize a novel stimulus or does not accurately perceive changes in a familiar performance situation. Teams are likely, in this case, to perceive that which is familiar to them and invoke a routine, thereby missing important cues regarding change. Miscoding may also occur when the stimulus remains the same but the situation surrounding it changes, thereby making a once effective habitual routine ineffective (Gersick & Hackman, 1990; and Weiss & Ilgen, 1985).

Another dysfunctional consequence of habitual routines is reduced innovation. Since they minimize active cognitive evaluation of situations and potential responses, habitual routines thereby reduce opportunity for innovation and creativity. Herein, they also minimize dissent and disagreement that might potentially improve performance. Habitual routines used over a long period also reduce opportunities for team members to grow in competence, skill, and understanding as they reduce the need for exploration by members (Gersick & Hackman, 1990; and Weiss & Ilgen, 1985).

The extent to which a specific habitual routine is functional or dysfunctional depends largely upon two factors, both of which deal with change in the team's performance situation. Frequency of performance-relevant changes in the situation and the severity of those changes together determine whether a habitual routine serves the team well. Performance situations characterized by frequent and/or severe change are not generally well suited to use of habitual routines. Stable situations with only minor changes are well served by habitual routines, as are situations with infrequent but major changes. Performance situations of the later variety send strong stimulus cues to the team that a new habitual routine needs to be established. Habitual routines are more suited to this type of situation than they are to those characterized by gradual change because gradual change is unlikely to send distinctive enough signals that the routine is becoming maladapted (Gersick & Hackman, 1990; and Weiss & Ilgen, 1985).

There are three ways teams are thought to develop habitual routines. Teams may import routines. In this case, the team's members utilize routines that they did not personally develop. They, nevertheless, understand how to behave. This would be the case when a team utilizes a standard operating procedure as a habitual routine. Team members may also import habitual routines that they have based on previous experience or based on a common set of shared norms about how things should be done. In addition to importation, teams may create habitual routines when the task or performance situation is novel. When groups are heterogeneous and, therefore, lack a common set of norms, routines may also be created. Routines also tend to be created when no procedure is provided a priori by the organization. Both importation and creation are definite means of acquiring routines that occur at a definite point in time. Routines may also develop or evolve over a long period of time. Unlike importing and creating routines, evolution is a means by which routines develop incrementally over the team's tenure together. All three means of forming habitual routines may be used by any given team and do not necessarily compete with each other or dominate the group's process (Gersick & Hackman, 1990; and Weiss & Ilgen, 1985).

Proponents of habitual routines indicate that routines become entrenched. As the routine is repeated, active cognitive evaluation of the situation is reduced. If the routine is perceived to be successful, it continues to be repeated. With repeated use, a sort of inertia occurs whereby the routine becomes a part of the teams behavioral repertoire. Herein lies, as aforementioned, one of the dysfunctional consequences of well entrenched habitual behavior. As cognitive processing is minimized, the inertia becomes so great that teams will continue to utilize routines that have become very dysfunctional. Inertia is likely to occur for several different reasons. Opposition to a well accepted routine is likely to draw negative responses from other team members. Therefore, dissenters may tend to suppress their reservations. The habitual routine may actually become entrained in the team's repertoire with the team's social processes actually promoting the persistence of the routine. Inertia may also be fostered by the potentially high cost of changing the routine. Furthermore, group norms tend to support habitual routines in that norms are used to enforce routines within a team (Gersick & Hackman, 1990; and Weiss & Ilgen, 1985).

The tenacity of a given habitual routine is thought to be a function of three factors: its orientation, its depth, and its centrality. Orientation refers to whether the routine is oriented toward guiding socio-emotional issue or task issues. Task oriented routines are thought to be more amenable to change because they are less personal than those dealing with socio-emotional issues. The depth of a routine refers to the extent to which it is deeply entrenched or "buried" in the life of the team. Thus, those that are so entrenched that they are unacknowledged are more difficult to dislodge. Finally, the centrality of a habit refers to whether the routine is peripheral or central to the team's work. The greater the degree of these attributes, the greater the difficulty in changing a routine (Gersick & Hackman, 1990; and Weiss & Ilgen, 1985).

Teams may tend to break habitual routines and develop new responses to performance situations in five instances. Novel situations may prompt abandonment of a habitual routine especially when the novelty causes sufficient uncertainty over the salient stimulus in that situation. Teams may also abandon routines when they experience a substantial failure or goal blockage as long as that failure does not result in an escalation of commitment by team members. Alternatively, when teams using a particular habitual routine reach a milestone or a natural breaking point in the task, there may be sufficient stimulation to reevaluate the routine and change. While novelty, failure, and passing milestones all occur within the group, two outside forces, intervention and restructuring, may facilitate reevaluation of a habitual routine. Teams may reevaluate a performance situation when they receive an intervention that might come from an authority figure, team leader, or consultant. Individuals in such a formal interventionist role may be effective in focusing the team's attention and thereby foster reevaluation of accepted habitual routines. Changes in the team's or organization's structure may also be an external force for reevaluating routines. Structural changes that would necessitate reevaluation include such things as changes in the team's composition, redesign of the team's task, or changes in its authority and autonomy to manage itself (Gersick & Hackman, 1990; and Weiss & Ilgen, 1985).

Comparison of Mechanisms

There is some obvious conceptual overlap between shared mental and problem models, performance strategies, and habitual routines. All speak to the manner in which groups develop behavioral patterns. Thus, each provides a viable explanation of how teams develop patterns of skill allocation and use: flexibility. In this respect, the means by which teams develop habitual routines are also informative when addressing the formation of shared models and performance strategies. No information could be located in the literature which directly compared these four different mechanisms.

To reiterate, shared mental models are used to generate descriptions of systems and their functioning as well as descriptions of their current and future states (Cannon-Bowers et al., 1993). Shared problem models are specific models of the situation and appropriate strategies for coping with task demands (Oransanu & Salas, 1993). Performance strategies are the collective choices made by team members regarding how they will perform their task (Hackman, 1987; and Hackman & Morris, 1975). And, finally, habitual routines "exist when a group repeatedly exhibits a functionally similar pattern of behavior in a given stimulus situation without explicitly selecting it over alternative ways of behaving" (Gersick & Hackman, 1990, page 69).

These definitions all appear to have a shared basis of thought. They also share the inference that the team's common thinking whether driven by shared models, shared performance strategies, or shared habitual routines is realized in the team's actual performance of its tasks. The primary distinction that can be inferred from the literature is that the mechanisms differ in the extent to which active cognitive processing is present. Shared models and habitual routines appear to require active cognitive processing during their development that declines with prolonged use. Performance strategies, on the other hand, appear to require somewhat more active cognitive processing given their strategic orientation, although Hackman (1987) clearly states that they may become implicit over time. Given that proponents of each mechanism indicate that active cognitive processing is required at some point and that some automacticity occurs with prolonged use, it appears that the common issue is what causes a team to switch from inactivity to conscious cognitive activity.

A great deal of theoretical and empirical evidence exists indicating that there is a difference between automatic and conscious cognitive models (Louis & Sutton, 1991). Cue-strategy associations are thought to be crucial to effective team performance as it is necessary for members to recognize cues provided by the task and environment which would signal required changes in strategy (Cannon-Bowers et al., 1995). Switching from inactivity to conscious cognitive activity is likely to be triggered when the team encounters novelty. It is also likely to be triggered when a team encounters a discrepancy in its performance situation significant enough to gain its attention. Finally, deliberate requests for active thinking are another likely trigger for switching cognitive gears (Louis & Sutton, 1991).

Given the conceptual similarity of shared models, performance strategies, and habitual routines and the dearth of comparative information, two possibilities exist. The first possibility is that only one construct exists that has been given various names in the literature. The alternative is that there are fine-grained conceptual differences between these mechanisms that have not yet been clearly articulated in the literature. In that case, the question becomes "Which mechanism is in operation as teams develop patterns of skill allocation and use?" The only reasonable response to this question is that of equifinality or that each mechanism might be guiding skill allocation and use in any given team in any given performance situation. For the purposes this research, the position was taken that a single construct, hereafter referred to as a shared mental model, exists. Thus, information theorizing about habitual routines and performance strategies was taken as applicable to shared mental models. Furthermore, for the present purpose, shared problem models were viewed as specialized versions of shared mental models that were applicable to novel situations faced by teams.

Shared Mental Models of Skill Use

To reiterate, the model of shared mental models of skill use (presented in Figure 1) focused on three components of the shared mental model: knowledge, behavioral expectations, and attitudes. As knowledge structures, a central component of shared mental models of skill use is the knowledge shared by the team. Shared knowledge facilitates coordination of the team's multiple redundant skills. It provides members with the corresponding declarative, procedural, and explanatory knowledge necessary to allocate skills for successful task performance. This shared knowledge enables each member to effectively perform his allocated role. It minimizes communication, negotiation, and explicit strategizing which would slow performance. Shared knowledge provides members with a common context from which to interpret information. It facilitates voluntary compensatory action and the speed with which such actions can be taken. Furthermore, shared knowledge provides the team members with a stable basis for predicting the actions of teammates (Oransanu & Salas, 1993). Shared knowledge provides the team with common ground from which to function. In the current model, four facets of knowledge are proposed: knowledge about the task, knowledge about the team, knowledge about the team's equipment, and knowledge about the team's interactions (Cannon-Bowers et al, 1993). Each of these facets of shared knowledge is necessary for successful task performance. Absence of one facet would leave the team with incomplete knowledge that would erode synergy and, therefore, diminish performance.

The second component of shared mental models of skill use in the model was behavioral expectations. Knowledge must be put into action if the team is to successfully perform its tasks. Based on their shared knowledge, team members form behavioral expectations for skill use in task performance. These shared expectations facilitate the allocation of resources (especially the team's multiple redundant skills), performance of complimentary task behaviors, back up support between members, coordination of actions to accomplish team goals, adaptation of behaviors to task demands, sequencing of task activity, and communication (Cannon-Bowers et al., 1993; Kraiger & Wenzel, 1997; and Rouse et al., 1992). These expectations function, in a sense, as anticipatory mechanisms that allow teams to function more quickly by minimizing explicit interaction. Since the behavioral expectations that teammates will have of each other are largely situationally dependent, this factor must be taken into consideration. That is to say that teammates are likely to have different expectations of each other depending on whether the situation is familiar and routine or unfamiliar and non-routine. Different mental models of skill use are likely to be invoked in non-routine situations. Shared problem models that differ from shared mental models in their scope and inclusion are invoked in non-routine situations. Three key aspects of non-routine situations should determine the type of mental models of skill use invoked and the extent of overlap among team members. Thus, the severity of the situation, the urgency of the situation, and the novelty of the situation should determine the type of mental model of skill use invoked by the team and the extent of that model's overlap among team members. Severe situations would have major and long lasting consequences if task performance was unsuccessful. Non-severe situations would have only minor and temporary consequences. Urgent situations are those that require swift attention and action. Non-urgent situations are those that do not require immediate attention or action, but rather allow a longer period of time for resolution. Finally, novel situations are those that have not been faced by the team in the past. In facing a non-routine situation, then, the team is unfamiliar with the situation, major factors within it and the contingencies of the situation. Of the three characteristics of non-routine situations, novelty is perhaps the most unique in terms of the mental model of skill use invoked and the extent of overlap between members for that model. Extremely novel situations (i.e., those in which no facet of the situation is familiar to team members) pose a situation for which team members are unlikely to have a shared mental model or a shared problem model of skill use to propose to the team. This investigated behavioral expectations for skill use in both routine and non-routine situations.

The model of shared mental models of skill use included shared attitudes as its final component. Shared team attitudes should also facilitate the coordinated allocation and use of the team's skills and, thereby, successful task performance. This model focused on two specific attitudes: collective orientation and collective efficacy. Both reflect the team member's belief in the team. Collective orientation reflects the member's belief in the team approach to job design and task accomplishment in general while collective efficacy reflects the member's specific belief in his team's ability to perform its tasks (Kraiger & Wenzel, 1997). These attitudes perform a motivational function in the team's task performance. Shared collective orientation and efficacy should promote high and sustained levels of effort and skill use in teams and thereby enhance task performance. Of the studies conducted regarding these attitudes, consensus exists that the members' confidence in the team's ability to complete specific tasks does contribute to enhanced performance by motivating members to perform the necessary teamwork behaviors (i.e., depending on and assisting fellow members – flexibility) (Cannon-Bowers et al., 1995).

A Model of the Development of Flexible Skill Use in Teams

The actual process of flexibly allocating and using skills has been referred to in the literature as load balancing, dynamic reallocation function, compensatory behavior, adaptability, and the label adopted here, flexibility. This describes the actual process of allocating and using skills in task performance (Cannon-Bowers et al., 1995). Taken together, the literature regarding team-level knowledge, skill, and attitudinal competencies and the literature regarding shared mental and problem models, habitual routines, and performance strategies can be used to build a model of the evolution of flexibility. Patterns of skill allocation and use in teams are likely to develop over a period of time as trial and error learning occurs and cue-strategy associations are formed. Thus, the model presented in Figure 3 is a cyclical one. As teams face task performance situations, they assess whether the task situation facing them is familiar or unfamiliar. If the situation is recognized as a familiar one, automatic cognitive processing of the task's situational characteristics is likely. Thus, shared mental models, habitual routines, and implicit performance strategies are likely to be invoked to guide skill allocation and use. The degree of flexibility will reflect shared knowledge and the efficacy of the team. The manner in which the team allocates and uses its redundant skills is a result of the group process and, therefore, serves as a source of either process gain or process loss (i.e., positive or negative synergy). The feedback received by the group upon task completion is then used as an indicator of the success or failure of the pattern of skill allocation and use. This feedback is used over time to refine the knowledge, skill, and attitudinal competencies of the group. For example, success or failure in task performance provides information about which individuals are good at which jobs and whether the pattern of skill allocation and use worked. It also provides the team with information regarding its efficacy.

If the task performance situation facing the team is assessed as an unfamiliar one, the team engages in active cognitive processing. During this active processing, the team is likely to assess several aspects of the situation. They are likely to assess how novel or unique the situation is. They are also likely to assess the severity of the situation and the degree of urgency of its resolution. Having assessed these aspects of the task situation, the team will likely evaluate any shared problem models it holds. It may also utilize shared mental models, habitual routines, and performance strategies if the situation or one similar to it has been previously addressed. The more novel, severe, and/or urgent the situation, the more active the cognitive processing that will be required for the team to most effectively allocate and use its skills. Furthermore, the more novel, severe, and/or urgent the situation, the more likely the team will formulate a new pattern of skill allocation and use. Once the team applies its skills, the model indicates that the task performance process is the same as in familiar situations. Implementation of the pattern of skill allocation and use results in positive or negative synergy during task performance. Feedback regarding the success of the skill allocation pattern is then used to refine the team’s knowledge, skill, and attitudinal competencies.

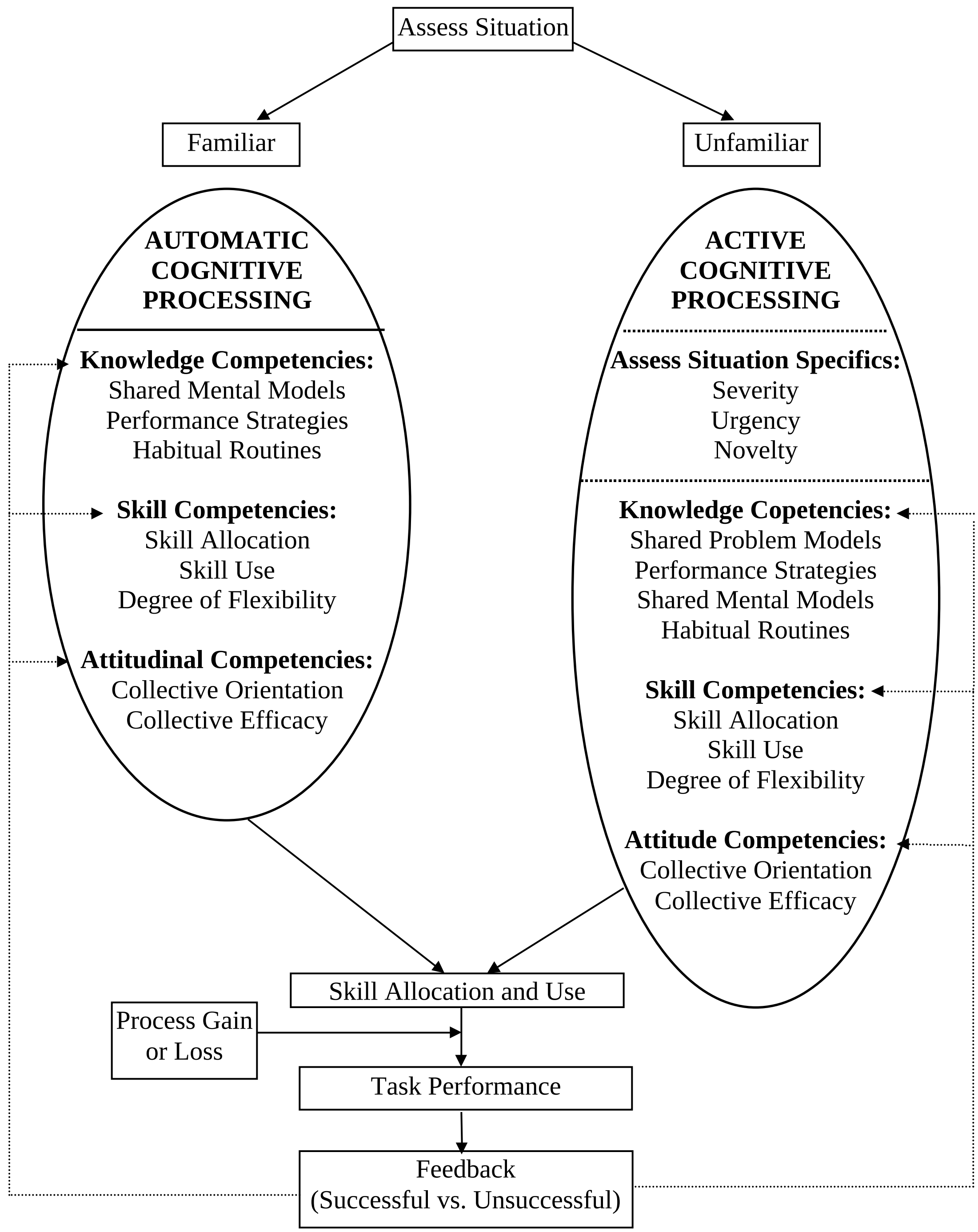

Figure 3: Model of the Development of Flexibility

Feedback which indicates that the method of skill allocation and use was successful in task performance increases the team's collective efficacy and further entrenches the shared mental and problems models, habitual routines, and performance strategies used to formulate it. This feedback also helps form cue-strategy associations via mapping thereby providing the team with information regarding the appropriateness of various patterns of skill allocation and use in various situations. By the same token, feedback indicating the failure of a method of skill allocation and use in a particular performance situation also provides the team with information regarding its shared models, habitual routines, and performance strategies. It likewise provides the team with information regarding inappropriate cue-strategy formation such as indications that novel situations were not accurately perceived or that they were not recognized early enough. Thus, an upward or downward performance spiral may be formed as is indicated in Figure 4.

The role of shared knowledge structures (shared mental models, shared problem models, performance strategies, and habitual routines) is central to the manner in which autonomous teams allocate and utilize the multiple redundant skills of their members. Since the best developed theoretical literature regarding knowledge structures focuses on shared mental models, they were adopted as the central theoretical and explanatory mechanism for this research. Thus, the factors that influence the development of shared mental models of skill use are of crucial importance. The chapter now turns to a discussion of the determinants of shared mental models of skill use in teams and culminates in a model of these determinants.

Determinants of Shared Mental Models of Skill Use

If shared mental models of skill use foster positive synergy and thereby enhance the performance of teams, then the determinants of shared mental models of skill use are of crucial importance. Investigation of these determinants could provide insight into how organizations can

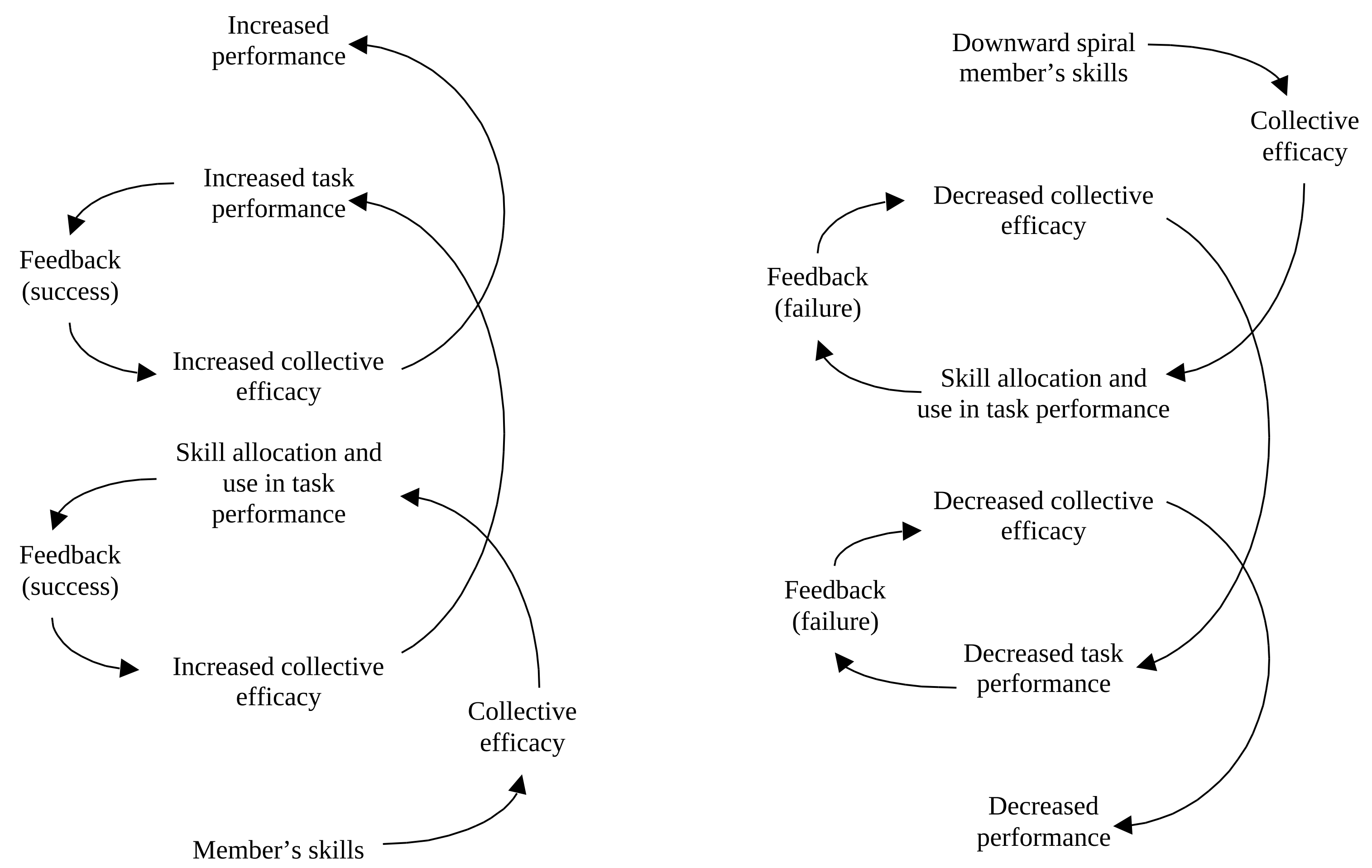

Figure 4: Team Performance Spiral

facilitate teams building shared models thereby giving organizations increased control over the team's processes and ultimately its performance. Individuals routinely formulate mental models and behave in accordance with these models. The key issue in team-based systems is the extent to which mental models of skill use are shared or the extent to which member's mental models of skill use overlap. Thus, this research focused on the question "What factors affect the extent of overlap in a team's mental model of skill use?" Theoretically, anything that increases team member's exposure to each other or teamwork should increase the team's degree of overlap in mental models of skill use.

It is likely that variables at the team level of analysis would serve as determinants of the extent of overlap in a team's mental model of skill use. Contextual variables are likely to have an impact on the extent of overlap. Past research into flexible skill use (Blumberg, 1978 and 1980; and Susman, 1968 and 1970) indicated that the nature of the task and technology play an important role in the rotation of skills or tasks among team members. Thus, technology was the focal contextual variable chosen for investigation. Specifically, three facets of technology were included as variables for the current investigation. The degree of interdependence required by the technology was the first contextual variable to be investigated. Interdependence was defined as " the degree to which individuals are dependent on and support others in task accomplishment" (Fry & Slocum, 1984). In some cases, the task's technology requires little interdependence between team members for successful task execution. However, in other cases, a high degree of interdependence is required of team members for successful task completion. A positive relationship was hypothesized between interdependence and the degree of overlap in a team's shared mental model of skill use. The greater the degree of interdependence required by the technology, the greater the exposure of the team members to each other because the technology would require that they interact. This increased opportunity for interaction should enhance the degree of overlap in the shared mental model of skill use in two ways. First, increased interaction between team members should foster the joint development of the mental model of skill use. Second, increased interaction should provide the opportunity for members to share their individual mental models of skill use with other members of the team allowing for joint adoption decisions to be made by the team's members (Klimoski & Mohammed, 1994; Kraiger & Wenzel, 1997; and Oransanu & Salas, 1993).

Uncertainty was the second facet of technology posited as an contextual variable and determinant of mental model overlap. Uncertainty was defined as the degree to which raw materials, transformation processes, and task activities are not well understood and are problematic for team members assigned to those tasks (Comstock & Scott, 1977). A negative relationship was hypothesized between uncertainty and the degree of overlap in a team's mental model of skill use. The greater the degree of uncertainty associated with the materials necessary for a task, the transformation process comprising the technology, and the task activities it requires, the lower the degree of overlap in the team's mental model of skill use. This should be the case because increasing degrees of uncertainty make the process of jointly forming shared mental models or sharing individually formed mental models more difficult. Increased uncertainty has this effect because tasks having high levels of uncertainty require more complex mental models of skill use that have to encompass many contingencies. The more complex the mental model required, the less likely it is to be formed jointly or shared among members (Klimoski & Mohammed, 1994; Kraiger & Wenzel, 1997; and Oransanu & Salas, 1993).

The final facet of technology proposed as a contextual variable and determinant of shared mental model overlap was complexity. Complexity was defined as how simple or complicated a set of tasks is (Fry & Slocum, 1984). Simple tasks would require very little skill for successful completion while more complicated tasks would require increasing levels of skill to complete successfully. A negative relationship was hypothesized between complexity and the degree of overlap in a team's mental model of skill use. Thus, complicated tasks require a higher degree of specialization than would simple tasks. The logic for this relationship is much the same as that of the relationship between uncertainty and mental model overlap. The more complex the technology and its tasks, the more difficult it is for team members to jointly form or share individual models of skill use. Increasingly complex tasks require increasingly complicated models of skill use which are difficult to formulate together or to share accurately between members (Klimoski & Mohammed, 1994; Kraiger & Wenzel, 1997; and Oransanu & Salas, 1993).

In addition to technology, three other variables from the team level of analysis were posited as key determinants of overlap in mental models of skill use. The first variable was cross-training. The relationship between cross-training and the extent of overlap in a team's mental model of skill use was hypothesized to be positive. The more fully cross-trained a team, the greater the extent of overlap in its mental model of skill use. Since cross-training systems typically utilize team members to train each other, there is greater opportunity for individuals to jointly develop and share previously developed mental models. Cross-training essentially incorporates the transmission of declarative, procedural, and explanatory knowledge between teammates. That is to say that during cross-training members currently certified in a skill block share information on what to do, how to do it, and why it needs to be done. Essentially, this transmission of information includes the elements of the trainer's mental model of skill use. As trainees question the trainer and practice new skills under the trainer's observation, opportunities should occur for these individuals to jointly form or revise the shared mental model of skill use (Klimoski & Mohammed, 1994; Kraiger & Wenzel, 1997; and Oransanu & Salas, 1993).

The next team level determinant proposed to affect extent of overlap in a team's mental model of skill use was team stability. This was defined as the stability of the team's membership over a given period of time. The relationship between stability and degree of overlap in the team's mental model of skill use was hypothesized to be positive. Teams with high stability have greater continuity of membership than teams with lower stability. Stability of membership (i.e., the team has the same membership over a given period of time with few or no membership changes) promotes joint development and sharing of the mental model of skill use. Lack of stability reflects frequent membership changes and thus, new members who are unfamiliar with the shared mental model. Maintaining a high degree of overlap in the team's mental model of skill use will become increasingly difficult as its membership becomes unstable (Klimoski & Mohammed, 1994; Kraiger & Wenzel, 1997; and Oransanu & Salas, 1993).

The last team level determinant proposed to affect the extent of overlap in a team's mental model of skill use was experience with teamwork. This variable was defined as the extent to which each team member has previous experience as a team member within the research cite and/or with other organizations. A positive relationship was hypothesized between experience with teamwork and the extent of overlap in the team's mental model of skill use. Individuals with previous teamwork experience already have a repetoire of skills and mental models of skill use that they can draw upon and offer their current team. Similarly, individuals with previous experience are likely to be predisposed to team processes (i.e., having joined another organization with team-based job design) and are likely to develop or adopt shared mental models easier and faster than members without such experience (Klimoski & Mohammed, 1994; Kraiger & Wenzel, 1997; and Oransanu & Salas, 1993).

Outcomes of Shared Mental Models of Skill Use

While investigation of the determinants of shared mental models of skill use is important, increased understanding of these determinants will prove of little value if these shared mental models do not result in advantageous outcomes with respect to task behavior. Thus, the current research was designed to address a second research question, "Does the extent of overlap in a team's model of skill use affect team behavior in task performance?" If shared mental models of skill use result in positive synergy, it is most likely to occur through an advantageous effect on the team's task performance behaviors. Thus, this research investigated four team task behaviors as outcomes of shared mental models of skill use.

The first team task behavior investigated was flexibility. It is arguably the most important team task behavior as it should be central to the synergistic process of skill allocation and use by teams. It is widely recognized as a central outcome of team-based systems. System users clearly desire flexibility because they view it as essential to desired organizational outcomes such as productivity and effectiveness. Team-based system users indicate that flexibility is a key factor in their decision to adopt these systems (Gupta et al., 1986; and Jenkins, Ledford, Gupta, & Doty, 1992). System users also clearly indicate that a key outcome of their team-based system is flexibility, and that flexibility via cross-training is directly related to performance outcomes such as productivity, customer satisfaction, quality, speed, profitability, and competitiveness (Gupta, et al, 1986; and Lawler et al., 1995).

Although its centrality to the success of team-based systems is widely recognized, flexibility is largely uninvestigated. The literature is conspicuously lacking in all regards. No clear construct definition of flexibility exists. No adequate studies of either its determinants or its consequences have been conducted to date. No theoretical or empirical literature exists detailing the means by which flexibility is hypothesized to improve team effectiveness. The largest literature that directly addresses flexibility is entirely descriptive in nature and consists of only five studies (Gupta et al., 1986; Jenkins, et al., 1992; Lawler, Mohrman, and Ledford, 1989; and Lawler et al., 1992 and 1995). Even in the case of these five studies, flexibility was not the central focus of the research. Rather it was one of many aspects of skill-based, team-based, and cross-training systems investigated.

Given that the centrality of flexibility to team-based systems is recognized by practitioners and theorists alike, it is somewhat startling to discover that an explicit definition of this key construct is conspicuously missing from the literature. Clearly, practitioners and academics have implied theories of flexibility which include assumptions about the nature of the construct. It is necessary to explicate these assumptions so that the construct can be clearly defined and adequately investigated. As previously noted, flexibility was defined as the degree to which a team allocates and uses the multiple competencies/skills of each of its members in pursuit of team goals. Thus, a team's degree of flexibility reflects the amount of knowledge and skill applied to task work relative to the total amount of knowledge and skill possessed by the team. It is a team level competency that involves compensatory, mutual adjustment and coordination by team members to facilitate adaptation to changing task conditions. Therefore, flexible skill use involves anticipating the needs of the task and the team so appropriate skill allocation and utilization facilitates necessary adjustments in a timely manner.

Since it is a result of cross-training, flexibility provides a degree of interchangeability between team members and, thereby, decreases dependence upon a given individual (Ledford, 1989). As a team-level phenomena, flexibility should increase as a function of the number of people who are cross-trained and the number of skills each person possesses (Cannon-Bowers et al., 1995). However, a distinction must be drawn between potential and realized flexibility. Organizations assume that individuals, once cross-trained, will actually utilize their skills in the performance of tasks. This is the classic issue of transfer of training. Unfortunately, having a widely cross-trained workforce does not mean that teams utilize their multiple skills in task performance. It only indicates that they have the potential to be flexible. Teams must allocate skills, and members must actually utilize their range of skills in the performance of multiple tasks for flexible performance to occur. Furthermore, the allocation and utilization of skills by the team must occur for both routine and non-routine tasks.

It is argued here, that teams develop a consistent level or pattern of skill use (i.e., degree of flexibility over the members' tenure together. Thus, a team's degree of flexibility is a consistent pattern of task behavior resulting from its allocation and utilization of its member's redundant skills. This allows for operationalization and measurement of flexibility as the degree to which a team's pattern of skill allocation and utilization in task performance behavior is characterized by rotation of tasks (or skill switching) in both routine and non-routine situations.

In terms of the model, a positive relationship was hypothesized between the extent of overlap in a team's mental model of skill use and the degree of flexibility in skill allocation to team tasks. A high degree of overlap in the team's mental model of skill use should facilitate the member's understanding of the talents, preferences, and responsibilities of teammates. This understanding based on the shared model of skill use should result in flexible allocation of skills. Members of teams with a high degree of overlap should understand the utility of moving highly skilled members to necessary tasks as the need arises. They should see that such flexibility is advantageous to the team both in terms of task performance and overall effectiveness (Rouse et al., 1992).

The second team task behavior to be investigated was quality of performance. A positive relationship was hypothesized between the degree of overlap in a team's mental model of skill use and the quality of its performance. The greater the extent to which the team shares the mental model, the better its performance should be as reflected by the quality of its product because the team will better utilize its skills and in doing so, minimize errors or defects in the product.

The third team task behavior to be investigated was verbal communication. A negative relationship was hypothesized between degree of overlap in a team's mental model of skill use and the frequency and duration of its verbal communication. The greater the extent of overlap in the mental model of skill use, the less overt verbal communication should be required for successful task performance. Explicit strategizing through verbal communication should not be necessary for those teams that have a high degree of overlap in the mental model, because the model serves as a substitute for such strategizing. Essentially, explicit strategizing in a high overlap situation would be redundant (Rouse et al., 1992).

Time required in task planning was the fourth team task behavior to be investigated. The relationship between the extent of overlap in a team's mental model of skill use and the time that is required of it in task planning was hypothesized to be negative. The logic for this relationship is much the same as that for the relationship between extent of overlap and communication. If there is a high degree of overlap in the team's mental model of skill use, little time will need to be spent in task planning because there will be a high degree of agreement over which activities should be done etc. Overt task planning should, therefore, be minimal if it occurs at all. Overt and extended task planning would be an unnecessary and redundant process for teams with a high degree of overlap in the mental model of skill use (Rouse et al., 1992).

Summary and Conclusions

The literature regarding performance of cross-trained autonomous teams is largely descriptive in nature. Consensus exists among practitioners and academics alike that teams can outperform traditional modes of job design. Consensus exists that teams performing synergistically have many advantageous outcomes such as improved productivity and quality.

Furthermore, there is widespread consensus that successful teams perform their tasks flexibly and that flexible performance requires coordination of a team's key resource, it skills. However, the literature lacks theory regarding how teams operate synergistically, coordinate use of their multiple redundant skills, and perform their tasks flexibly. Furthermore, empirical investigations of the means by which teams operate synergistically, coordinate use of their skills, and perform flexibly are conspicuously lacking in the literature. Thus, while models of team performance abound, there is little empirical or theoretical literature to inform investigations of team performance processes that are synergistic and flexible. The literature even lacks consensus on the labeling and definition of key constructs such as flexibility.

A notable exception to the scarcity of the literature can be found in the theoretical literature addressing knowledge structures (i.e., shared mental models, shared problem models, performance strategies, and habitual routines). This literature, while not fully developed, does elucidate a viable mechanism by which teams can operate synergistically coordinating their skills in flexible task performance. However, even this literature is not without problems. Again, there is no consensus in the labeling and definition of key constructs. Furthermore, while a useful explanatory mechanism, essentially no empirical studies of shared mental models exist in the area of organizational science (although a few do exist in the areas of linguistics, cognitive science, and operations). Of the few studies that do exist, many are laboratory experiments that lack realism and generalizability to organizations. Similarly, the literature, while providing this useful explanatory mechanism, does not elucidate either the determinants or consequences of shared mental models. Thus, this construct is generally used in a post hoc fashion to explain phenomena which limits its explanatory power and potential as well as its utility to organizations.

The current study sought to redress some of the shortcomings in the literature. First, this effort focused on developing sound theory in both the areas of shared mental models and flexible skill use. With respect to shared mental models, the theoretical literature regarding all forms of knowledge structures was reviewed and integrated. Theory regarding both determinants and outcomes of shared mental models was developed. With respect to flexibility, a construct definition was derived from the literature and a theory of the development of flexibility in teams was offered. Furthermore, the current effort sought to advance the measurement of both constructs as such measures are clearly lacking. Thus, this effort made preliminary contributions to construct validation efforts for both shared mental models and flexibility. In terms of shared mental models, the method known as structural assessment was actually applied to the measurement of shared mental models in teams.

Perhaps the greatest potential contribution of this research is the integration of the literature on shared mental models with flexible skill use in teams. This integration provided a theory and model of the means by which teams can operate synergistically coordinating their skills in flexible task performance. In doing so, this study provided insight into team processes that have heretofore remained in the "black box" of team performance. As such, this effort advanced both theory and measurement. The results provided valuable insight for organizations into the utility of shared mental models (i.e., to valued outcomes) and the means by which shared mental models could be developed (e.g., cross-training). Another potential contribution rests in the fact that this study was conducted in an organization with autonomous cross-trained teams, rather than in a laboratory. While exploratory in nature, this study makes valuable contributions to our knowledge of teams.

This research, then, sought to investigate the following propositions:

- Certain factors (e.g., cross-training) increase the extent of overlap in a team's mental model of skill use.
- Certain factors (e.g., complexity of technology) decrease the extent of overlap in a team's mental model of skill use.

- Increasing overlap in a team's mental model of skill use results in certain outcomes (e.g., flexibility) that should be advantageous to the team's performance.

- Increasing overlap in a team's mental model of skill use results in reduction of certain outcomes (e.g., time required in task planning) that should be disadvantageous to the team's performance.

Chapter 3 presents the research method, a description of the research site, sample and data collection procedures, measures, and statistical analyses designed to test the model and answer the research questions that guided this effort.

Chapter 3: Research Method

Research Method

This research investigated shared mental models of skill use in autonomous, cross-trained teams within a single organization. To reiterate, it was designed to address two research questions:

- Which of the factors identified affects the extent of overlap in a team's mental model of skill use?
- Does the extent of overlap in a team's mental model of skill use affect team behavior in task performance?

This study was designed as a preliminary construct validation effort for the shared mental model construct. The model investigated and the relationships it outlined regarding the determinants and outcomes of shared mental models comprise a nomological network. The research design of the study was cross-sectional and correlational. The team was the level of analysis.

The sections that follow describe the study's site, sample and data collection procedures, the operational measures of constructs and behaviors, and the analytic procedures.

Research Site

The site of this research was a non-unionized large-scale glass manufacturer located in the mid-west. The plant was one of seven plants owned by this company. This research site was opened by the company in 1989 and was designed in accordance with socio-technical system tenets to be an autonomous work-team plant. While many types of glass are produced by the company, this site produced large scale clear glass, tempered glass, and low emissivity glass for applications requiring energy conservation.

The manufacturing process at this facility utilized a continuous process production technology and had one production line that ran twenty-four hours a day, three-hundred and sixty five days a year. Shutdowns of the production process occur only for scheduled maintenance or in the event of an emergency. Teams were responsible for allocation of tasks, goal setting and attainment, selection of new members, cross-training and certification of skill acquisition, and conducting peer appraisals.

Job Design and Cross-Training

Job or task design was at the team level and task accomplishment required team members to work together. Task design was along functional lines that mirror the major functional components of the production process. Since there were eight major production areas (hot end, cutter lab, cold end, tempering, warehouse, maintenance, stores, and batch house), there were eight sets of teams. Each of the eight functional areas had a skill-based system comprised of four or five skill blocks, which were as follows:

- Hot End Team:
  - Batch Handling
  - Lehr Operation
  - Bath Operation
  - Furnace Operation
  - Furnace and Equipment Maintenance

- Cutter/Lab Team:
  - Inspection Booth/Line
  - Siempelkamp
  - Lab
  - Cutter Operation

- Cold End Team:
  - Case Closing
  - Packing
  - Fork Lift
  - Final Inspection

- Tempering Team:
  - Loader/Edger
  - Oven/Quench
  - Inspection/Closing
  - Packer/Fork Lift

- Warehouse Team:
  - Shipping Inspector
  - Warehouse Maintenance
  - Stager
  - Loader

- Maintenance Team:
  - Welding
  - Mechanical
  - Electrical
  - Instrumentation
  - Equipment

- Stores Team:
  - Store Room Tech - Level 1
  - Store Room Tech - Level 2
  - Store Room Tech - Level 3
  - Store Room Tech - Level 4

- Batch House
  - Materials Manager
  - Unloading Panel/Dump Truck
  - Fork Truck
  - Trackmobile/Loader
  - Sweeper

(Position responsibilities for hot end, cutter/lab, and cold end teams are provided as illustrations of team responsibilities in A, B, and C.) In order to continuously run the production process, the plant was staffed by a number of different shifts of employees. Some production areas such as the hot end, cutter lab, and cold end were staffed by four twelve-hour shifts of employees. These shifts swung from day to night on a rotating basis. Each twelve hour shift (named "A", "B", "C", and "D", respectively) had a team in each of the aforementioned functional areas. Thus, there were four hot end teams, four cutter lab teams, and four cold end teams. The hot end and cutter lab teams were comprised of seven members. The cold end teams were comprised of 27 members due to the labor-intensive nature of the skill blocks in that function. The tempering function was run based on customer demand and thus, was not run constantly. When in operation, the tempering teams worked one eight-hour shift per day. The tempering teams were comprised of nine members. Maintenance teams had two types of schedules. One team was permanently assigned as a maintenance team unto itself. The remaining maintenance team worked a twelve-hour rotating shift corresponding to the shifts staffed by the hot end, cutter lab, and cold end teams. The permanent maintenance team was comprised of three members and the rotating team had ten members. Warehouse teams worked eight-hour rotating shifts and were comprised of ten members. Stores teams had two members and worked overlapping swing shifts. Batch house teams worked a regular eight-hour shift and were comprised of three members (internal company document., n.d.).

Newly hired employees were assigned either as production or maintenance technicians. (Please refer to Appendices D and E for production and maintenance technicians job descriptions). If selected as a production technician, new employees automatically became members of the cold end team. Upon completion of the probationary period, team members could opt to join other teams in other functional areas of the production process subject to availability. Regardless of the functional area, each individual was required to spend five to six months learning and working in each skill block. Team members already certified became trainers for teammates who wanted to acquire additional skill certification. Trainers were responsible for cross-training, assessing progress, and certifying skill acquisition by teammates. The skill-based system also had a "pay-back" period of varying length during which each person who was successfully certified was required to train other team members. The varying duration of the payback period was due to the variety of skill-blocks in the system. The skill-based system was designed so that an individual could be trained in all of the skill blocks for one functional area in two years. After mastery of all skill blocks within functional areas, employees could request transfer to a team in another functional area to continue cross-training. Such transfers also depended on availability of positions and were subject to selection processes by the "hiring" team. Team members were not required to recertify in any skill block once they had successfully achieved certification (internal company document, n.d.). The cross-training system was supported by a skill-based pay system and a gainsharing system.

Skill Allocation and Use by Teams.

Given the differing technological nature of the skill blocks in each functional area, each area was scheduled to rotate routine tasks or skill blocks on a different basis. Therefore, each functional area represented a different configuration of skill allocation and use for routine tasks. Hot end teams comprised of seven members allocated several members to work in the furnace skill block. Furnace operators worked in this skill block for six hours per shift and then rotated to another skill block. The remaining hot end team members operated in skill blocks as required. Cutter lab teams, which were also comprised of seven members, allocated three members as designated cutters. Two of the cutters were in this position long-term and the third rotated so that all members could serve in this position. Rotation of cutters in this third position occurred every few months. Cutter lab team members not designated as cutters rotated on a more frequent basis. The cutter lab team’s personnel rotated into the lab position once a month and the line inspectors rotated every shift. Cold end teams, consisting of 27 members, were the largest of any in this plant. These teams used six-hour rotations for all members. Thus, each cold end team member performed two skills per shift. The teams that staffed the tempering line were separate from the others, as this process is an additional production step carried out after the glass had been fully produced on the float glass line. Tempering teams consisted of nine members. These teams routinely switched skill blocks every three hours. Thus, each tempering team member performed three different skills block each shift (internal company document, n.d.).

The remaining four functional areas were somewhat different from the others because they were considered support functions. This is not to say, however, that they were less essential to the production process. It is only to say that they functioned in a different capacity. The warehouse function was staffed by two teams each with ten members. Warehouse teams worked eight-hour shifts and used a seven day rotation as opposed to the "three day on and two day off" rotation used for employees on twelve hour shifts. These warehouse teams did, however, swing shifts. Rotation of routine tasks for the warehouse team occurred every three months. The maintenance teams were actually grouped with the warehouse teams. These teams also worked an eight-hour swing shift with seven-day rotations. Maintenance teams consisted of three members that rotated routine skill blocks every three months. Stores teams swung shifts from day to evening, but worked only between 6:00 A.M. and 7:00 P.M. and used a seven-day rotation. The batch house teams worked regular eight-hour shifts Monday through Friday with occasional rotation in support of teams with specific problems or requirements. Both stores and batch house teams rotated skill blocks on as needed basis responding to task demands.

In order to be eligible to rotate into a given skill block, a team member must have either been certified in the block or have been training in that block. Employees were eligible to rotate into any skill block for which they were certified if a unique or non-routine situation arose where their skill and experience could be of help. Non-routine rotation could be to skill blocks within a member's currently assigned functional area or to another functional area from which they had been transferred (i.e., where they had previous experience) (internal company document, n.d.).

Skill block rotation or skill use assignment was decided largely by the teams. Thus, hot end, cutter lab, tempering, warehouse, maintenance, stores, and batch house team members actually decided which team member were to be assigned to each skill block for routine tasks. The only team that did not allocate it members was the cold end team. A supervisor made skill block assignments for cold end teams. This was largely because all new employees entered the production process through a cold end team. Thus, many inexperienced employees were members of these teams. There were also significant safety considerations for cold end team tasks as this was the point in the production process where the glass was handled the most.

Sample and Data Collection Procedures

A pilot study was conducted at the plant by the researcher over a five-day period. Eighty-two useable questionnaires were obtained. Members of teams from each shift and from six of the eight types of teams participated. Upon completing the questionnaire, each subject was debriefed and a request was made for suggestions to improve the instrument. Based on analysis of the data and suggestions from pilot study participants, changes were made to improve the questionnaire. The pilot study represented a significant step in the survey development process since it allowed for refinement of original measures constructed for the instrument.

Two hundred and twenty team members and fifteen supervisors participated in the final survey administration. The two hundred and twenty team members represented nineteen teams from seven functional areas of the production facility. The final sample consisted of four hot end teams, four cutter lab teams, four cold end teams, one tempering team, three warehouse teams, two maintenance teams, and one stores team. No batch house teams were obtained.

The fifteen supervisors who completed the questionnaire each directly supervised the teams for which they completed the questionnaire. Some supervisors were responsible for more than one team and, therefore, completed more than one questionnaire. The questionnaire completed by supervisors was essentially the same as that completed by the team members except the referent for each question was changed appropriately (i.e., instead of "my team" for team members, "this team" for supervisors). Several questions were also added to the supervisors questionnaire as supervisors were the main source of the data (e.g., team stability).

The full-scale research study was conducted approximately eight weeks after the pilot study. The researcher administered each survey in the plant over a seven-day period. All team members and supervisors present in the plant during that period were required to complete the questionnaire during their shift. Team members were relieved of their duties to complete the questionnaire. The average time required to complete the survey was approximately 30 minutes. The only measures not collected directly by the researcher were the hard productivity/quality measures. These measures were provided by the quality manager in the plant from data that was routinely collected from teams for quality control.

Measures

Shared Mental Models

The central construct of this research was shared mental models of skill use, which consists of three shared components of mental models: knowledge, behavioral expectations, and attitudes. This research operationalized shared mental models in terms of these three components.

Shared Knowledge.

In order to determine the degree to which knowledge is shared in a team's model of skill use, it was first necessary to define the likely content of the model (Kraiger & Wenzel, 1997). The knowledge contents of a model of skill use logically fall into four categories or facets: task (KTASK), equipment (KEQUIP), team (KTEAM), and team interaction (KINTERACT) (Cannon-Bowers et al., 1993). Thus, facets of the core knowledge in each of these domains was defined for the current research. Individual team members were asked to rank the importance of each facet to the key team outcome (i.e., using skills well). Specifically, each team's members were asked to rank the importance of the following concepts to the outcome of skill use. In doing so, team members revealed the structure of their mental model by ranking concepts from most important to least important. For the task facet of the mental model:

- Knowing what my team's task(s) is/are
- Knowing the requirements for performing my team's task(s)
- Understanding the procedures for performing my team's task(s)
- Understanding the situations that are likely to arise as my team performs its task(s)
- Understanding of the strategies for performing my team's task(s)
- Knowing limitations the situation puts on my team's ability to perform its task(s)
- Knowing how severe problems might be that may occur as my team performs its task(s)
- Knowing how urgent problems might be that may occur as my team performs its task(s)
- Understanding new problems that may occur as my team performs its task(s)
- Knowing when my teammate's need help
- Knowing how difficult a task is
- Knowing how long it takes to complete a task
- Knowing what is needed to complete a task
- Knowing when I need help to complete a task

For the equipment facet of the mental model:

- Understanding how my team's equipment works
- Understanding the procedures for running my team's equipment
- Knowing what my team's equipment can't do or its limitations
- Understanding the problems that are likely to occur with my team's equipment
- Understanding the equipment failures that are likely to occur

For the team facet of the mental model:

- Knowing how much my teammate's know about my team's task(s)
- Knowing how skilled my teammate's are in performing my team's task(s)
- Knowing the abilities of my teammate's to perform my team's task(s)
- Knowing my teammate's preferences when performing my team's task(s)
- Knowing my teammate's limitations
- Knowing my teammate's faults
- Realizing how much I know or don't know about my team's task(s)
- Knowing my level of skill in performing my team's task(s)
- Knowing my level of ability in performing my team's task(s)
- Realizing my preferences when performing my team's task(s)
- Realizing my tendencies when performing my team's task(s)
- Realizing my limitations when performing my team's task(s)

For the team interaction facet of the mental model:

- Understanding my teammate's roles
- Understanding my teammate's responsibilities
- Understanding how my team gets information
- Understanding of the way my team's members interact with each other
- Understanding where my team gets information

By determining how team members jointly defined key interrelationships (i.e., between each facet and the key team outcome of skill use) such as these, it was possible to determine whether they held similar mental models of skill use. Facets ranked as highly important to the outcome of skill use revealed the structure of a member's mental model by indicating which aspects were central to skill use and which were peripheral or altogether unimportant. According to the process of structural assessment, if two team members give the same concept a high ranking, it is assumed that both members agree that it is structurally related to a certain outcome. These two members, therefore, share that aspect of the mental model (Kraiger & Wenzel, 1997). Overall similarity in rankings indicated sharing. Diversity in rankings across team members indicated a lack of sharing.

Difference or deviation scores were used to assess the degree of overlap among teammates' for the four knowledge facets. Specifically, degree of overlap in facets was calculated as the absolute value of:

$$\frac{\Sigma \text{ Item differences across all pairs of team members}}{\text{(Number of pairs of team members)}}$$

This divisor controlled for differences in team size since larger teams had more difference scores computed than small teams. This served as an index of agreement on the importance of concepts to skill use by the team. An average deviation of zero would indicate perfect agreement or a totally shared mental model facet across all a team's members. Thus, smaller numbers indicate low disagreement or high overlap and sharing of mental models and are, therefore, desirable. Conversely, large numbers would indicate greater disagreement and less overlap or sharing of mental models.

Shared Behavioral Expectations.

In addition to operationalizing the construct of shared mental models in terms of knowledge, this research also operationalized the construct of shared mental models in terms of the team's shared expectations for skill use in task performance. It stands to reason that teammates may have different behavioral expectations of each other based on the type of situation they are facing. Shared expectations for skill use in routine (ROUT) and non-routine (NONROUT) situations with various characteristics (e.g., urgency, severity, and novelty) were assessed. Routine situations were defined as those involving typical, non-problematic tasks. Non-routine situations were defined as those involving atypical or problematic tasks. These expectations were measured via a series of perceptual measures constructed for this study which specifically assessed expectations for skill use. For routine situations, the perceptual measures were as follows:

- I expect each of my teammates to regularly use all of the skill blocks for which they are certified.
- I expect to be assigned to a different job each shift or several jobs per shift.
- My team tends to let each person do his or her favorite job.
- I expect to do the same job day after day.
- I expect to have say in who does which job.

For non-routine situations, the perceptual measures were as follows:

- When I've got a problem, I expect my teammates to leave what they're doing to help me.
- I only expect my teammates to help me when I've got a really big problem.
- I expect my teammates to help me when I've got a problem that must be solved immediately.
- If my teammates aren't busy with their jobs, I expect them to help me out when I need it.
- If I run into a problem I've never seen before, I expect my teammates to help me out.
- I don't usually expect my teammates to help me out.

The response format was a five point Likert scale (strongly agree to strongly disagree). Shared behavioral expectation facets were computed for both types of situations by calculating individual scale scores then aggregating the individual scores to attain a mean team score and finally, redistributing the mean team score back to each individual team member.

Shared Attitudes.

Two attitudes that should affect skill use are collective orientation and collective efficacy. Collective orientation is the "shared capacity to take others' behavior into account during team interactions or a belief in the team approach" (Kraiger & Wenzel, 1997, p. 70). Collective efficacy was the "team member's assessment of his team's collective ability to perform required tasks" (Kraiger & Wenzel, 1997, p. 70). The current research defined collective orientation (CORIENT) as a team member's belief in the team approach. A five point Likert scale (strongly agree to strongly disagree) was developed to assess collective orientation. Its items were as follows:

- I think that using teams is the best way to organize the production process.
- I think teams produce more than the same number of people could working alone.
- I think teams are an inefficient way to organize the production process.
- I would rather work by myself than have to work on a team.
- I think teams improve the quality of our product.
- I think teams are an effective way to organize production.
- I think working in teams slows down the production process.
- I thing working in teams is harder than working alone.

A measure of collective efficacy (CEFFIC) was adopted from the literature (Guzzo, et al., 1993). Items were as follows:

- My team has confidence in itself.
- My team believes it can become unusually good at producing high-quality work.
- My team expects to be known as a high-performing team.
- My team feels it can solve any problem it encounters.
- My team believes it can be very productive.
- My team can get a lot done when it works hard.
- No task is too tough for my team.
- My team expects to have a lot of influence around here.

Team members used a five point Likert scale (to no extent to to a great extent) to respond to these items. Team scores for both attitude facets were developed using the procedure describe above for the behavioral expectation facets.

Determinants of Shared Mental Models of Skill Use

In order to address the first research question, measures of the determinants of overlap in components of the mental model of skill use were constructed.

Technology.

The primary contextual determinant to be investigated at the team level was technology. Team members were asked to rate their functional production areas in terms of interdependence required (INTERDEP), degree of uncertainty (UNCERT), and degree of complexity (COMPLEX). Measures of these aspects of technology were adopted from the literature (Fry & Slocum, 1984; and Mohr, 1971) and adapted for use in this research. The items for the interdependence scale were as follows:

- Most of this team's tasks are one person tasks; there is little necessity for working with others.
- There is little or no need for members of this team to check or to work with others.
- To do their jobs properly, this team's members must collaborate extensively with each other.
- In order to be successful, members of this team must work closely together.
- Working actively with others as a part of this team is a requirement for these jobs.
- It doesn't make a difference whether members of this team work closely together or not, they can get the job done either way.

Items for the uncertainty scale were as follows:

- There are hardly any exceptional cases in the things this team works on.
- From day to day, this team usually doesn't have to deal with any unusual situations.
- This team pretty much knows what it will face from day to day in terms of the work it has to do.
- This team doesn't know from one day to the next, what it will face in doing its work.
- This team can pretty well predict what will happen in terms of the nature of the work it must do.
- Because of the nature of its work, this team never knows what it will have to face.

Items for the complexity scale were as follows:

- Generally, this team must do only simple tasks.
- This team's work is very complex.
- This team's work is very complicated.
- This team's work is not very complicated.
- This team's work is not very complex for the most part.

Team members used a five point Likert scale (strongly agree to strongly disagree) to respond to these items. Participants were required to complete these items for their current team. As with the behavioral expectation and attitude facets, team scores were obtained by calculating individual scale scores then aggregating the individual scores to attain a mean team score and finally, redistributing the mean team score back to each individual team member.

Cross-training.

Cross-training (CROSS) was measured by an index which divided the number of skill blocks a team's members were certified in by the product of the number of team members and the number of skill blocks available to the team. The formula for the cross-training index, thus, was:

$$\frac{\text{Number of skill block certifications within team}}{(\text{Number of team members} \times \text{Number of available skill blocks})}$$

This index was essentially a proportion of the team's members that were certified relative to the maximal configuration possible. Basically, it was a measure of a team's potential flexibility. The closer the index was to one, the more extensive the team's cross-training. An index of one would indicate that all team members were certified in all skill blocks available to that team. Team members reported the number of skill blocks in which they were certified and these were summed to provide the numerator of the index. Supervisors provided data regarding the number of team members and available skill blocks, which were multiplied to provide the denominator of the index.

Stability.

Stability (STABIL) was defined as the percentage of membership changes within the past year for each team and was calculated as the number of changes divided by the number of team members. The team's supervisor provided this information.

Experience with Teamwork.

Experience with teamwork (EXPERTM) was measured with a two item scale, which assessed the amount of experience members had with teams at other organizations, and with other teams at this plant. Specifically, these items were as follows:

- Have you ever worked on a team(s) in another organization(s)? If so, how many years did you work on each?
- Have you worked on any other teams at this plant besides the one that you now belong to? If so, how long were you a member of each?

The score for the first measure was computed as:

OTHEREXP = Years experience on teams in other organization(s)

The score for the second measure was computed as:

ORGEXP = Years experience on other teams within company

The score for this scale (EXPERTM) was computed as:

$$\frac{\text{OTHEREXP + ORGEXP}}{\text{Number of team members}}$$

The larger this number, the greater the team's experience with teamwork prior to their membership in the current team.

Outcomes of Shared Mental Models of Skill Use

The second research question addressed whether overlap in models of skill use affected a team's behavior in task performance. The first task behavior investigated was flexibility which was defined as the extent to which a team utilized the multiple and redundant skills of all its members in pursuit of team goals. Flexibility was assessed by asking team members to estimate how many times, on average, they switched to a new skill block during a shift. This self-reported average was an acceptable measure of flexibility because team members were in the best position to estimate the degree to which they typically switched to new skill blocks (i.e., in both routine and non-routine situations). A team average for block shifts was then calculated by summing each team member's estimate and dividing by the number of team members. From this data, an index was calculated as the average number of switches divided by the cross-training index. The formula for the flexibility index, then, was:

$$\frac{\Sigma\text{Average skill block switches} \div \text{Number of team members}}{\text{Cross-Training Index}}$$

Where the cross-training index equaled:

$$\frac{\text{Number of skill block certifications within team}}{(\text{Number of team members} \times \text{Number of available skill blocks})}$$

The flexibility index indicated the extent to which the team was fully utilizing the cross-trained skills of its members. It was a ratio of the team's actual use of its multiple redundant skills relative to its potential for such skill use. The larger the index, the more flexibly the team was using its skills in task performance.

Improved quality of team performance was another important outcome of mental models being shared by teammates. Since each team performed a different set of behaviors and tasks, each team had a different measure of quality. However, each measure shared in common the metric that 100% was perfect quality. Essentially, each team had a measure of errors or defects such that higher percentages represented better quality performance than lower percentages. The quality measure for hot end teams was a composite of goals met with respect to twenty glass production goals. Thus, hot end teams quality measure was average percent of goals met over the measurement period. If all goals were met, the resulting measure would be 100%. The quality measure for cutter lab teams was a percentage cutting loss. Simply put, it was a measure of scrap or waste that reflected cutting errors that resulted in the loss of otherwise acceptable quality glass. The measure for cutter lab teams, therefore, was the cutting loss percentage subtracted from 100% (to put this measure on the same metric as other teams) averaged over the measurement period for each team. The higher the percentage, the higher the quality of the cutting operations. The quality measure for cold end teams was the percentage of cases (of glass) not closed per instructions which was equivalent to the number of cases rejected for shipping. As in the case of the cutter lab measure, the cold end measure was also subtracted from 100% to yield an acceptance rate as opposed to a rejection rate. This acceptance rate was also averaged over the measurement period for each team. Again, the higher the percentage, the higher the quality of the team's performance. Tempering teams had a quality measure based on throughput in the glass production system. The quality of tempering teams' performance was the percentage of throughput through the tempering process compared to the process' capacity. If the measure for a team was 100%, it would indicate maximum production of tempered glass. This throughput measure was averaged over the measurement period for each team. The quality of maintenance teams' performance was assessed by measuring the percentage of maintenance orders issued versus the number completed within the timeframe allowed for each type of repair. A measure of 100% would indicate that every maintenance order issued was completed within the allowable timeframe. This measure was averaged over the measurement period for each team. No quality measures were available for either the warehouse or stores teams because such data was not collected by the quality supervisor at the plant.

The remaining task behaviors, communication and time spent in task planning, were assessed via scales constructed for this research. Items comprising the communication (COMM) scale were as follows:

- In doing our work, my team doesn't communicate much.
- My team communicates frequently while we work.
- My teammates communicate only when there is a problem.
- My teammates frequently ask questions about doing our work.
- My teammates hardly ask any questions about doing our work.
- When we do communicate while we're working, my teammates do so quickly.
- It doesn't take very long for my team to communicate what it needs to.

Items comprising the time spent in task planning (PLAN) scale were as follows:

- My team spends a lot of time planning its tasks and activities.
- My team spends very little time planning its tasks and activities.
- Planning tasks is an important activity for my team.
- My team doesn't need to spend time planning its activities and tasks.
- My teammates never seem to know what to do, so we have to spend a lot of time planning our tasks and activities.
- My teammates seem to know what to do and when to do it, so we don't spend much time planning tasks and activities.

Team members responded to these two scales using a five point Likert scale (strongly agree to strongly disagree). Team scores were obtained by calculating individual scale scores then aggregating the individual scores to attain a mean team score and finally, redistributing the mean team score back to each individual team member. This score not only represented the degree to which members share this facet, but the degree to which verbal communication and time spent in task planning were viewed as high or low by the team.

Statistical Analyses

Since this was an exploratory study investigating the nature of basic relationships within a model, the first analyses conducted were simple Pearson's correlations. These correlations were used to assess whether hypothesized relationships between variables existed. Cronbach's alpha reliability coefficients were calculated for all Likert scales as a measure of the internal reliability of items in the scale. Factor analysis was performed for each scale in order to assess the dimensionality of items.

Appropriateness of aggregation of measures to the team level was assessed through a three step process: (1) ANOVAs were calculated to assess whether significant between team differences existed; (2) the correlation based on between-team differences was assessed in order to determine if it was statistically significant (i.e., significantly different from zero); and (3) the correlation based on between-team differences was assessed in order to determine if it was statistically different from the correlation based on within-team differences. Satisfaction of all three of these conditions indicated clear team level effects and thereby, supported aggregation of the measures to the team level of analysis. Thus, if all three conditions were met the variables in the tested relationship were retained for further analysis. If the variables in the tested relationship did not meet all three conditions, aggregation of measures to the team level of analysis was clearly in appropriate and these measures were dropped from subsequent analyses.

Measures that demonstrated clear team level effects were subjected to regression analysis in order to address the two research questions. For all regressions, the enter method of variable entry was utilized to enter variables into the regression equation in a single block. Variance inflation factors were calculated and inspected as a means to assess mutlicollinearity among independent variables in the regression analyses.

For research question one, regression analysis was used to assess the relationship between the hypothesized determinants and the degree of overlap in the model of skill use. Regression analysis allowed for investigation of the combined effects of determinants on the degree of overlap. In order to investigate this relationship (i.e., research question number one), four regressions were run, one for each set of variables demonstrated to be appropriately aggregated to the team level. Mental model facets (e.g., for the knowledge component – task, equipment, team) served as a dependent variable upon which the determinants (e.g., complexity and uncertainty) were regressed.

Regression analysis was also used to address the second research question. This analysis assessed the relationship between the degree of overlap in the team's mental model of skill use and each task behavior. Specifically, three regressions were run, one for each set of variables that demonstrated appropriate aggregation of the measures to the team level of analysis. In each, the task behavior served as the dependent variables (e.g., quality and communication). In each, the task behavior served as the dependent variable and shared mental model facets (e.g., knowledge - task, equipment, and team) served as the independent variables.

As an additional test of the explanatory power of shared mental models, a competing model that did not include the shared mental model components was analyzed. This test was conducted to give additional support to the role of shared mental models as an explanatory mechanism. It is possible that the determinants identified could have a direct effect on team task behaviors which would indicate that shared mental models do not add any explanatory power to the model. Or, it is possible that determinants have an effect on team task behaviors only through shared mental model overlap. Comparison of regression results for the full model and the alternative model address this issue. In the alternative model, the determinants (e.g., cross-training) served as independent variables and the outcome measures (e.g., flexibility, quality) served as dependent variables.

An additional set of analyses were performed to address the practical question of the extent to which cross-trained teams actually utilized the full range of their cross-trained member's skills. Descriptive statistics and the flexibility index were utilized to address this issue. To reiterate, the flexibility index indicated the extent to which the team fully utilized its members' skills. The average flexibility index across teams was calculated as an indicator of the extent to which teams, on average, utilized the skills of their members. The range of the flexibility index was also reported as an indicator of the maximal and minimal utilization of skills by teams. In order to assess whether there were significant differences between teams with respect to skill use, ANOVAs were performed. Specifically, ANOVAs were run to assess differences between teams regarding skill block certifications, skill block use per shift and per week, and skill block switches per shift and per week.

Chapter 4: Research Results

This chapter begins with the presentation of the results of the pilot study and revisions made to the questionnaire based on that study. The results of the factor analyses and ANOVAs utilized for data reduction are then presented. Next, the results of analyses designed to test the appropriateness of aggregation to the team level are reviewed. Then, descriptive statistics for the measures retained including reliability estimates are presented. The results of the full study's regression analyses are presented next. The chapter concludes with presentation of the descriptive statistics and the ANOVAs results regarding team flexibility. The interpretation of the statistical results is given in this chapter following each analysis.

Pilot Study

Based on analysis of the data and suggestions from pilot study participants, changes were made to improve the questionnaire. Pilot study participants' comments suggested items should be added to capture important issues that the pilot questionnaire did not. Additionally, some items were reworded to improve clarity based on pilot study participants' suggestions. Participants' comments and analysis of the pilot data also indicated that a few items should be dropped. Changes made based on the pilot study are summarized in Appendix F.

Results

Descriptive statistics (i.e., means and standard deviations) for each scale item are presented in Table 4 which can be found in Appendix G. Inter-item correlations can be found in Table 5 which is located in Appendix H. Table 6 presents means, standard deviations, and correlations between full scales (i.e., prior to data reduction) (N = 184). The following results were obtained.

Table 6: Descriptive Statistics for Full Scales at the Individual Level of Analysis

	Mean	S.D.	1	2	3
(1) Interdependence	11.613	3.266		-.134	-.299**
(2) Uncertainty	11.484	3.258			.485*
(3) Complexity	10.337	2.428			
(4) Experience with Teams	3.549	2.080			
(5) Routine	28.597	5.627			
(6) Non-Routine	20.537	3.203			
(7) Collective Orientation	15.721	5.119			
(8) Collective Efficacy	30.564	6.733			
(9) Communication	31.144	3.673			
(10) Planning	17.227	2.927			

	4	5	6	7	8
(1) Interdependence	.031	-.042	.247**	.459**	-.258**
(2) Uncertainty	-.072	.072	-.025	-.260**	.200*
(3) Complexity	.095	-.066	-.084	-.326**	.201**
(4) Experience with Teams		-.098	-.079	.025	.080
(5) Routine			.097	.016	-.045
(6) Non-Routine				.217**	-.085
(7) Collective Orientation					-.280**
(8) Collective Efficacy					
(9) Communication					
(10) Planning					

	9	10
(1) Interdependence	.212**	-.132
(2) Uncertainty	.194*	.452**
(3) Complexity	.177*	.232**
(4) Experience with Teams	.049	-.085
(5) Routine	-.040	.094
(6) Non-Routine	-.217**	-.079
(7) Collective Orientation	-.281**	-.118
(8) Collective Efficacy	.181*	.036
(9) Communication		-.001
(10) Planning		

A series of factor analyses were performed in order to assess the dimensionality of scales and aid in reduction of the number of variables to be used in the final analyses. A factor analysis was performed for each component of the full model (i.e., determinants, shared mental model facets, and team task behaviors) in which all scales for that component were entered into a single factor analysis. In all three cases, the results of the factor analyses demonstrated that each scale's items loaded uniquely together without cross-loadings on other factors. Subsequently, an additional factor analyses was performed for each scale. The factor analysis was used to reduce the number of items in each scale. All factor analyses were performed at the individual level of analysis (N=200). The final results of the factor analyses are presented in Table 7 through Table 15 below.

Table 7: Factor Analysis Results for Interdependence Scale

ID	Item	Factor 1
INTERDEP29	Members must collaborate	.875
INTERDEP4	Members must work closely together	.875

Table 8: Factor Analysis Results for Uncertainty Scale

ID	Item	Factor 1
UNCERT3	Team knows what it will face day to day	.707
UNCERT2	Team doesn't have to deal with unusual situations	.728
UNCERT4	Team can predict what will happen	.666
UNCERT1	Hardly any non-routine cases	.813

Table 9: Factor Analysis Results for Complexity Scale

ID	Item	Factor 1
COMPLEX3	Team's work is not very complicated	.847
COMPLEX2	Team's work is very complex	.760
COMPLEX1	Team must do only simple tasks	.705

Table 10: Factor Analysis Results for Routine Scale

ID	Item	Factor 1	Factor 2
ROUT3	Team lets each person do his favorite job	.739	
ROUT26	Teammates can avoid doing jobs	.739	
ROUT 27	Team lets members do job their best at	.721	
ROUT28	Team doesn't encourage use of new skill blocks		.778
ROUT29	Don't get to use all skill blocks		.784
ROUT210	Don't make teammates use blocks their not good at		.626

Table 11: Factor Analysis Results for Routine Scale

ID	Item	Factor 1
NONROUT26	Expect teammates to leave work to help with problem	.609
NONROUT2	Expect teammates to help with a big problem	.561
NONROUT3	Expect teammates to help with an immediate problem	.789
NONROUT27	Expect teammates to help with a novel problem	.780

Table 12: Factor Analysis Results for Collective Orientation Scale

ID	Item	Factor 1
CO1	Teams are best way to organize production	.812
CO5	Teams improve quality of product	.811
CO6	Teams slow down the production process	.770
CO2	Teams produce more than people working alone	.760
CO4	Would rather work by myself than on a team	.738
CO7	Working on teams is harder than working alone	.695
CO3	Teams are an inefficient way to organize production	.335

Table 13: Factor Analysis Results for Collective Efficacy Scale

ID	Item	Factor 1
CE1	Team has confidence in itself	.813
CE2	Team believes it can be good at producing high quality	.895
CE3	Team expects to be known as high performing	.829
CE4	Team feels it can solve any problem	.892
CE5	Teams believes it can be productive	.894
CE6	Teams gets a lot done when it works hard	.848
CE7	No task is too tough for team	.845

Table 14: Factor Analysis Results for Communication Scale

ID	Item	Factor 1	Factor 2
COMM26	Team communicates frequently about work		.660
COMM27	Team doesn't communicate unless there is a problem		.817
COMM28	Teammates don't ask each other work questions		.727
COMM11	Teammates communicate frequently about non-work	.867	
COMM12	Teammates spend time in non-work communication	.870	
COMM13	Teammates don't communicate about non-work	.813	

Table 15: Factor Analysis Results for Planning Scale

ID	Item	Factor 1
PLNG1	Team spends a lot of time planning tasks and activities	.889
PLNG2	Planning tasks is an important team activity	.889

Cronbach's alpha reliability coefficients were calculated to assess the internal reliability of Likert scales. The results of these analyses are presented below in Table 16.

Table 16: Reliability Analysis Results

Scale	Cronbach's Alpha	Final Number of Items in Scale
Interdependence	.71	2
Uncertainty	.75	4
Complexity	.66	3
Routine	.73	6
Non-Routine	.61	4
Collective Orientation	.86	6
Collective Efficacy	.94	7
Communication	.74	6
Planning	.73	2

Once the number of items in each scale was reduced based on factor analysis results, ANOVAs were performed to assess whether aggregation of scales to the team level was appropriate. In each ANOVA, the team was the factor. Thus, differences on each variable/scale between teams were indicated by significant F statistics. The results of these ANOVAs are presented in Table 17.

Table 17: ANOVA Results at the Individual Level of Analysis

Variable	Sum of Squares	df	Mean Square	F	Sig.
Interdependence					
Between Groups	10.633	18	.591	1.024	.437
Within Groups	88.853	154	.577		
Total	99.486	172			
Uncertainty					
Between Groups	25.629	18	1.424	2.658	.001
Within Groups	56.636	102	.536		
Total	80.264	120			
Complexity					
Between Groups	31.361	18	1.742	3.228	.000
Within Groups	77.527	164	.540		
Total	119.888	182			
Equipment					
Between Groups	679.559	17	39.974	7.903	.000
Within Groups	6626.067	1310	5.058		
Total	7305.627	1327			
Task					
Between Groups	3963.946	17	233.173	3.106	.000
Within Groups	96857.091	1290	75.083		
Total	100821.037	1307			
Team					
Between Groups	247762.212	17	14574.248	286.667	.000
Within Groups	69549.681	1368	50.840		
Total	317311.893	1385			
Team Interaction					
Between Groups	238.293	17	14.017	1.215	.244
Within Groups	15778.544	1368	11.534		
Total	16016.838	1385			
Routine					
Between Groups	34.515	18	1.918	4.131	.000
Within Groups	72.409	156	.464		
Total	106.924	174			
Non-routine					
Between Groups	11.366	18	.631	1.948	.016
Within Groups	50.896	157	.324		
Total	62.261	175			
Collective Orientation					
Between Groups	16.143	18	.897	1.579	.071
Within Groups	92.597	163	.568		
Total	108.740	181			

Table 17: ANOVA Results at the Individual Level of Analysis (Continued)

Collective Efficacy					
Between Groups	16.281	18	.904	1.199	.267
Within Groups	122.945	163	.754		
Total	139.226	181			
Communication					
Between Groups	9.023	18	.501	2.339	.003
Within Groups	34.510	161	.214		
Total	43.533	179			
Planning					
Between Groups	26.483	18	1.471	1.709	.042
Within Groups	140.319	163	.861		
Total	166.802	181			

Results of the ANOVAs indicated that aggregation to the team level was inappropriate for four variables (i.e., interdependence, team interaction, collective orientation, and collective efficacy) as significant between-team differences were not found (i.e. F statistic was not significant). Thus, these four variables were dropped from subsequent analyses. Aggregation to the team level for all other variables was supported. Therefore, the remaining variables were utilized in subsequent analyses.

Descriptive statistics and bivariate correlations (J = 17) for aggregated weighted refined scales are presented below in Table 18.

Table 18: Descriptive Statistics for Aggregated Weighted Refined Scales at the Team Level of Analysis

	Mean	S.D.	1	2	3
(1) Uncertainty	2.705	.374		.829**	-.114
(2) Complexity	3.413	.392			-.026
(3) Cross-training	.828	.163			
(4) Stability	.439	.412			
(5) Experience with Teams	3.429	.801			
(6) Equipment	3.983	1.170			
(7) Task	24.167	2.399			
(8) Team	23.542	10.793			
(9) Routine	2.962	.369			
(10) Non-routine	2.083	.259			
(11) Flexibility	2.710	.639			
(12) Quality	82.019	9.688			
(13) Communication	3.968	.267			
(14) Planning	2.986	.378			

	4	5	6	7	8
(1) Uncertainty	.284	.377	-.125	.729**	.427*
(2) Complexity	.118	.453*	-.084	.720**	.315
(3) Cross-training	-.108	.443*	-.235	.116	-.219
(4) Stability		.043	-.050	.471*	.423*
(5) Experience with Teams			-.293	.340	-.073
(6) Equipment				-.382	.204
(7) Task					.274
(8) Team					
(9) Routine					
(10) Non-routine					
(11) Flexibility					
(12) Quality					
(13) Communication					
(14) Planning					

Table 18: Descriptive Statistics for Aggregated Weighted Refined Scales at the Team Level of Analysis (Continued)

	9	10	11	12	13
(1) Uncertainty	.194	-.431*	-.106	-.359	.266*
(2) Complexity	.200	-.418	-.175	-.334	.282
(3) Cross-training	-.457*	.179	-.760**	.542*	-.220
(4) Stability	.071	-.391	.276	.014	-.036
(5) Experience with Teams	-.150	-.249	-.214	.276	-.165
(6) Equipment	-.128	.141	-.002	-.152	.303
(7) Task	.042	-.589**	-.135	-.412	.222
(8) Team	.327	-.039	.214	-.122	-.050
(9) Routine		-.070	.245	.054	-.010
(10) Non-routine			-.121	.383	-.571**
(11) Flexibility				-.216	-.228
(12) Quality					-.470*
(13) Communication					
(14) Planning					

	14
(1) Uncertainty	.306
(2) Complexity	.363
(3) Cross-training	-.047
(4) Stability	.060
(5) Experience with Teams	.236
(6) Equipment	.309
(7) Task	.290
(8) Team	-.004
(9) Routine	-.005
(10) Non-routine	-.501*
(11) Flexibility	-.138
(12) Quality	-.214
(13) Communication	.399
(14) Planning	

Variables/scales remaining after the initial analyses having demonstrated appropriate aggregation of the measure to the team level, were then subjected to several other tests to further assess the appropriateness of the aggregation to the team level. These tests were based upon the work of Dansereau, Alluto, and Yammarino (1984) which indicated that reliability measures are not sufficient to establish the existence of a team level construct when its measurement is conducted at the individual level of analysis. Their work detailing Within and Between Analysis

(WABA) offers a statistical and inferential process through which the appropriateness of aggregation to the team level of analysis may be assessed. Specifically each bivariate pair was analyzed in order to determine if the correlation based on between-team differences was significantly different from zero and significantly different from the correlation based on within-team differences. Appropriateness of aggregation was demonstrated by satisfaction of these criteria for the variables presented below in Table 19.

Table 19: Variables Demonstrating Appropriate Aggregation to the Team Level

Relationship	Dependent Variable	Independent Variable
Determinants to Shared Mental Model Facets	Task Facet	Stability Uncertainty Complexity
	Team Facet	Uncertainty
	Routine Facet	Cross-training
	Non-routine Facet	Uncertainty Complexity
Shared Mental Model Facet to Team Task Behavior	Quality	Task Facet
	Communication	Non-routine
	Planning	Non-routine
Determinants to Team Task Behaviors	Flexibility	Cross-training
	Quality	Cross-training

Descriptive statistics (i.e., means and standard deviations) for final weighted scales at the team level of analysis (J = 17) are provided below in Table 20.

Table 20: Descriptive Statistics for Final Scales at the Team Level of Analysis

Scale	Mean	Standard Deviation
Uncertainty	2.872	.366
Complexity	3.538	.427
Cross-training	.832	.194
Stability	.434	.434
Experience with Teamwork	3.843	.984
Equipment Facet	4.083	1.391
Task Facet	24.741	2.697
Team Facet	25.178	7.668
Routine Facet	2.938	.492
Non-routine Facet	2.062	.272
Flexibility	2.697	.827
Quality	81.198	13.032
Communication	3.995	.325
Planning	3.161	.615

<u>Regression Analysis Results for Shared Mental Models as the Criterion Variable</u>

The first set of regression analyses was designed to investigate the research question regarding which factors affect (i.e., increase or decrease) the extent of overlap in a team's shared mental model of skill use. Thus, the first set of regression analyses conducted tested the relationship between facets of shared mental model components and their determinants. As indicated in Table 20, aggregation to the team level was appropriate for only four sets of relationships. Thus, only four regressions were justified. Aggregation to the team level was appropriate for two of the knowledge facets of the shared mental model, task and team and for both the routine and non-routine facets of the behavioral expectation component. Aggregation to the team level was not appropriate for either facet of the attitude component of the shared mental model. The results of these four regressions are presented in Tables 21 through 24 below.

Table 21 below presents the results of the regression for the task facet as the criterion variable and determinants as the independent variables (J = 17). The multiple *R* for this equation was .826 which accounted for 63.8% of the variance in the criterion variable (F = 10.032; p <

.01). These results indicate that this model explained a large amount of variance in the predictor variable and generated three significant predictors. Thus, three significant relationships were demonstrated between stability, uncertainty, and complexity and overlap in the task facet of the shared mental model. However, two of the three significant relationships, uncertainty and complexity, were in the opposite direction than hypothesized as negative relationships were expected. Greater stability of team membership resulted in increased overlap in the task facet as was predicted while increased uncertainty and complexity of the technology resulted in decreased overlap in the task facet contrary to the prediction.

Table 21 Regression Model
Criterion Variable - Task Facet of the Shared Mental Model

Variable	Regression Coefficient (*b*)	Beta Weights (ß)	t	Significance
CONSTANT	9.094		10.220	
STABILITY	2.044	.351	7.757	.01
UNCERTAINTY	1.378	.215	2.672	.01
COMPLEXITY	3.062	.501	6.456	.01

The results of the regression for the team facet as the criterion variable and determinants as the independent variable are presented below in Table 22 (J = 17). The multiple *R* for this equation was .427 which accounted for 18.2% of the variance in the criterion variable (F = 3.558; n.s.). These results indicate a significant relationship between uncertainty and overlap in the team facet of the shared mental model. However, the sign of the beta weight for the significant predictor variable was in the opposite direction than was hypothesized as a negative relationship was expected. Thus, increased uncertainty in the technology resulted in increased overlap in the team facet of the shared mental model contrary to the prediction.

Table 22 Regression Model
Criterion Variable - Team Facet of the Shared Mental Model

Variable	Regression Coefficient (*b*)	Beta Weights (ß)	t	Significance
CONSTANT	-9.786		-1.835	
UNCERTAINTY	12.323	.427	6.310	.05

The regression results for the analyses of the routine facet as the criterion variable and determinants as the independent variable are presented in Table 23 (J = 17) below. The multiple *R* for this equation was .457 which accounted for 20.9% of the variance in the criterion variable (F = 4.216; n.s.). These results indicate that a significant relationship was found between cross-training and overlap in the routine facet of the shared mental model. However, the sign of the beta weight indicates that this relationship was in the opposite direction than hypothesized as a positive relationship was expected. Thus, the greater the cross-training of the team the less its overlap in the routine facet.

Table 23 Regression Model
Criterion Variable - Routine Facet of the Shared Mental Model

Variable	Regression Coefficient (*b*)	Beta Weights (ß)	t	Significance
CONSTANT	3.817		30.079	
CROSS-TRAINING	-1.033	-.457	-6.868	.05

Regression results are presented below in Table 24 for the analyses investigating the non-routine facet as the criterion variable and determinants as the independent variables (J = 17). The multiple *R* for this equation was .445 which accounted for 19.8% of the variance in the criterion variable (F = 1.848; n.s.). These results indicate that a significant relationship did exist for uncertainty as a predictor variable, but that the relationship between complexity and the non-routine facet was significant. The sign of the beta weight indicates that the relationship between uncertainty and overlap in the non-routine facet was in the hypothesized negative direction was expected. Thus, increased uncertainty of the technology resulted in decreased overlap in the non-routine facet of the shared mental model.

Table 24 Regression Model
Criterion Variable - Non-Routine Facet of the Shared Mental Model

Variable	Regression Coefficient (*b*)	Beta Weights (ß)	t	Significance
CONSTANT	3.029		19.857	
UNCERTAINTY	-.187	-.270	-2.250	.05
COMPLEXITY	-.129	-.195	-1.622	n.s.

Overall, the regression results for research question number one indicate that significant predictors were obtained for two facets of the knowledge component and both facets of the behavioral expectation component of the shared mental model. No significant predictors were obtained for either facet of the attitude component of the shared mental model. Of the six significant relationships, four were in the opposite direction than was hypothesized.

Regression Analysis Results for Team Task Behaviors as the Criterion Variable

The second set of regression analyses was designed to investigate the research question regarding the outcomes of increased overlap in a team's mental model of skill use. Thus, the second set of regression analyses conducted tested the relationship between extent of overlap in shared mental model facets and their outcomes in terms of team task behaviors. As indicated in Table 20, aggregation to the team level was appropriate for three out of the four team task behaviors. Therefore, three regressions were justified. The results of these regressions are presented in Tables 25 through 27 below.

Table 25 below presents the results of the regression analysis for quality as the criterion variable and shared mental model facets as the independent variable (J = 17). The multiple *R* for this equation was .412 which accounted for 17.0% of the variance in the criterion variable (F =

3.267; n.s.). A significant predictive relationship was not found for the relationship between the task facet of the shared mental model and the quality team task behavior.

Table 25 Regression Model
Criterion Variable - Quality Team Task Behavior

Variable	Regression Coefficient (*b*)	Beta Weights (ß)	t	Significance
CONSTANT	122.204		17.407	
TASK FACET	-1.663	-.412	-5.752	n.s.

The results of the regression analyses for communication as the criterion variable and shared mental model facets as the independent variable are found below in Table 26 (J = 17). The multiple *R* for this equation was .571 which accounted for 32.6% of the variance in the criterion variable (F = 7.725; p<.05). These results indicate a significant relationship between overlap in the non-routine facet of the shared mental model and amount of verbal communication. The sign of the beta weight for the significant relationship was in the hypothesized negative direction. thus, the greater the overlap in the non-routine facet of the shared mental model the less verbal communication among teammates.

Table 26 Regression Model
Criterion Variable - Communication Team Task Behavior

Variable	Regression Coefficient (*b*)	Beta Weights (ß)	t	Significance
CONSTANT	5.191		39.159	
NON-ROUTINE	-.587	-.571	-9.296	.01

The results of the regression analysis presented below in Table 27 are for planning as the criterion variable and shared mental model facets as the independent variable (J = 17). The multiple *R* for this equation was .501 which accounted for 25.1% of the variance in the criterion variable (F = 5.366; p<.05). These results indicate a significant relationship between overlap in the non-routine facet of the shared mental model and the amount of time spent in planning activities. The sign of the beta weight for the significant relationship was in the hypothesized negative direction. Thus, the greater the overlap in the non-routine facet of the shared mental model the less time spent by the team in task planning activities.

Table 27 Regression Model
Criterion Variable - Planning Team Task Behavior

Variable	**Regression Coefficient (*b*)**	**Beta Weights (ß)**	**t**	**Significance**
CONSTANT	4.506		22.788	
NON-ROUTINE	-.730	-.501	-7.748	.05

Inspection of these results reveals that significant predictive relationships existed for two of the four team task behaviors. Both of the significant relationship were in the direction predicted.

Regression Analysis Results for Team Task Behaviors as the Criterion Variable

The third set of regression analyses performed tested the relationship between the chosen set of determinants and their outcomes in terms of team task behaviors. As discussed in Chapter 3, this set of analyses was performed as an additional test of the explanatory power of shared mental models. These analyses are useful because they allow comparison between the full model that includes shared mental models as an explanatory mechanism and one that does not, so that the contribution of shared mental models to the outcome variables (i.e., team task behaviors) can be further assessed. As indicated in Table 20, aggregation to the team level of analysis was appropriate two of the four team task behaviors. Therefore, two regressions were justified. The results obtained are presented below in Tables 28 and 29.

Table 28 below provides the results of the regression for flexibility as the criterion variable and determinants as the independent variable (J = 17). The multiple *R* for this equation was .760 which accounted for 57.7% of the variance in the criterion variable (F = 21.858; p<.01). These results indicate a significant relationship cross-training and flexibility. The sign of the beta weight for the significant relationship was in the opposite direction than was expected. Thus, the more cross-training the team, the less flexibly it utilizes its skills in task performance.

Table 28 Regression Model
Criterion Variable - Flexibility Team Task Behavior

Variable	Regression Coefficient (*b*)	Beta Weights (ß)	t	Significance
CONSTANT	5.171		32.236	
CROSS-TRAINING	-2.974	-.760	-15.638	.001

The results of the regression analysis using quality as the criterion variable and determinants as the independent variable are presented below in Table 29 (J = 17). The multiple *R* for this equation was .542 which accounted for 29.4% of the variance in the criterion variable ($F = 6.659$; $p<.05$). These results indicate a significant relationship between the cross-training and quality. The sign of the beta weight for the significant relationship was in the direction that would be expected. Thus, the more cross-trained a team, the higher the quality of its performance.

Table 29 Regression Model
Criterion Variable - Quality Team Task Behavior

Variable	Regression Coefficient (*b*)	Beta Weights (ß)	t	Significance
CONSTANT	55.416		16.783	
CROSS-TRAINING	32.140	.542	8.211	.001

Inspection of these results indicates that in two cases, determinants were good predictors of team task behaviors. The purpose of these analyses was a comparative one. These analyses were performed as an additional test of the explanatory power of shared mental models to predict team task behaviors. It appears from the results that in the case of quality, the determinant cross-training displayed the best predictive relationship. Similarly, flexibility was best predicted by a determinant, cross-training. However, the relationship was not positive as expected, but rather was negative such that increased cross-training actually led to decreased flexibility.

In order to assess the possibility of multicollinearity, variance inflation factors were inspected. Variance inflation factors represent the influence each regression coefficient experiences above an ideal. It is generally accepted in the literature that variance inflation factors exceeding ten are reason for concern (Myers, 1986). Inspection of variance inflation factors indicates that multicollinearity was not an issue in the current study as all variance inflation factors were well below the acceptable level.

Descriptive Statistics Regarding Team Flexibility

The last set of analyses conducted was designed to address the practical question of the extent to which cross-trained teams actually utilized the full range of their cross-trained member's skills. Overall, team members in this facility were cross-trained in an average of 3.54 skill blocks for their current teams. Team members, on average, were certified for 2.18 skill blocks outside their current team, which reflected movement of individuals through the eight production areas and types of teams in this plant. On average, employees reported that they used 2.58 skill blocks for their current team per shift and 2.98 skill blocks for their current team per week. Employees reported that they switched skill blocks for their current team 2.29 times per shift and 2.43 times per week on average. Furthermore, team members indicated that they switched to skill blocks they were certified in for other teams an average of 1.59 times per shift. Surprisingly, team members reported that they used an average of 1.55 skill blocks per shift for their current team in which they are not certified and that they used an average of 1.28 skill blocks per shift from other teams in which they are not currently certified.

One way ANOVAs were performed in order to determine if there were significant differences between teams with respect to the extent to which they used their skills and switched between skill blocks. Specifically, ANOVAs were performed to test for differences between teams with respect to five variables: the number of skill block certifications within a team, the number of skill blocks used per shift and per week and the number of skill block switches per shift and per week. The ANOVA results are presented below in Table 30.

Table 30: ANOVA Results for Skill Use Differences Between Teams

Variable		Sum of Squares	df	Mean Square	F	Sig.
Skill Block Certifications	Between Groups	55.300	17	3.253	2.597	.001
	Within Groups	197.882	158	1.252		
	Total	253.182	175			
Skill Block Use per Shift	Between Groups	31.803	17	1.871	1.638	.060
	Within Groups	181.565	159	1.142		
	Total	213.367	176			
Skill Block Switches per Shift	Between Groups	35.773	17	2.104	2.260	.005
	Within Groups	149.936	161	.931		
	Total	185.709	178			
Skill Block use per Week	Between Groups	55.942	17	3.291	2.739	.001
	Within Groups	191.007	159	1.201		
	Total	246.949	176			
Skill Block Switches per Week	Between Groups	52.949	17	3.115	2.652	.001
	Within Groups	189.062	161	1.174		
	Total	242.001	178			

Inspection of these results indicates that there were statistically significant differences between teams with respect to number of skill block certifications, number of skill block switches per shift, skill blocks used per week, and skill block switches per week between teams. Post hoc Tukey's tests were performed in order to determine which teams were significantly different from each other in terms of these variables. With respect to number of skill block certifications, two hot end teams differed from two cold end teams ($p<.033$ and $p<.001$) and one cold end team differed from a maintenance team ($p<.004$). With respect to number of skill blocks used per shift, one hot end team differed from one maintenance team ($p<.019$). With respect to skill block switches per shift, two hot end teams differed from the same maintenance team ($p<.015$ and $p<.004$) and from the same stores teams ($p<.033$ and $p<.010$) respectively. With respect to number of skill blocks used per week, two hot end teams differed from the same maintenance team ($p<.001$ and $p<.013$), two cold end teams differed from each other ($p<.023$), and one cold end team differed from a maintenance team ($p<.001$). With respect to the number of skill block switches per week, three hot end teams differed significantly from one maintenance team ($p<.005$, $p<.005$, and $p<.025$), two hot end teams differed significantly from the same stores team ($p<.016$ and $p<.014$) and one cold end team differed from a maintenance team ($p<.020$). These results demonstrate that four different types of teams from four different production areas in the facility differ significantly in terms of how they used their skill blocks and the frequency with which they switch between skill blocks.

As detailed in Chapter 3, one of the main outcome measures in this study was the flexibility index. To reiterate, the flexibility index is:

$$\frac{\Sigma \text{ Average skill block switches} \div \text{Number of team members}}{\text{Cross-Training Index}}$$

Where the cross-training index is:

$$\frac{\text{Number of skill block certification within team}}{(\text{Number of team members x Number of available skill blocks})}$$

The larger a team's score on the flexibility index, the more flexibly it used its skills. Information was collected from team members regarding the number of times they switched skill blocks both per shift and per week. The flexibility indices indicated that teams switched skill blocks an average of 2.73 times per shift and 3.01 times per week. The minimum flexibility index when calculated for shift switches was 1.73 while the maximum was 5.0. Fifteen percent of teams switched skill blocks less than twice per shift on average. Fifty-five percent switched skill blocks between two and three times per shift on average. Twenty-five percent of teams switched skill blocks between three and four times per shift on average. Five percent of teams switched skill blocks five times per shift on average.

The minimum flexibility index when calculated with weekly switches was 1.54 while the maximum was 5.0. Fifteen percent of teams switched skill blocks less than twice per week on average. Thirty-five percent of teams switched skill blocks between two and three times per week on average. Thirty percent switched skill blocks between three and four times per week on average. And, twenty percent of teams switched skill blocks between four and five times per week on average.

These analyses indicate variability between teams with respect to their use of members' skill blocks. Furthermore, these results indicate that the organization was not receiving the full return on its training investment as many teams were not fully utilizing the skills of their members. This was evidenced by the low rate of switching between skill blocks. This research can not, however, provide insight into why teams utilized their skills with differing degrees of flexibility.

This chapter has presented the results of the statistical analyses. Chapter 5 summarizes these results, draws conclusions based on them, and examines their implications.

Chapter 5: Summary And Conclusions

This chapter summarizes the results of this research and attempts to draw conclusions from those results. Limitations of this research are presented. Also included in this chapter are suggested extensions and refinements based on this research.

<u>Research Questions</u>

<u>Research Question 1</u>

The first research question asked: "Which factors affect the extent of overlap in a team's mental model of skill use?" The model presented in Chapter 1 proposed that six variables would affect the extent of overlap in a team's mental model of skill use: interdependence, uncertainty, and complexity of technology; cross-training; team stability; and experience with teamwork. Interdependence, cross-training, team stability, and experience with teamwork were hypothesized to increase the extent of overlap in facets while uncertainty and complexity were hypothesized to decrease the extent of overlap in facets.

Results of preliminary analyses to assess the appropriateness of aggregation to the team level indicated that two determinants, interdependence and experience with teamwork, could not be aggregated to that level. So, these variables were dropped from further analyses. Furthermore, these analyses indicated that aggregation was also inappropriate for the team interaction facet of the knowledge component and for both the collective orientation and collective efficacy facets of the attitude component of the shared mental model. Again, these variables were dropped from further analyses because the team level of analysis did not produce valid results. This was due to the statistical distribution within teams which suggested that another level of analysis would have been appropriate for these variables. Additional tests regarding the appropriateness of aggregation to the team level further pared down the variable set for use in the regression analyses. The regression results demonstrated that significant relationships existed between determinants and degree of shared mental model overlap for each of the four remaining facets.

Specifically, stability of team membership was found to enhance overlap in the task facet of the shared mental model, while both uncertainty and complexity of the technology were found to decrease overlap in that facet. As expected, the results demonstrated that teams whose membership was stable were more likely to have significant overlap in their model of the task. This was likely the case because they had greater opportunity to jointly form and share their mental models of the task. Surprisingly, however, the significant relationships between aspects of technology and overlap in the task facet were opposite of those predicted. Thus, the data did not bear out the expected negative relationships between uncertainty and complexity and the task facet. The logic underlying these hypothesized relationships was that both uncertainty and complexity of the technology would necessitate increasingly complex shared mental models, which, in turn, would be increasingly difficult to jointly form or share. The data indicates, however, that both uncertainty and complexity, in fact, increased the degree of overlap in teammates' models of their task. A viable explanation for these relationships is not counterintuitive, however. It is possible that both uncertain and complex technologies actually drove teammates to interact more and, therefore, increased the extent of overlap in the task facet.

Significant relationships were also found for both facets of the behavioral expectation component of the shared mental model. Interestingly, cross-training was found to have a negative impact on overlap in the routine facet of the shared mental model. Thus, increasing levels of cross-training actually resulted in decreased overlap in the routine facet. Cross-training should have resulted in teammates having a greater opportunity to jointly form and share expectations for routine situations. However, this was not the case. The logic underlying the hypothesized positive relationship was, perhaps, incomplete. The hypothesized positive relationship assumed that team members would view their cross-training experience as a positive one and their trainer as a "mentor" from whom information and experience could be gained. It is possible, however, that team members did not view their cross-training experience as a positive one. Furthermore, it is possible that once trained, they came to view themselves as more knowledgeable than their trainers and thereby, undertook the development of new models rather than the adoption or adaptation of those taught to them.

Uncertainty also emerged in a significant relationship with the non-routine facet of the behavioral expectation component of the shared mental model. Thus, the greater the degree of uncertainty in the team's technology, the less overlap there was among teammates' shared mental models for non-routine situations. Unlike the relationship between uncertainty and the task and team facets, however, the relationship between uncertainty and the non-routine facet was negative as expected. Thus, uncertainty appeared to erode sharing of the mental model for non-routine situations as had been expected.

Note that aspects of the technology (i.e., uncertainty and complexity) were significant predictors for three of the four shared mental model facets. Uncertainty emerged as an especially important variable with respect to shared mental model overlap for both knowledge and behavioral expectation facets.

<u>Research Question 2</u>

The second research question asked: "Does the extent of overlap in a team's mental model of skill use affect team behavior in task performance?" The model presented in Chapter 1 proposed that overlap in the facets of the shared mental model of skill use would affect four team task behaviors: flexibility, quality, communication and planning. Overlap in the shared mental model facets was hypothesized to have a positive effect on flexibility and quality. Conversely, overlap was predicted to have a negative effect on communication and planning.

Results of preliminary analyses to assess the appropriateness of aggregation to the team level indicated that the two team task behaviors not defined at the team level, communication and planning, could be appropriately aggregated to that level. The remaining two team task behaviors were defined at the team level of analysis so aggregation to that level was appropriate by definition. Additional tests regarding the appropriateness of aggregation to the team level further pared down the variable set for use in the regression analyses. The regression results demonstrated that significant relationships existed for only two of the team task behaviors, communication and planning.

Specifically, regression analysis results demonstrated that no significant relationships were found between overlap in the four shared mental model facets (i.e., task, team, routine, and non-routine) and the quality team task behavior. However, the non-routine facet was significantly negatively related to verbal communication among teammates as was hypothesized. Thus, greater overlap in the non-routine facet resulted in decreased verbal communication. This demonstrates, then, that when teammates shared the model for non-routine situations, communication was not necessary, because they knew what to expect of each other and the situation they faced as had been predicted. The non-routine facet also emerged in a significant relationship with the planning team task behavior. As was the case with communication, a negative relationship was demonstrated as had been expected. Thus, the greater the degree to which teammates shared the model for non-routine situations, the less time they spent in planning activities. Again, the logic is the same. Planning activity was unnecessary in the face of a shared model. It is interesting to note the presence of these two relationships in comparison to the absence of such relationships for the routine facet of the shared mental model. It would seem intuitive that communication and planning would more likely be unnecessary in the face of shared models for routine situations. This was not borne out by the data, however.

Alternative Model of Team Task Behaviors

The final set of analyses to test the proposed model was performed as an alternative test of the explanatory power of shared mental models. This set of analyses tested the relationship between the determinants (i.e., uncertainty, complexity, cross-training, and team stability) and the team task behaviors (i.e., flexibility, quality, communication, and planning). Essentially, these results are interpretable only in comparison to the analyses of the relationship between overlap in shared mental model facets and team task behaviors.

Results of these regression analyses reveal significant relationships for two team task behaviors: flexibility and quality. Specifically, a significant negative relationship was found between cross-training and flexibility. This finding is quite counterintuitive. The fundamental notion underlying cross-training systems is that teams, once cross-trained with utilize their multiple redundant skills. These results indicate that the more cross-trained a team, the less likely it was to flexibly use its skills. In other words, the more skills the team's members were trained in, the fewer they actually used. This would suggest that the organization was not receiving an adequate return on its investment in cross-training, because team members were not using the range of skills for which they had been trained. This might furthermore suggest that members cannot actually utilize multiple skills or that, perhaps, maximal cross-training (i.e., training each member in all skill blocks available) is not the optimal configuration for a cross-training system. Alternatively, these results might suggest that team members simply favor one skill block over another and exercise this preference. In either case, the assumption that members fully used their skills was not supported.

Cross-training also emerged in a significant relationship with the quality team task behavior. Specifically, cross-training was positively related to quality as was expected. Thus, the greater the extent of a team's cross-training, the higher the quality of its performance. These results indicate that having multiple skills definitely improves quality. Coupled with the relationship between cross-training and flexibility, this finding is interesting. The data indicates that teams are not fully utilizing their skills flexibly, but that having multiple skills improves the quality of their performance. An additional assumption underlying cross-training is that employees will have improved knowledge and, therefore, problem solving skills. It is probable that this improved knowledge and problem solving skills had the benefit of improving a team's performance. So, while team members may not have used their skills, the additional knowledge gained through cross-training did appear to improve quality. This is an important finding because it indicates that one potential avenue for quality improvement is the cross-training of employees. This has major implications for those organizations in pursuit of improved quality.

Overall, the results of the alternative model test are interesting because the alternative model demonstrated significant relationships for the two team task behaviors (i.e., flexibility and quality) for which the full model including shared mental models did not. Conversely, the full model demonstrated significant relationships for the two team task behaviors (i.e., communication and planning) for which the alternative model did not. Thus, it appears that shared mental models have explanatory power for some team task behaviors, but not others.

Flexibility

The last set of analyses performed was designed to address the practical question of the extent to which cross-trained teams actually utilize the full range of their cross-trained member's skills. The underlying notion was that teams were likely to have differing degrees of skill use and differing extents to which they switched between skill blocks. The results of these analyses suggest that this was the case. Up until this point, is has been assumed in the literature that once cross-trained, teams actually utilized their multiple redundant skills. These results demonstrate that this assumption may be fallacious. Furthermore, it indicates that organizations might have to find ways to monitor skill use and rotation to ensure that they receive an adequate return on their investment in cross-training. It might further indicate that organizations may have to actively address skill block use and rotation in order to ensure not only an adequate return on their training investment, but that they receive the maximum benefit from cross-training in terms of its other advantages (e.g., increased quality of solutions to problems, ability to address absenteeism, decreasing the impact of fatigue and boredom etc.)

Advantages and Limitations

The site yielded both advantages and disadvantages for this research. Conducting this research in a single site addressed Goodman, Ravlin, and Schminke's (1987) call for idiographic research within a single technological context. Thus, it allowed for isolation of the phenomena of interest. This, in turn, enhanced control and eliminated internal threats to validity, which often occur in multi-site research. Furthermore, since the plant was designed as an autonomous work team plant, it was reasonable to assume that system characteristics (e.g., cross-training, compensation, information, and appraisal systems) that would vary across organizations in a multiple site study were held constant and, therefore, had a uniform impact on the phenomena of interest. This site provided the unique advantage of multiple teams (across seven different functional areas) which rotated skills on a varied basis. This allowed for multiple comparisons that the typical organization with one type of team would not. Thus, the teams were comparable with respect to variable reflecting organizational policies and practices. Additionally, this site provided an advantage in terms of sample size. Most studies that investigate phenomena at the team level suffer from very small sample sizes. This site provided the opportunity to study up to eighteen teams which was a large sample size relative to the norm in this type of empirical investigation.

This study suffers from several potential limitations. First, given the small sample size (i.e., relative to traditional studies), statistical power may simply have been too low to detect significant relationships and effects. The second potential limitation is the low Cronbach's reliability coefficients of some of the measures. While not as high as would be desirable, none is fatally low. Low reliability is likely due to the fact that most of the measures utilized in the study were developed for this research. Additionally, refinement of measures based on these results and other tests would likely improve reliability coefficients. Any inferences made based on the study's results should be made cautiously. The final potential limitation reflects the non-random nature of the sample. Generalization of results to other organizations should be made cautiously as the representativeness of the sample could be debatable.

Suggestions for Future Research

As stated in Chapter 3, this research was a theory-guided, exploratory effort. It was designed to facilitate theory building and refinement of measures. In this respect, this research has been successful as it has suggested many possibilities for future research. Replications of the current study would be most helpful as a means to determine if the counterintuitive findings (i.e., the direction of hypothesized relationships) are generalizable to other settings and other types of teams. In this regard, qualitative work might prove quite useful, as it would allow investigation of the nature and direction of these relationships in a more in depth manner. Replication would also add credence to the notion that it is possible to assess shared mental model overlap with general measures and would thus, demonstrate the generalizability of the measures used herein. Further investigation of the facets of shared mental models of skill use would greatly advance the current state of the literature as well. Future work into other specific shared mental model facets is also called for. Additional variables of interest in future studies might include: trust in teammates, team citizenship behavior, quality of past teamwork experiences, reaction to cross-training, authoritarianism, opportunity to use skill blocks, preference for specific skill blocks, and personality. By the same token, future research investigating other outcomes of overlap in shared mental models would be useful. Future research on larger samples would also be helpful. From a practical perspective, these findings indicate that team members are not maximally using the full extent of the skills they have acquired through cross-training. Further investigation of how and why teams use their skills would have both practical and theoretical significance.

This research has demonstrated both practical and theoretical importance of examining precursors of team performance. Specifically, this research demonstrated that aspects of technology played an important role in the formation of shared mental models as did the stability of the team's membership. Furthermore, it demonstrated that shared mental models and cross-training were important precursors to advantageous outcomes such as quality in team-based systems. This research also addressed practical questions regarding skill use and desirable team task behaviors. By lending credence to the notion that shared mental models do exist and that they have an impact on team task behaviors, this research has shed some light into the "black box" of synergy that is central to so many models of team performance and effectiveness.

Appendix A: Hot End Team Position Responsibilities

1) Batch Operator Duties and Responsibilities:

- Monitors batch so it conforms to specified standards.
- Monitors automatic weighting of batch and makes necessary corrections.
- Monitors scales as batch is unloaded into mixer.
- Monitors scales as batch is unloaded into check scale.
- Removes improperly mixed batches from the system.
- Runs system manually until autonomic system can be repaired.
- Checks all equipment to insure proper performance.
- Maintains log book of all problems.
- Maintains record of all batches run, good and bad.
- Monitors and records raw material levels.
- Maintains a clean work area.
- Reports all problems to supervisor.
- Assists in areas where necessary during an emergency.

2) Furnace Operator Duties and Responsibilities:

- Records temperatures from temperature recorders and indicators on a daily log according to pre-determined schedule.
- Makes necessary changes to fuel and air flow to maintain desired furnace temperatures.
- Check temperatures with portable radiation pyrometer in accordance with spot and checking time schedule.
- Checks operation of automatic control of furnace pressure.
- Checks pressure of furnace and working end.
- Makes adjustments for furnace and working end pressure.
- Checks burners and makes necessary adjustments (i.e., checks flame geometry).
- Follows standard procedures in the event of an emergency, such as a power or fuel failure, knows the manual procedure to reverse fuel and combustion air.
- After each reversal, checks to make sure all burners are firing.
- Monitors glass level and batch charger to maintain proper glass level.
- Verifies automatic glass level indicator by means of manual glass level site.
- Monitors batch and foam line in melter.
- Checks all equipment in basement, at stack and cooling tower at least twice per shift.
- Checks all water cooled equipment and water temperature at least twice per shift. Including:
  - Doghouse cooler
  - Waist cooler
  - Stirrers
  - Hairpin coolers
  - Coaxial coolers

    - Waist arch support steel
- Maintains sufficient water level in cooling tower.
- Makes routine furnace inspection for hot spots, leaks (both atmosphere and glass), at least twice per shift.
- Keeps work area clean.
- Reports all instrument variations or failures to supervisors.
- In case of an emergency, assists where necessary.

3) Tin Bath Operator Duties and Responsibilities:

- Maintains control over ribbon spread, width, thickness and pull.
- Maintains control of top-roll machines including speed and angle.
- Using television displays in the control room, constantly inspects ribbon for width, position and condition.
- Records all adjustments, incidents, and conditions required.
- During a shutdown, checks installation and maintains operation of gas burners around tweel.
- Regulates the flow of glass into the bath by tweel operation.
- Assists in fence and pusher placement.
- Physically measures width of ribbon at exit end.
- Regularly checks cooling, water flows, bath cooling fans, condition of bath structure and other bath related equipment.
- Regularly checks state of bath seal and re-seals when necessary.
- Maintains communication between cutter and lab personnel.
- Assists in areas where needed in the case of an emergency.
- Keeps work area clean.
- Assists in replacement of bath window.
- Assists in replacement of all bath operating carbons.
- Assists in installation of removal of overhead water coolers.
- Reports all changes and problems to supervisor.
- Records and controls:
    - Tin temperatures
    - Bus bar temperatures
    - Bath casing temperatures
    - Glass temperatures
    - Ribbon width and thickness
    - Lehr speed
    - Atmosphere distribution and flows
    - Atmosphere composition
    - Atmosphere supply pressure
    - Keeps all records of tin depth
    - Adjust bath heat to maintain desired operating temperatures
    - Monitors nitrogen plan conditions
    - Monitors hydrogen tank levels
    - Monitors SO2 flows
    - Monitors bath pressures
    - Monitors bath dew points

- Cleans, places and checks condition of coolers
- Places of fences, pushers, and flags
- Keeps records of dates when they were replaced

4) Lehr Operator Duties and Responsibilities:

- Operates Lehr to anneal the glass ribbon.
- Controls Lehr temperatures within desired ranges.
- Monitors and records Lehr temperatures reporting any deviation to supervisor.
- Checks condition of cooling fans, control motors and linkages.
- Continually monitors Lehr for causes of glass scratches and corrects problems.
- Maintains communication between cutter and lab personnel.
- Monitors condition of cutting glass and responds to splits and crossbreaks.
- Maintains proper SO_2 application.
- Monitors glass with on-line strain gauge and takes corrective action when necessary.
- Keeps Lehr free of broken glass.
- Regulates Lehr temperatures manually when automatic controller fails.
- Assists in areas where needed during an emergency.
- Maintains proper housekeeping.
- Reports all problems to supervisor.

Appendix B: Cutter/Lab Team Position Responsibilities

1) Booth Inspector Duties and Responsibilities:

- Inspects and marks defects on float glass on line according to standards as instructed by QC supervisor.
- Keeps proper inspection limit samples in place and changes them according to glass quality being packed or size changes.
- Performs routine booth counts and audits as instructed by QC supervisor.
- Informs QC supervisor of abnormal conditions in glass, or any noticeable changes in defect level.
- Alternates with other Cutter/Lab Technicians as instructed by QC supervisor.
- Keeps work are clean.
- In case of an emergency, assists where necessary.

2) Line Inspector Duties and Responsibilities:

- Inspects glass on line from cutters through packing stations. Inspection consists of such items as cut conditions, knurl distortion, cutting oil ratio and application, powder application, proper operation of chip blower, static bar and any other condition that affects the quality of the glass.
- Performs size checks, observes on line checks for roll scar, scratches and breakout
- Checks packing for quality such as scratches, digs, and size at packing stations.
- Keeps work area clean.
- In the case of an emergency, assists where necessary.

3) Lab Inspector Duties and Responsibilities:

- Performs laboratory tests to establish base quality such as thickness profile, CRI, sebra and edge bos. Make routine lab calculations and plots graphs.
- Performs additional lab tests as instructed including diaphragm stress, on-line strain and top-speck.
- Keeps work area clean.
- In case of an emergency, assists where necessary.

4) Cutter Operator Duties and Responsibilities:

- Insures glass is cut to proper size and quality.
- Maintains proper cutting wheel air and oil pressure.
- Replaces cutting wheels, axles and heads as necessary.
- Monitors X and Y cutters to maintain proper dimensions.
- Observes quality of cuts and breaks and makes appropriate adjustments to score runners.
- Responds in a timely fashion to size changes by having the next size(s) set up.

- Efficiently coordinates activities with other cutter operators.
- Controls operation of mainline cullet crusher, monitors and operates cullet control panel, and cullet transfer in basement.
- Programs proper sizes for X cutter using keyboard and monitor and manually sets all Y cutters.
- Assists in maintain Oxy-Dry unit and spray-A unit.
- Maintains proper cutting oil ratio and application.
- Keeps and maintains logs and records are required.
- Assists in cutting and removing inspection samples when necessary.
- Operates Siemplekamp machine.
- Maintains open lines of communication from cutter/lab to cold end and hot end.
- Stays mentally alert to surroundings and aware of location of E-stops and conveyor section of line.
- Keeps work area clean.
- Adheres to safety rules and regulations.
- Assists where necessary in case of an emergency.
- Reports problems to supervisor.

Appendix C: Cold End Team Position Responsibilities

1) Fork Lift Operator Duties and Responsibilities:

- Operates boom truck, fork truck, overhead cranes and tugger to move glass, cases, and racks.
- Obtains and keeps supply of containers on hand and set up for packing (minimum of two hour supply)
- Responsible for keeping empty cases/racks in department properly stored.
- Positions empty containers on line where required for efficient packing.
- Inspects containers for proper construction and repairs as necessary.
- Installs proper lining in containers in preparation for packing.
- Removes glass from line and repositions in re-packing or closing area in an orderly manner.
- Assists in re-packing as necessary.
- Removes properly packaged glass from closing area to prescribed warehouse zone.
- Assures glass quality is maintained from closing area to warehouse.
- Fills out mobile equipment PM sheets as required.
- Responsible for maintenance and charging of batteries in battery room, including keeping logs of all batteries used.
- Keeps work area clean.
- Adheres to safety rules and regulations.
- Assists where necessary in case of an emergency.
- Informs supervisor of problems.

2) Glass Packer Duties and Responsibilities:

- Positions and prepares empty containers for packing.
- Inspects containers for proper construction and makes repairs as necessary.
- Packs glass from line to appropriate containers without creating any packing defects.
- Counts lites in all containers and applies interleaving as required.
- Performs final inspection of glass by visually checking glass for obvious defects such as chips, scratches, cutting defects, and marked defects.
- Informs supervisor of glass quality problems.
- Assists in re-packing as necessary.
- Operates Zim-air (handling and packing machine).
- Keeps work area clean.
- Assists where necessary in case of an emergency.
- Adheres to all safety rules and regulations.

3) Case Closer Duties and Responsibilities:

- Operates auxiliary glass packing equipment.

- Operates shaker/up-ender as necessary.
- Prepares, closes and bands packed glass in containers or on racks for shipping per specifications.
- Assists in re-packing as necessary.
- Assures quality of glass in containers before closing and removes defective lites as necessary.
- Uses says as necessary to cut material for closing containers.
- Responsible for keeping adequate closing supplies in work area.
- Keeps work area clean.
- Assists where necessary in case of an emergency.
- Adheres to safety rules and regulations.
- Informs supervisor of problems.

4) Final Inspector Duties and Responsibilities:

- Responsible for glass quality meeting customer specifications before storage in warehouse.
- Visually inspects each container for condition of the glass including cut, ships, scratches, powder application and the case construction, pads, and banding.
- Responsible for glass size corresponding to case and card specifications.
- Maintains lite count to -2 to +5% or as specified.
- Adjusts lite count on case card as necessary.
- Records date, time, packing station, shift, case number, case card number and lite count as required for production log.
- Informs Cold End and Q.C. supervisors of quality problems.
- Assists in re-packing and repairing and closing cases as necessary.
- Adheres to all safety rules and regulations.
- Keeps work area clean.
- Assists where necessary in case of an emergency.

Appendix D: Production Technician's Job Description

In order to perform necessary tasks of production reporting, records keeping, quality inspecting, and timely decision making, all candidates must be capable of performing mathematical calculations (add, subtract, multiply, divide), work fractions and be capable of applying simple algebra and geometry, and read, write, and speak the English language proficiently.

Must have mechanical aptitude to perform minor maintenance on equipment; therefore, knowledge of proper use and application of common hand tools necessary. Besides hand tools, individuals must be capable of operating mobile equipment, overhead cranes, and power tools.

Good health is a requirement as some of the tasks require physical exertion. Individuals must be capable of performing continuous pushing, pulling, raking, sweeping, shoveling, and lifting tasks.

Must be able to work on a continuous moving process line that will require dexterity and timeliness to avoid product loss.

All persons must be willing and active participants in their appropriate work team. This will require learning and practicing good problem solving techniques with the use of statistical process controls. This will also mean participating in on-going safety, educational, and operations training provided through and by the company.

All individuals must follow all safety procedures and standards established. Must also actively pursue good housekeeping practices during daily activities. Therefore, a good housekeeping and safety record in previous employment should have been established.

Candidates must have completed high school or secured a GED accreditation. One year of production oriented experience helpful.

Appendix E: Maintenance Technician's Job Description

Each candidate must be able to read, write, and speak the English language proficiently as this position will require the accurate, legible entry and interpretation of work logs; the ability to read and interpret blueprints, and be an active and willing participant in his/her appropriate work team's training and problem-solving responsibilities.

Good health is a requirement as some of the tasks require moderate to heavy physical exertion. Continuous standing, walking, with considerable climbing, squatting, pulling, bending, carrying, etc. will be required. This work will be somewhat continuous, non-routine and with many variations.

This position will incorporate frequent exposure to water, heat, dirt, oil and/or different weather and climatic conditions.

Each person must be able to perform basic mathematical calculations to include addition, subtraction, multiplication, division, and fractions with the capability of applying simple algebra and geometry.

All individuals will be required to follow all safety procedures and standards established. Therefore, a good housekeeping and safety record in previous employment and/or personal activities should have been established.

A working knowledge of the proper use and maintenance of all hand and power tools will also be a requirements.

Each candidate must meet at least one of the following craft areas with the potential and desire to learn all four:

1. Mechanic/Millwright - Must have completed requirements for an Associate of Applied Sciences in Mechanical Technology with a minimum of two years practical experience or eight years practical experience, in the application of fabrication, installation, repairs, adjustments, and servicing of process equipment including piping.

2. Instrumentation - Must have completed requirements for an Associate of Engineering Technology in Instrumentation Engineering Technology or eight years practical experience performing installations, adjustments, servicing and measuring control devices of both electronic and pneumatic principles of operation. Capable of working from wiring diagrams and other drawings, specifications and instructions. Will be required to take necessary action to restore instrument control loops to proper operating conditions.

3. Welding - Must have completed requirements for an Associate of Applied Science degree in Welding Technology or eight years practical experience in oxy-fuel

cutting/welding, gas metal arc welding, shielded metal arc welding, gas tungsten arc welding, and other processes.

4. Electrical **-** Must have completed requirements for an Associate of Applied Sciences degree in Electrical Technology or eight years practical experience as a maintenance electrician in troubleshooting, repair, installation, and performance of preventive maintenance on motors, controllers, transformers, lighting and internal distribution systems

Candidates must have completed high school or secured GED accreditation. One year of production oriented experience helpful.

Appendix F: Revisions to Questionnaire Items Based on Pilot Study

Task facet of the mental model:

- The items reading "Knowing the requirements for performing my team's task(s)" and "Understanding the procedures for performing my team's task(s)" were combined into a single item that read "Knowing the requirements and procedures for performing my team's task(s)".
- The items reading "Knowing how severe problems might be that may occur as my team performs its task(s)" and "Knowing how urgent problems might be that may occur as my team performs its task(s)" were combined into a single item that read "Knowing how severe and urgent problems might be that may occur as my team performs its task(s)".
- The item reading "Knowing how difficult a task is" was dropped.
- The item reading "Knowing what is needed to complete a task" was dropped.

Equipment facet of the mental model:

- The items reading "Understanding the problems that are likely to occur with my team's equipment" and "Understanding the equipment failures that are likely to occur" were combined into a single item that read "Understanding the problems and failures that are likely to occur with my team's equipment.

Routine Situations:

- An item reading "If one of my teammates doesn't want to do a certain job or use a certain skill block. S/he can generally avoid doing it" was added.
- An item reading "My team tends to let each member do the job s/he is best at" was added.
- An item reading "My team doesn't really encourage members to try out new skills they've been certified in" was added.
- An item reading "I don't generally get to use all of the skill blocks I'm certified in for this team" was added.
- An item reading "If one of our teammates isn't very good in a particular skill block, we generally don't make them use it" was added.

Non-routine Situations:

- The item reading "I only expect my teammates to help me when I've got a really big problems" was rephrased to read " I expect my teammates to help me when I've got a really big problem".
- The item that read "If my teammates aren't busy with their jobs, I expect them to help me out when I need it" was dropped.
- An item reading "I don't expect my teammates to leave what they're doing to help me if my problem is a small one" was added.
- An item reading "I can depend on my teammates to leave what they're doing to help me out if I've got a problem" was added.

- An item reading "Although I expect my teammates to leave what they're doing to help me with a problem, I can't depend on them to do so" was added.

Communication:

- The item reading "In doing our work, my team doesn't communicate much" was dropped.
- The item reading "My team communicates frequently while we work" was rephrased to read "My team communicates frequently about our work while we are working on it."
- The item "My teammates communicate only when there is a problem" was rephrased to read "My teammates don't communicate unless there is a problem with our work".
- The item "My teammates frequently ask questions about doing our work" was rephrased to read "My teammates don't usually ask each other questions about our work".
- The item "When we do communicate while we're working, my teammates do so quickly" was rephrased to read "When we do communicate about our work, my teammates and I do it quickly".
- The item "It doesn't take very long for my team to communicate what it needs to" was rephrased to read "It doesn't take very long for my teammates to let each other know what to do".
- An item reading "My teammates and I communicate frequently at work about non-work related topics like family and hobbies was added.
- An item reading "My teammates and I spend a lot of time communicating about non-work related topics to pass the time while we work" was added.
- An item reading "My teammates and I don't really communicate about non-work related topics while we're on the job" was added.
- An item reading "If my teammates and I are communicating about non-work related topics, we're usually on break or not on the clock" was added.

Planning:

- The item reading " My team spends very little time planning its tasks and activities" was dropped.
- The item reading "My team doesn't need to spend time planning its activities and tasks" was dropped.
- The item reading "My teammates never seem to know what to do, so we have to spend a lot of time planning our tasks and activities" was dropped.
- The item reading "My teammates seem to know what to do and when to do it, so we don't spend much time planning tasks and activities" was rephrased to read "My team's activities are planned for us, so we don't do much planning for ourselves".
- An item reading "When my team needs to plan our tasks and activities, all of my teammates participate in the planning" was added.
- An item reading "My team has a set of plans from past activities and tasks that we can choose from instead of having to set up a new plan" was added.

Appendix G

Table 4: Individual Item Means and Standard Deviations

Item	Mean	Standard Deviation
Shift switch skill blocks	2.29	1.02
Years in other org teams	3.28	1.50
Years in other teams within org	2.13	1.37
Routine1	2.10	1.13
Routine2	2.96	1.24
Routine3	2.97	1.20
Routine4	2.45	1.14
Routine5	3.42	1.18
Routine26	3.42	1.23
Routne27	3.35	1.13
Routine 28	2.39	1.07
Routine 29	2.44	1.32
Routine 210	3.17	1.23
Non-routine26	3.08	1.03
Non-routine2	1.99	1.03
Non-routine3	1.50	.78
Non-routine27	1.73	.74
Non-routine5	3.24	1.23
Non-routine28	4.13	.09
Non-routine29	2.27	1.05
Non-routine210	2.69	1.12
Communication26	3.94	.92
Communication27	3.94	.94
Communication28	4.03	.86
Communication29	2.86	.98
Communication210	2.06	.82
Communication211	4.10	.90
Communication212	3.78	1.06
Communication213	4.10	.82
Communication214	2.33	1.02
Planning1	2.79	1.01
Planning2	3.15	1.14
Planning3	2.18	.95
Planning24	3.09	1.20
Planning25	3.14	1.20
Planning26	2.88	1.00
Collective Orientation1	2.34	1.10
Collective Orientation2	2.07	.95
Collective Orientation3	2.55	1.25

Table 4: Individual Item Means and Standard Deviations (Continued)

Item	Mean	Standard Deviation
Collective Orientation4	2.22	1.05
Collective Orientation5	2.11	.95
Collective Orientation6	1.95	.91
Collective Orientation7	2.47	1.12
Interdependence27	1.91	.99
Interdependence28	1.34	.65
Interdependence29	1.90	.90
Interdependence4	1.96	.82
Interdepednence5	1.95	.83
Interdependence6	2.65	1.11
Uncertainty1	3.41	1.10
Uncertainty2	3.52	1.19
Uncertainty3	2.20	1.08
Uncertainty4	2.13	.88
Complexity1	3.87	1.05
Complexity2	3.21	.96
Complexity3	3.26	1.13
Collective Efficacy1	3.90	1.05
Collective Efficacy2	3.77	1.02
Collective Efficacy3	3.79	1.07
Collective Effiicacy4	3.76	1.02
Collective Efficacy5	4.03	.99
Collective Efficacy6	4.33	.97
Collective Efficacy7	3.89	1.02
Collective Efficacy8	3.08	1.18

Appendix H

Table 5: Inter-Item Correlations

	YRTMORG2	YRAFGTM2	ROUT1	ROUT2	ROUT3
SFTSWTM	-0.02	0.021	-.182(*)	-.186(*)	-0.075
YRTMORG2		0.124	0.047	0.017	-0.079
YRAFGTM2			0.118	0.161	-0.037
ROUT1				.333(**)	0.063
ROUT2					.164(*)

	ROUT4	ROUT5	ROUT26	ROUT27	ROUT28
SFTSWTM	-.204(**)	0.022	0.034	0.006	0.043
YRTMORG2	0.109	-0.206	-0.035	-0.064	-0.006
YRAFGTM2	-0.044	-0.092	-.183(*)	-0.06	0.067
ROUT1	.295(**)	0.055	0.029	0.022	0.075
ROUT2	0.136	-0.125	-0.014	0.04	-0.035
ROUT3	.241(**)	-0.137	.351(**)	.506(**)	.293(**)
ROUT4		-0.034	0.142	0.05	.190(*)
ROUT5			-0.116	-0.079	-0.111
ROUT26				.245(**)	0.091
ROUT27					.249(**)

	ROUT29	ROUT210	NROUT26	NONROUT2	NONROUT3
SFTSWTM	-0.125	0.005	-0.002	-0.084	-0.004
YRTMORG2	0.097	-0.131	-.251(*)	-.234(*)	-0.159
YRAFGTM2	0.031	-0.035	0.044	-.206(*)	0.039
ROUT1	.211(**)	0.122	-0.01	0.071	0.143
ROUT2	0.117	0.035	.177(*)	0.012	-0.006
ROUT3	.269(**)	.332(**)	-0.039	-0.005	0.123
ROUT4	.252(**)	0.123	-0.064	0.032	-0.092
ROUT5	-.299(**)	-.149(*)	.173(*)	0.031	0.081
ROUT26	.162(*)	.285(**)	-0.081	-0.011	0.119
ROUT27	.175(*)	.479(**)	0.008	-0.056	0.007
ROUT28	.357(**)	.369(**)	0.097	0.016	-0.013
ROUT29		.436(**)	-0.081	-0.081	-0.114
ROUT210			-0.059	-0.048	0.04
NROUT26				.190(*)	.273(**)
NONROUT2					.301(**)

	NROUT27	NONROUT5	NROUT28	NROUT29	NROUT210
SFTSWTM	0.103	0.004	0.121	-0.033	-0.091
YRTMORG2	-0.085	0.135	0.103	.224(*)	-0.117
YRAFGTM2	0.051	-0.008	0.126	-0.025	-0.083
ROUT1	0.115	0.026	-.155(*)	0.096	0.048
ROUT2	0.004	0.039	.151(*)	-0.009	-0.019
ROUT3	0.095	0.061	0.071	-0.122	-0.012
ROUT4	-0.054	-0.086	-0.08	0.083	.180(*)
ROUT5	-0.007	0.091	-.162(*)	-0.026	-0.015
ROUT26	0.044	-0.104	0.105	0.139	.196(**)
ROUT27	0.013	0.11	0.091	-.146(*)	-0.049
ROUT28	.164(*)	0.012	0.016	-0.01	0.017
ROUT29	0.119	-0.068	0.077	0.104	0.079
ROUT210	0.14	0.041	0.005	0.081	0.042
NROUT26	.320(**)	-0.084	0.127	0.133	0.052
NONROUT2	.244(**)	-.270(**)	-.156(*)	0.139	0.028
NONROUT3	.548(**)	-0.014	-0.002	0.117	0.049
NROUT27		-0.075	-0.039	.320(**)	0.135
NONROUT5			-0.023	-.216(**)	-0.14
NROUT28				-0.121	-0.014
NROUT29					.374(**)

	COMM26	COMM27	COMM28	COMM29	COMM210
SFTSWTM	-0.006	-0.074	-0.056	-0.019	0.007
YRTMORG2	0.035	0	-0.047	0.106	0.199
YRAFGTM2	0.083	0.003	0.02	-0.082	0.107
ROUT1	-0.068	-0.034	0.055	0.076	.177(*)
ROUT2	0.093	0.13	0.117	0.12	0.003
ROUT3	0.024	-0.087	-0.076	0.072	0.098
ROUT4	-0.018	-0.088	-.156(*)	-0.046	0.088
ROUT5	-0.106	-0.032	0.033	0.025	-0.015
ROUT26	-0.093	-.243(**)	-.172(*)	-0.06	0.021
ROUT27	0.094	-0.037	0.068	0.116	0.003
ROUT28	-0.04	-.214(**)	-0.129	-0.058	0.07
ROUT29	0.043	-0.129	-0.08	-0.02	0.047
ROUT210	-0.016	-.218(**)	-0.111	-0.137	-0.015
NROUT26	-0.072	-0.012	0.016	0.039	-0.032
NONROUT2	-0.092	-0.121	-0.092	-0.05	0.033
NONROUT3	-0.117	-.177(*)	-0.052	-0.031	0.094
NROUT27	-.168(*)	-.151(*)	-.196(**)	-0.075	0.088
NONROUT5	.196(**)	.167(*)	.189(*)	-0.025	-0.04
NROUT28	0.103	0.109	.197(**)	0.072	-0.146
NROUT29	-.301(**)	-.180(*)	-.417(**)	0.027	.169(*)
NROUT210	-0.125	-.161(*)	-.175(*)	-0.122	0.013
COMM26		.377(**)	.250(**)	-0.12	-.202(**)
COMM27			.425(**)	.243(**)	-0.133
COMM28				.177(*)	-0.129
COMM29					.244(**)

	COMM211	COMM212	COMM213	COMM214	PLNG1
SFTSWTM	-0.137	-0.101	-.160(*)	0.09	-0.058
YRTMORG2	-0.04	-0.111	0.073	0.154	0.112
YRAFGTM2	-0.079	-0.12	-0.006	0.111	0.045
ROUT1	0.031	0.033	0.13	-0.106	-0.009
ROUT2	0.054	-0.068	0.01	-0.104	0.026
ROUT3	0.024	0.034	-0.047	-0.019	-0.009
ROUT4	-0.036	-0.006	-0.033	0.022	0.001
ROUT5	-0.04	0.059	-0.112	0.004	-0.016
ROUT26	-0.05	-0.054	-0.03	-0.088	-.172(*)
ROUT27	0.013	0.013	-0.104	0.136	0.099
ROUT28	-0.066	0.064	-.151(*)	0.037	0.028
ROUT29	0.132	0.131	0.11	0.026	-0.041
ROUT210	0.019	0.118	-0.071	-0.084	-0.089
NROUT26	0.021	-0.014	-0.102	-0.026	0.05
NONROUT2	-0.094	-0.116	-0.089	0.048	-0.086
NONROUT3	-.168(*)	-0.14	-0.122	-0.014	-0.036
NROUT27	-0.133	-0.109	-.165(*)	0.012	-.160(*)
NONROUT5	.230(**)	0.108	0.072	-0.068	0.093
NROUT28	0.072	-0.087	0.117	-0.011	-0.09
NROUT29	-.242(**)	-0.107	-.223(**)	-0.14	-.239(**)
NROUT210	-0.051	0.042	-0.057	-0.077	-0.022
COMM26	.304(**)	.177(*)	.154(*)	0.019	0.13
COMM27	.265(**)	.149(*)	.231(**)	-.172(*)	0.139
COMM28	.270(**)	.156(*)	.232(**)	-0.006	.186(*)
COMM29	0.093	0.136	0.086	-.181(*)	0.09
COMM210	-.219(**)	-0.095	0	0.005	-0.141
COMM211		.687(**)	.632(**)	-.342(**)	0.101
COMM212			.536(**)	-.354(**)	0.046
COMM213				-.371(**)	0.042
COMM214					0.083

	PLNG2	PLNG3	PLNG24	PLNG25	PLNG26
SFTSWTM	-0.142	0.129	0.014	0.038	0.094
YRTMORG2	0.033	0.02	0.064	-0.01	-0.074
YRAFGTM2	0.074	0.011	0.106	-0.023	0.001
ROUT1	-0.113	0.106	0.01	0.056	-0.108
ROUT2	-0.053	.150(*)	.169(*)	-0.099	-0.064
ROUT3	-0.004	.269(**)	.176(*)	-0.13	0.143
ROUT4	0.011	0.092	0.014	-0.038	-0.088
ROUT5	-0.023	-0.028	-0.092	0.007	0.048
ROUT26	-.202(**)	0.103	-0.042	.170(*)	0.099
ROUT27	0.028	0.131	0.053	-0.095	-0.003
ROUT28	-0.088	0.11	0.127	0.03	0.094
ROUT29	-0.11	0.122	0.062	0.055	-0.016
ROUT210	-0.052	.164(*)	0.118	0.135	0.025
NROUT26	0.102	0.083	0.124	0.058	-0.05
NONROUT2	-0.064	-0.076	-0.003	-0.003	0.074
NONROUT3	-0.135	-0.041	-0.002	0.111	0.121
NROUT27	-.166(*)	-0.013	-0.028	.205(**)	.183(*)
NONROUT5	0.055	-0.047	0.004	-0.14	-0.089
NROUT28	-0.032	-0.112	-0.037	0.013	-0.057
NROUT29	-.171(*)	-0.001	-0.033	0.141	0.078
NROUT210	-0.136	0.024	-.202(**)	0.079	0.047
COMM26	0.046	-0.043	0.065	-.149(*)	-0.104
COMM27	.184(*)	-0.126	0.079	-0.141	-0.043
COMM28	0.085	-0.019	-0.014	-0.064	-0.067
COMM29	0.045	0.03	-0.003	-.166(*)	0.102
COMM210	-0.071	.242(**)	0.023	0.099	0.123
COMM211	0.127	-0.066	-0.056	-0.004	-.179(*)
COMM212	0.123	-0.044	-0.094	0.003	-0.119
COMM213	0.096	-0.123	-0.032	0.053	-.162(*)
COMM214	0.032	0.027	-0.103	-.226(**)	0.032
PLNG1	.584(**)	0.027	.174(*)	-.345(**)	-.300(**)
PLNG2		0.01	.249(**)	-.210(**)	-.254(**)
PLNG3			.287(**)	.158(*)	0.082
PLNG24				-0.075	0.144
PLNG25					0.121

	CO1	CO2	CO3	CO4	CO5
SFTSWTM	0.019	0.041	-0.107	0.016	0.028
YRTMORG2	-0.097	-0.143	-0.182	0.066	-0.137
YRAFGTM2	0.06	-0.012	.199(*)	0.119	0.112
ROUT1	0.074	-0.001	-0.042	-0.028	0.131
ROUT2	-0.029	-0.081	-0.096	-0.127	-0.06
ROUT3	0.021	-0.046	-0.107	-0.064	0.018
ROUT4	0.082	0.087	-0.092	0.104	0.048
ROUT5	-0.039	0.105	0.084	-0.08	0.05
ROUT26	.170(*)	0.088	-0.081	0.035	.180(*)
ROUT27	-0.089	-.202(**)	-0.013	-0.069	-0.071
ROUT28	0.027	0.033	-0.115	0.009	0.124
ROUT29	0.045	-0.125	-0.09	0.107	-0.064
ROUT210	0.1	-0.079	0.021	0.095	0.144
NROUT26	0.045	0.029	-0.045	-0.14	0.045
NONROUT2	.172(*)	0.09	-0.06	0.109	0.129
NONROUT3	.189(*)	0.108	0.066	-0.03	.233(**)
NROUT27	.219(**)	.170(*)	-0.009	0.118	.220(**)
NONROUT5	-.167(*)	-0.104	0.075	-0.141	-0.075
NROUT28	0.012	-0.143	-.184(*)	-0.024	-0.093
NROUT29	.326(**)	.324(**)	-0.001	.176(*)	.286(**)
NROUT210	.203(**)	0.132	0.002	.154(*)	.148(*)
COMM26	-0.134	-.230(**)	0.074	-0.118	-.323(**)
COMM27	-.253(**)	-0.117	0.007	-.225(**)	-.329(**)
COMM28	-.235(**)	-.247(**)	-0.062	-.162(*)	-0.077
COMM29	-0.124	-0.133	-0.05	-.239(**)	-.165(*)
COMM210	0.107	.245(**)	0.066	0.108	.177(*)
COMM211	-0.114	-.252(**)	-0.095	-.220(**)	-.259(**)
COMM212	-0.043	-0.056	-0.024	-0.11	-0.117
COMM213	-0.038	-0.089	-0.081	-0.051	-0.091
COMM214	-0.093	-0.044	0.12	0.076	0.133
PLNG1	-.256(**)	-.230(**)	-0.046	-.230(**)	-.225(**)
PLNG2	-.332(**)	-.217(**)	-0.076	-.239(**)	-.296(**)
PLNG3	0.03	0.004	-0.07	0.009	0.044
PLNG24	-0.139	-0.078	-.184(*)	-.157(*)	-.169(*)
PLNG25	.331(**)	.199(**)	-0.052	.292(**)	.210(**)
PLNG26	0.11	0.106	0.087	0.014	0.12
CO1		.585(**)	.250(**)	.480(**)	.645(**)
CO2			.216(**)	.459(**)	.554(**)
CO3				.207(**)	.219(**)
CO4					.462(**)

	CO6	CO7	INTRDP27	INTRDP28	INTRDP29
SFTSWTM	0.093	0.014	0.088	-0.007	0
YRTMORG2	-0.103	0.14	0.038	0.164	-0.041
YRAFGTM2	0.092	0.172	0.046	0.118	0.036
ROUT1	-0.033	0.063	-0.048	-0.097	0.018
ROUT2	-0.089	-0.017	-0.018	-0.142	0.058
ROUT3	-0.032	-0.001	-0.14	-0.064	-0.008
ROUT4	-0.011	0.127	-0.021	0.02	0.014
ROUT5	-0.068	-0.095	-0.077	0.007	-0.075
ROUT26	.162(*)	.178(*)	0.073	-0.039	-0.034
ROUT27	-0.103	-0.137	-0.054	-0.027	-0.01
ROUT28	0.102	0.081	-0.034	0.043	0.003
ROUT29	0.014	0.067	-.166(*)	-0.085	-0.033
ROUT210	0.071	0.085	-0.042	-0.084	-0.062
NROUT26	0.073	-0.078	-0.014	0.058	.167(*)
NONROUT2	.247(**)	0.071	-0.065	0.059	0.069
NONROUT3	0.121	0.088	0.076	0.101	.229(**)
NROUT27	.217(**)	.160(*)	-0.004	0.117	.273(**)
NONROUT5	-0.117	-.160(*)	-0.106	0.017	-0.069
NROUT28	0.038	-0.004	0.039	-0.086	-0.039
NROUT29	.299(**)	.177(*)	0.078	.206(**)	0.069
NROUT210	0.146	0.141	.164(*)	-0.009	-0.012
COMM26	-.222(**)	-.155(*)	-.183(*)	-0.071	-0.096
COMM27	-.293(**)	-0.141	-.257(**)	-0.13	-.188(*)
COMM28	-.180(*)	-0.101	-0.068	-0.11	-0.062
COMM29	-0.111	-0.103	-.167(*)	-0.115	-0.085
COMM210	0.111	.184(*)	-0.069	0.048	0
COMM211	-.218(**)	-0.131	-.201(**)	-.203(**)	-0.105
COMM212	-0.104	-0.045	-.216(**)	-0.136	-.163(*)
COMM213	-0.147	-0.063	-.199(**)	-.218(**)	-0.115
COMM214	-0.007	-0.047	.251(**)	.211(**)	0.077
PLNG1	-.184(*)	-.151(*)	0.11	0.012	-0.025
PLNG2	-.193(**)	-.163(*)	-0.08	-0.035	-0.097
PLNG3	-0.002	0.024	0.007	0.003	0.126
PLNG24	-0.071	-0.037	-0.128	-0.076	-.159(*)
PLNG25	.190(*)	.232(**)	-0.035	-0.02	0.081
PLNG26	0.048	0.004	-0.123	-0.076	0.051
CO1	.576(**)	.408(**)	0.117	.240(**)	.162(*)
CO2	.483(**)	.419(**)	0.135	.330(**)	.160(*)
CO3	.164(*)	0.083	0.057	.240(**)	0.144
CO4	.456(**)	.585(**)	.202(**)	.354(**)	.224(**)
CO5	.594(**)	.453(**)	.201(**)	.198(**)	.181(*)
CO6		.455(**)	.192(*)	.342(**)	0.061
CO7			.204(**)	.254(**)	0.109

	CO6	CO7	INTRDP27	INTRDP28	INTRDP29
INTRDP27				.324(**)	.187(*)
INTRDP28					.257(**)

	INTRDEP4	INTRDEP5	INTRDEP6	UNCERT1	UNCERT2
SFTSWTM	0.007	-0.124	-0.039	0.007	0.013
YRTMORG2	-0.121	0.028	-0.212	0.018	-0.128
YRAFGTM2	0.054	-0.077	0.077	0.032	-0.043
ROUT1	0.088	0.145	0.041	0.025	-0.006
ROUT2	0.047	0.109	0.048	0.041	0.163
ROUT3	-0.068	0.086	-0.033	0.097	.192(*)
ROUT4	0.033	.161(*)	0.034	-0.058	0.01
ROUT5	-0.021	-0.029	0.034	-.175(*)	-.279(**)
ROUT26	-0.057	-0.023	-0.023	0.029	0.066
ROUT27	-0.077	-0.065	-0.007	0.056	0.108
ROUT28	-0.036	-0.024	-0.017	0.035	-0.043
ROUT29	-0.065	-0.013	-0.087	0.022	0.129
ROUT210	-0.016	-0.124	0.06	0.072	0.075
NROUT26	0.126	0.084	.167(*)	.162(*)	0.009
NONROUT2	0.143	.172(*)	0.116	-0.03	-0.117
NONROUT3	0.112	.166(*)	0.092	0.087	0.029
NROUT27	.238(**)	.225(**)	.190(*)	-0.033	0.104
NONROUT5	-0.109	0.034	-0.032	0.112	-0.035
NROUT28	-0.024	-0.066	0.002	0.128	0.093
NROUT29	.149(*)	.154(*)	0.02	-0.132	-.318(**)
NROUT210	0.118	0.068	-0.082	-0.144	-0.12
COMM26	-.171(*)	-0.018	-0.007	0.055	.195(*)
COMM27	-.160(*)	-0.039	-0.083	0.131	0.068
COMM28	-0.113	0.071	0.04	0.036	0.16
COMM29	-0.028	0.081	-0.045	0.14	0.147
COMM210	0.147	.217(**)	0.006	0.09	0.015
COMM211	-0.033	-0.038	0.003	0.049	0.029
COMM212	-0.03	-0.044	-0.104	0.042	0.074
COMM213	-0.036	-0.041	0.034	0.022	0.127
COMM214	-0.046	-0.047	-0.032	-0.018	0.06
PLNG1	-.203(**)	-.148(*)	-.148(*)	-0.003	0.129
PLNG2	-.151(*)	-.211(**)	-.164(*)	0.098	0.109
PLNG3	0.123	0.101	0.024	.171(*)	.324(**)
PLNG24	-.212(**)	-0.125	-0.1	.270(**)	.281(**)
PLNG25	0.133	0.035	.178(*)	-0.039	0.057
PLNG26	-0.069	0.007	-0.039	0.097	0.033
CO1	.266(**)	.258(**)	.314(**)	-.198(**)	-0.163
CO2	.266(**)	.296(**)	.211(**)	-0.123	-.234(**)
CO3	0.007	0.016	.158(*)	-0.058	-.185(*)
CO4	.313(**)	0.132	.280(**)	-.218(**)	-0.136
CO5	.252(**)	.248(**)	.250(**)	-.212(**)	-.254(**)
CO6	.174(*)	.297(**)	.222(**)	-0.073	-0.106
CO7	.233(**)	.161(*)	.204(**)	-.165(*)	-0.111

	INTRDEP4	INTRDEP5	INTRDEP6	UNCERT1	UNCERT2
INTRDP27	.164(*)	0.02	.160(*)	-0.12	-0.1
INTRDP28	.228(**)	0.145	.221(**)	-0.089	-.228(*)
INTRDP29	.547(**)	.191(*)	.356(**)	-0.094	-0.068
INTRDEP4		.424(**)	.369(**)	-0.133	-0.137
INTRDEP5			.248(**)	-0.056	-0.011
INTRDEP6				-.195(**)	0.035
UNCERT1					.498(**)

	UNCERT3	UNCERT4	COMPLEX1	COMPLEX2	COMPLEX3
SFTSWTM	0.067	0.107	0.14	0.017	0.049
YRTMORG2	-0.114	0.098	0.083	0.064	0.014
YRAFGTM2	0.009	0.08	0.163	0.105	0.121
ROUT1	-0.061	0.07	-0.082	-0.14	-0.041
ROUT2	0.121	.179(*)	0.079	-0.093	.164(*)
ROUT3	0.086	0.081	-0.016	-0.018	0.111
ROUT4	-0.073	-0.066	-.217(**)	-0.084	0.034
ROUT5	-.235(**)	-.161(*)	-.160(*)	-0.082	-.233(**)
ROUT26	0.051	0.035	-0.112	-.167(*)	-0.105
ROUT27	0.055	0.016	-0.017	0.098	0.098
ROUT28	0.132	0.066	-0.018	0.065	0.076
ROUT29	0.093	0.085	0.041	0.014	0.084
ROUT210	0.045	-0.105	-0.01	0.017	0.034
NROUT26	0.12	0.084	.205(**)	-0.027	0.004
NONROUT2	-0.028	-0.017	0.054	-0.064	-0.059
NONROUT3	-0.043	0.036	0.144	-0.015	0.009
NROUT27	-0.071	0.012	0.048	-0.105	-0.025
NONROUT5	0.012	0.068	-0.019	0.022	-0.057
NROUT28	0.005	0.012	.179(*)	0.091	0.094
NROUT29	-0.07	-0.045	-0.076	-.183(*)	-.252(**)
NROUT210	-0.01	-0.103	-.149(*)	-0.134	-.170(*)
COMM26	0.08	-0.033	0.094	.251(**)	0.133
COMM27	-0.023	-0.046	0.08	0.107	.152(*)
COMM28	0.061	0.074	-0.005	0.09	0.104
COMM29	0.033	0.127	.170(*)	0.145	0.097
COMM210	.207(**)	.322(**)	-0.089	-0.095	0.067
COMM211	-0.093	0.003	0.062	0.026	-0.015
COMM212	-0.058	-0.095	-0.061	-0.064	-0.066
COMM213	-0.038	-0.004	0.041	0.021	0.062
COMM214	.171(*)	0.144	0.023	0.083	.201(**)
PLNG1	0.039	0.029	0.099	.242(**)	.147(*)
PLNG2	-0.034	-0.062	0.057	0.126	.156(*)
PLNG3	.312(**)	.319(**)	0.006	0.055	0.141
PLNG24	.187(*)	0.071	.195(**)	.155(*)	.275(**)
PLNG25	0.058	0.096	0.004	-.239(**)	-.157(*)
PLNG26	0.131	0.117	0.094	0.045	0.108
CO1	-0.045	-0.039	-0.081	-.218(**)	-.172(*)
CO2	-0.057	-0.043	-.222(**)	-.263(**)	-.170(*)
CO3	-0.058	-0.122	-0.087	-0.015	-0.11
CO4	-.147(*)	-0.036	-.253(**)	-.264(**)	-.239(**)
CO5	-0.049	0.035	-.149(*)	-.223(**)	-.174(*)
CO6	0.021	0.028	-0.064	-.221(**)	-.170(*)
CO7	-0.124	-0.038	-.295(**)	-.218(**)	-0.143

	UNCERT3	UNCERT4	COMPLEX1	COMPLEX2	COMPLEX3
INTRDP27	0.091	-0.086	-0.128	-0.029	-0.025
INTRDP28	-0.112	-0.121	-.210(**)	-0.108	-0.148
INTRDP29	-0.037	0.125	-0.061	-0.088	-0.1
INTRDEP4	-0.059	0.122	-0.121	-.198(**)	-0.142
INTRDEP5	-0.008	.180(*)	-0.076	-.214(**)	-0.109
INTRDEP6	-0.096	-.167(*)	-0.019	-0.059	-0.124
UNCERT1	.352(**)	.246(**)	.272(**)	0.127	.277(**)
UNCERT2	.521(**)	.341(**)	.289(**)	.265(**)	.544(**)
UNCERT3		.527(**)	.254(**)	0.108	.372(**)
UNCERT4			0.123	0.053	.220(**)
COMPLEX1				.264(**)	.423(**)
COMPLEX2					.492(**)

	CE1	CE2	CE3	CE4	CE5
SFTSWTM	-0.009	-0.017	0.008	-0.02	-0.039
YRTMORG2	-0.034	0.074	0.058	0.211	0.062
YRAFGTM2	-0.02	0.045	0.027	0.004	0.022
ROUT1	-0.052	-0.126	-0.122	-0.107	-0.047
ROUT2	-0.012	0.011	-0.042	-0.004	0.036
ROUT3	0.015	0.077	0.031	-0.029	-0.013
ROUT4	-0.05	-0.081	-0.098	-0.053	-0.112
ROUT5	-0.077	-0.029	-0.03	-0.062	-0.075
ROUT26	0.058	0.116	0.057	-0.025	0.08
ROUT27	-0.06	0.024	0.023	-0.05	-0.014
ROUT28	-0.074	0.035	-0.027	-0.033	-0.058
ROUT29	0.009	0.03	-0.034	0.009	0.01
ROUT210	0.006	0.012	0.027	-0.033	-0.01
NROUT26	-0.095	-0.025	-0.006	-0.023	-0.042
NONROUT2	-0.062	-0.024	-0.008	-0.044	-0.005
NONROUT3	-0.088	-0.084	-0.06	-0.124	-.146(*)
NROUT27	-0.072	-0.075	-0.107	-0.139	-.162(*)
NONROUT5	0.04	0.016	-0.023	-0.031	0.039
NROUT28	0.083	0.098	0.041	0.116	0.082
NROUT29	-0.081	-0.081	-0.021	-0.102	-0.128
NROUT210	-0.058	-0.082	-0.115	-0.129	-0.096
COMM26	0.072	.201(**)	0.091	.180(*)	0.121
COMM27	0.146	0.052	0.064	0.135	.162(*)
COMM28	0.108	0.112	0.086	.198(**)	.175(*)
COMM29	0.065	0.043	0.101	0.126	0.087
COMM210	-.196(**)	-.176(*)	-0.108	-.182(*)	-0.142
COMM211	.170(*)	.169(*)	0.123	0.146	0.147
COMM212	0.116	0.143	.186(*)	0.147	0.094
COMM213	.178(*)	0.099	0.084	.172(*)	.187(*)
COMM214	-0.085	-0.098	-0.046	-0.097	-0.063
PLNG1	0.079	0.102	0.107	0.111	0.088
PLNG2	0.086	0.063	0.142	0.129	0.064
PLNG3	-0.081	-0.031	-0.081	-0.119	-0.098
PLNG24	0.099	0.136	0.085	0.059	0.044
PLNG25	-.153(*)	-0.141	-0.109	-0.133	-0.085
PLNG26	0.001	0.037	-0.013	-0.082	-0.03
CO1	-.189(*)	-0.129	-0.125	-.209(**)	-.220(**)
CO2	-.158(*)	-.180(*)	-0.13	-.219(**)	-.178(*)
CO3	-0.121	-0.101	-0.111	-.170(*)	-0.093
CO4	-0.105	-.151(*)	-.183(*)	-.185(*)	-.187(*)
CO5	-.197(**)	-.163(*)	-0.12	-.207(**)	-.207(**)
CO6	-0.138	-0.118	-.173(*)	-.207(**)	-.200(**)
CO7	-.195(**)	-.198(**)	-.165(*)	-.227(**)	-.226(**)

	CE1	CE2	CE3	CE4	CE5
INTRDP27	-0.063	-0.044	-0.065	-0.04	-0.065
INTRDP28	-0.132	-0.109	-.158(*)	-.224(**)	-.291(**)
INTRDP29	-0.117	-0.071	-0.034	-0.101	-0.113
INTRDEP4	-.248(**)	-.202(**)	-0.128	-.255(**)	-.230(**)
INTRDEP5	-.200(**)	-0.083	-0.115	-.175(*)	-.199(**)
INTRDEP6	-.166(*)	-0.042	-0.07	-0.094	-0.111
UNCERT1	.159(*)	.152(*)	0.091	.160(*)	.176(*)
UNCERT2	.203(*)	.183(*)	0.149	.189(*)	.207(*)
UNCERT3	0.047	0.034	-0.015	0.009	0.072
UNCERT4	-0.034	-0.076	-0.07	-.149(*)	-0.029
COMPLEX1	.153(*)	.153(*)	0.143	.180(*)	.167(*)
COMPLEX2	0.135	0.126	0.094	.190(**)	0.121
COMPLEX3	.165(*)	0.107	0.125	0.134	0.136
CE1		.743(**)	.592(**)	.662(**)	.660(**)
CE2			.756(**)	.756(**)	.743(**)
CE3				.724(**)	.733(**)
CE4					.788(**)

	CE6	CE7	CE8
SFTSWTM	-0.068	-0.091	-0.021
YRTMORG2	0.165	0.13	-0.002
YRAFGTM2	0.022	0.044	-0.023
ROUT1	0.035	-.151(*)	-0.143
ROUT2	0.03	-0.007	-0.127
ROUT3	0.075	-0.011	0.1
ROUT4	-0.05	-0.11	-.202(**)
ROUT5	-0.064	-0.01	-0.012
ROUT26	0.105	0.051	-0.032
ROUT27	-0.031	-0.109	0.072
ROUT28	-0.033	-0.073	-0.085
ROUT29	0.026	0.017	-0.106
ROUT210	0.015	-0.026	-0.024
NROUT26	-0.051	-0.053	0.021
NONROUT2	0.036	-0.017	-0.003
NONROUT3	-0.083	-0.121	-0.005
NROUT27	-0.11	-0.123	-0.023
NONROUT5	0	0.08	0.078
NROUT28	0.072	0.076	0.013
NROUT29	-0.056	-0.088	0.061
NROUT210	-0.007	-0.076	-0.113
COMM26	0.026	0.056	0.072
COMM27	0.094	0.137	0.128
COMM28	0.142	0.146	0.003
COMM29	.183(*)	0.087	0.008
COMM210	-0.11	-0.139	-0.087
COMM211	.166(*)	0.146	0.042
COMM212	.158(*)	.167(*)	.159(*)
COMM213	.180(*)	.186(*)	0.062
COMM214	-.171(*)	-.227(**)	-0.123
PLNG1	0.075	0.061	0.078
PLNG2	0.067	0.052	.147(*)
PLNG3	-0.011	-0.125	0.061
PLNG24	0.072	0.106	0.072
PLNG25	-0.002	-0.144	-0.119
PLNG26	0.024	-0.012	0.031
CO1	-0.132	-.174(*)	-0.136
CO2	-0.133	-.184(*)	-0.045
CO3	-0.124	-0.127	-0.1
CO4	-0.111	-.166(*)	-0.109
CO5	-.159(*)	-.183(*)	-0.107
CO6	-0.118	-.165(*)	-.164(*)
CO7	-0.144	-.150(*)	-0.097

	CE6	CE7	CE8
INTRDP27	-0.097	-.151(*)	-0.082
INTRDP28	-.248(**)	-.234(**)	0.007
INTRDP29	-0.043	-0.103	-0.071
INTRDEP4	-.196(**)	-.210(**)	-0.118
INTRDEP5	-0.115	-0.142	-0.07
INTRDEP6	-0.109	-0.132	-0.059
UNCERT1	.170(*)	.169(*)	0.134
UNCERT2	.197(*)	0.168	0.07
UNCERT3	0.067	0.012	0.005
UNCERT4	-0.023	-0.105	-0.064
COMPLEX1	.180(*)	0.125	0.106
COMPLEX2	0.084	0.141	0.064
COMPLEX3	0.102	0.115	-0.018
CE1	.618(**)	.641(**)	.275(**)
CE2	.689(**)	.699(**)	.413(**)
CE3	.596(**)	.598(**)	.453(**)
CE4	.707(**)	.730(**)	.348(**)
CE5	.760(**)	.691(**)	.283(**)
CE6		.739(**)	.267(**)
CE7			.393(**)
CE8			

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Cannon-Bowers, J. A., Oser, R., & Flanagan, D. L. (1992). Work teams in industry: A selected review and proposed framework. In R. W. Swezey & E. Salas (Eds.), Teams: Their Training and Performance. Norwood, NJ: Ablex Publishing Corporation.

Cannon-Bowers, J. A., Salas, E., & Converse, S. A. (1990). Cognitive psychology and team training: Shared mental models in complex systems. Human Factors Society Bulletin, 33, 1-4.

Cannon-Bowers, J. A., Salas, E. & Converse, S. (1993). Shared mental models in expert team decision making. In A. Castellan (Ed.), Individual and Group Decision Making: Current Issues. Hillsdale, NJ: Erlbaum.

Cannon-Bowers, J. A., Tannenbaum, S. I., Salas, E., & Volpe, C. E. (1995). Defining competencies and establishing team training requirements. In R. A. Guzzo, E., Salas, and Associates (Eds.), Team Effectiveness and Decision Making in Organizations. San Francisco, CA: Jossey-Bass Publishers.

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Hackman, J. R. (1987). The design of work teams. In J. W. Lorsch (Ed.), Handbook of Organizational Behavior. Englewood Cliffs, NJ: Prentice-Hall, Inc.

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Lawler, E. E., Morhman, S. A., & Ledford, G. E. (1989). Employee Involvement in America: A study of contemporary practice. Houston, TX: American Productivity and Quality Center.

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Ledford, G. E., (1989). The Design of Skill-Based Pay Plans. Center for Effective Organizations: University of Southern California.

Levine, J. M., & Moreland, R. L. (1990). Progress in small group research. Annual Review of Psychology, 41, 585-634.

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Meyer, R. H. (1986). Classical and Modern Regression with Applications. Boston, MA: Ducksbury Press.

Nunnally, J. C. (1978). Pscyhometric Theory. New York: McGraw-Hill.

Oransanu, J., & Salas, E. (1993). Team decision making in complex environments. In G. Klein, J. Orananu, R. Calderwood, & C. E. Zsambok (Eds.), Decision Making in Action: Models and Methods. Norwood, NJ: ABLEX.

Pearce, J. A., & Ravlin, E. C. (1987). The design and activation of self-regulating work groups. Human Relations, 40 (11), 751-782.

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Susman, G. I. (1968). An investigation of task allocation decisions in autonomous work groups in a continuous process industry. Dissertation, University of California, Los Angeles.

Susman, G.I. (1970a). The concept of status congruence as a basis to predict task allocations in autonomous work groups. Administrative Science Quarterly, 15, 164-175.

Susman, G. I. (1970b). The impact of automation on work group autonomy and task specialization. Human Relations, 23 (6), 567-577.

Weiss, H. M.,& Ilgen, D. R., (1985). Routinized behavior in organizations. Journal of Behavioral Economics, 14, 57-67.

Curriculum Vitae
Karen Ann Tarnoff
September 1999

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120 Sam Wilson Hall
East Tennessee State University
Johnson City, TN 37614-0625
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EDUCATION

Ph.D. Virginia Polytechnic Institute and State University, R.B. Pamplin College of Business, Department of Management, 1999
Major: Human Resource Management
Minors: Labor Relations and Industrial-Organizational Psychology
Dissertation: *An Exploratory Study of the Determinants and Outcomes of Shared Mental Models of Skill Use in Autonomous Teams*

M.S. Virginia Polytechnic Institute and State University, R.B. Pamplin College of Business, Department of Management, 1993
Major: Human Resource Management and Labor Relations
Thesis: *Student Attitudes Toward Unions and Employment Rights Issues: A Preliminary Investigation*

B.S. Virginia Polytechnic Institute and State University, 1987 (Cum Laude)
Double Major: Psychology and Sociology

ACADEMIC EXPERIENCE

August 1994 - Present Assistant Professor - Department of Management & Marketing, East Tennessee State University

Responsibilities/activities: Teach courses including Introduction to Business, Organizational Management, Organizational Behavior, and Human Resource Management; develop/revise Introduction to Business; develop Organizational Management and Human Resource Management as instructional television courses; serve as faculty advisor to Society for Human Resource Management Student Chapter; Compose Honors Program syllabus and materials for Organizational Management; develop new course proposals (Human Resource Certification, Planning and Staffing, and Human Resource Management in Team-Based Organizations); write recommendation letters for students; and serve on various departmental, college, and university committees

June 1993 - August 1993 Instructor - Department of Management
Virginia Polytechnic Institute and State University

January 1993 - May 1994	Graduate Research Assistant Dr. Robert Madigan - Department of Management Virginia Polytechnic Institute and State University
Responsibilities/activities:	Software evaluation and implementation for graduate and undergraduate compensation course, statistical programming and data analysis for various tests of adult literacy and autonomous work team selection procedures
June 1992 - December 1992	Instructor - Department of Management Virginia Polytechnic Institute and State University
May 1991 - August 1992	Research Assistant and Project Manager - Personnel Services Specialist Department of Personnel Services Virginia Polytechnic Institute and State University
Responsibilities/activities:	Periodic administration and data analysis of university employee attitude survey; design, administration, and analysis of program utilization surveys; design and administration of team building training; design of ADA (1990) utilization and compliance survey
August 1988 - May 1991	Research Assistant and Project Manager Barringer Center for Research in HRM Virginia Polytechnic Institute and State University Dr. K. Dow Scott, Director
Selected Corporate	Bell Atlantic, Dominion Bank Shares, First American Bank
Affiliate Members:	Shares, Ingersoll-Rand, Kay Jewelers, Medical Facilities of America, Philip Morris, Piedmont/USAir, Reynolds Metals, Sara Lee Knit Products, Signet Bank, Southern States, U.S. Postal Service, Washington Post
Responsibilities/activities:	Project management, questionnaire design, data collection, data analysis, executive summaries, literature reviews, statistical programming, conference organization, corporate affiliates' publications
Topics of Research:	Profit sharing, merit pay, performance appraisal, human resource audits
August 1987 - August 1988	Graduate Research Assistant Dr. Frederick S. Hills and Dr. Robert Madigan Department of Management Virginia Polytechnic Institute and State University
Responsibilities/activities:	Statistical programming and data analysis, literature searches and reviews, psychological measures searches and reviews
Current Research Interests:	Autonomous work teams, team based management systems, skill-based pay systems, cross-training, employment rights issues, procedural justice, interactional justice, performance appraisal, HIV/AIDs in the workplace

RESEARCH

Proceedings - Refereed

Burkette, G. D., Nash, J. F., and Tarnoff, K. A. (1997). "Romtech Corporation (A)". Proceedings of the Southwest Case Research Association, p. 29.

Tarnoff, K. A., Burkette, G. D., and Nash, J. F. (1997). "Romtech Corporation (B)". Proceedings of the Southwest Case Research Association, p. 36. Selected as the *Iwrin Distinguished Paper Award winner at the 1997 SWCRA meeting.*

Cobb, A. T., Vest, M. J., Hills, F. S., Frey, F. M., and Tarnoff, K. A. (1991). Procedural justice: Source attributions and group effects in performance evaluations. In Ray, D.F. (Ed.) Proceedings of the Southern Management Association, 278-280.

Tarnoff, K. A. and Partridge, D. M. (1991). Student attitudes toward unions and employment rights issues. In Kaufman, B. E. (Ed.) Proceedings of the Twelfth Annual Southern Regional Industrial Relations Academic Seminar, 36-38.

Presentations - Refereed

Burkette, G. D., Nash, J. F., and Tarnoff, K. A. (1998). "Planning and control in team-based organizations: Implications for management accounting." Southeast American Accounting Association Regional Meeting.

Tarnoff, K. A., Burkette, G. D., and Nash, J. F. (1997). "Romtech Corporation (B) Case." Presented at Southwest Federation of Applied Disciplines - Southwestern Case Research Association. *Selected as the Irwin Distinguished Paper Award winner at the 1997 SWCRA meeting.*

Burkette, G. D., Tarnoff, K. A., and Nash, J. F. (1997). "Romtech Corporation (A) Case." Presented at Southwest Federation of Applied Disciplines - Southwestern Case Research Association.

Partridge, D. M. and Tarnoff, K. A. (1994). "The relationship between students' attitudes toward unions and attitudes toward employment rights issues." Presented at the Industrial Relations Research Association Annual Meeting, poster session.

Vest, M. J., Scott, K. D., and Tarnoff, K. A. (1992). "When accuracy is not enough: The moderating effect of perceived appraisal use." Presented at the Academy of Management Annual Conference.

Tarnoff, K. A. and Partridge, D. M. (1990). "Student attitudes toward unions and employment rights issues: A preliminary investigation." Presented at the Industrial Relations Research Association Annual Meeting, poster session.

Book Chapters

Burkette, G. D., Nash, J. F., and Tarnoff, K. A. (1997). "Romtech Corporation" in Nash, J. F. and Bartell, H. R. Cases in Corporate Financial Planning and Control. Dame Publications.

Presentations - Invited

1999: Mid-South Teams Conference - Cross-training and Skill-based pay systems in team-based organizations Middle Tennessee State University

1999: East Tennessee State University Applied Human Sciences, Corporate Etiquette (AHSC 4547) - Interviewing skills

1998: City of Bristol Board of Mayor and Aldermen - Performance appraisal for city executives and employees

1998: Tennessee Bankers Association Annual Conference - Strategic human resource management

1997: 21st Annual Accounting, Auditing, and Tax Updating Conference - Team-based management systems

1997: East Tennessee State University Teaching and Learning Center - Peer review

1997: Society of Internal Auditors - Team-based management systems and accounting issues

1996: Delta Sigma Pi -The seven habits of highly effective people, time management

1995: East Tennessee State University Engineering Technology, Project Management (ENTC 5690) - Comparative analysis of incentive-based compensation systems

1994: East Tennessee State University Executive Briefing - Team-based management systems

1993 - 1998: East Tennessee State University Introduction to Business (BADM 1130) - Human resource management and management issues, five presentations

Refereed Publications

Vest, M. J., Scott, K. D., and Tarnoff, K. A. (1995). "When accuracy is not enough: The moderating effect of perceived appraisal use," Journal of Business and Psychology, 1995.

Research Submitted to Refereed Publications

Burkette, G. D., Nash, J. F., and Tarnoff, K. A., (1999). "Planning and control in team-based organizations." Submitted to Managerial Accounting.

Research to be Submitted to Referred Publications

Tarnoff, K. A. (1999). "Shared Mental Models of Skill Use in Autonomous Teams." to be submitted to Academy of Strategic and Organizational Leadership Journal in Spring 2000.

Vest, M. J. and Tarnoff, K. A. (1999). "Factors Influencing AIDS-Related Hiring and Firing Decisions" - to be submitted to Personnel Psychology in October 1999.

Vest, M. J. and Tarnoff, K. A. (1999). "Fear of AIDS and the Decision to Discipline Individuals Who Refuse to Work with Coworkers who have AIDS" - to be submitted to the Journal of Organizational Behavior in December 1999.

SERVICE

Departmental Service

1996 - Present Departmental Student Awards Committee
Department of Management and Marketing, East Tennessee State University

1996 - Present: Member of Departmental Search Committee
Department of Management and Marketing, East Tennessee State University

1995 - Present: Member of Ad Hoc Departmental Student Retention Committee
Department of Management and Marketing, East Tennessee State University

1994 - Present: Member Curriculum Committee - Human Resource Management Coordinator
Department of Management and Marketing, East Tennessee State University

1994 - Present: Advisor - Society for Human Resource Management Student Chapter
Department of Management and Marketing, East Tennessee State University; This chapter has grown from two to up to fifty members, has won consecutive National Superior Merit Awards (1997, 1998, 1999) for chapter achievements, was ranked as the number one chapter in the nation (tied with two other chapters) in 1998-1999, has received the ETSU Departmental Service Award in 1997-1998 for accumulating more hours of volunteer community service than any other departmental organization on campus, has received the ETSU award for most improved student organization in 1998-1999, has produced a National SHRM Scholarship winner, and has gained national recognition in the SHRM National Newsletter.

College of Business Service

1997 - 1999: Member Student Affairs Committee
College of Business, East Tennessee State University

1996-1999 Liberty Bell Middle School Students ETSU day
College of Business, East Tennessee State University

1995 - Present: Curriculum Coordinator and Instructor For Human Resource Management Certification Review Course
College of Business - Management Development Center, East Tennessee State University

1995 - 1997: Student advisor (Freshman orientation)
College of Business, East Tennessee State University

1995-1999; Host for Alumni Return to the Classroom Program
College of Business, East Tennessee State University

1995 -1998: Member Honors Program Advisory
College of Business, East Tennessee State University

1995 - 1998: Member Undergraduate Programs Committee
College of Business, East Tennessee State University

1994 - 1998: Member Library Committee
College of Business, East Tennessee State University

University Service

1999 - 2000: Student Life and Leadership Office - Departmental representative to help establish an interdisciplinary leadership minor,
College of Business, East Tennessee State University

1998 - Present: Member Academic Advisement Council - Freshman Instructors Council
College of Business, East Tennessee State University

1998 - Present: Instructional Television Course Mentor
College of Business, East Tennessee State University

1997: East Tennessee State University Teaching and Learning Center - Peer Review Article and Brown Bag Seminar, East Tennessee State University

1995-1998: Member University Marketing Advisory Committee
College of Business, East Tennessee State University

Professional Service

1999: Reviewer, Academy of Strategic and Organizational Leadership Journal

1999: Participant in Society for Human Resource Management Chapter Advisor Workshop - Society for Human Resource Management National Conference

1997-1998: Reviewer Southwest Case Research Association

1997: Panel Discussant - Southwestern Case Research Association Annual Conference, Southwestern Federation of Administrative Disciplines

1996: Participant in the Teaching Excellence in HRM Conference

1996: Participant in Society for Human Resource Management Chapter Advisor Workshop - Teaching Excellence in HRM Conference

1993 - Present: Member Society for Human Resource Management, Northeast Tennessee Professional Chapter - Board of Directors

Community Service

1998 - Present: Member of committee to produce Gray United Methodist Church's case study for building and funding campaigns

1997 - Present: Facilitator and organizational consultant to Gray United Methodist Church for redesign of the organization's structure

1996 - 1998: Member (appointed by the Bishop) Ministry Design Team of the Holston Valley Conference, United Methodist Church

1995 - 1997: Member of Kingsport Habitat for Humanity Volunteer Coordination Committee

PROFESSIONAL DEVELOPMENT ACTIVITIES

1999: Mid-South Teams Conference
Middle Tennessee State University

1998: Advisor Training
College of Business, East Tennessee State University

1997: Principle Centered Leadership Training Seminar
Holston Valley Methodist Conference

1997: Undeclared Major Advisor Training Seminar
Advisement Center Business, East Tennessee State University

1996: Freshman Advisor Training
Academic Affairs, East Tennessee State University

1996: Instructional Television Instructors Training
School of Continuing Studies, East Tennessee State University

1995: Mid-East Network of Employers with Teams - Team-Based Systems Seminar
Management Development Center, Tusculum College

1995: Teleconference - "Teams in Organizations"
School of Continuing Studies, East Tennessee State University

1994: Faculty Development Seminar - Statistical Analysis for Research
College of Business, East Tennessee State University

AWARDS AND HONORS

1998 Jan Phillips Mentoring Award
Office of Student Life and Leadership, East Tennessee State University

1998 Advisor of the Year Nominee (student nominated award)
National Society for Human Resource Management

1998 Advisor of the Year Nominee (student nominated award)
Office of Student Life and Leadership, East Tennessee State University

1996, 1997, 1998 College of Business Teaching Award Nominee (student nominated award)
Department of Management and Marketing, East Tennessee State University

1993 Jack Hoover Award - Doctoral Student Teaching Award (conferred by faculty)
Department of Management, Virginia Polytechnic Institute and State University

1993 Outstanding Leadership and Service Award - Graduate Student Assembly
Virginia Polytechnic Institute and State University

1992 Academy of Management Doctoral Consortia, Human Resource Management Division, National Academy of Management Meetings
Department of Management, Virginia Polytechnic Institute and State University

1992 R.B. Pamplin Fellowship
Department of Management, Virginia Polytechnic Institute and State University

1992 Omicron Delta Kappa - National Leadership Fraternity

1987 Gamma Beta Phi - National Honor and Service Fraternity

1986 Phi Kappa Phi - National Honor and Service Fraternity

1985 Psi Chi - National Psychology Honor Fraternity

PROFESSIONAL AFFILIATIONS

Academy of Management
Society for Human Resource Management
Southern Management Association
South Western Case Research Association

CONSULTING EXPERIENCE

I-95 Corridor Coalition	Ad Hoc Issues Consultant
Responsibilities/activities:	Diagnose organizational problems and offer methods of solution
Holston Valley Methodist Conference	Organizational Change Consultant
Responsibilities/activities:	Assess organizational inefficiencies; design, implement and evaluate an organizational change program; participate in strategic planning
Inland Container Corp	Organizational Change Consultant
Responsibilities/activities:	Develop, administer, and analyze a survey assessing employee readiness for a team-based system
Laure` Beverages	Ad Hoc Issues Consultant
Responsibilities/activities:	Evaluate and provide input on the design and implementation of team-based system components

Virginia Tech Management Development Center	Research Assistant/Trainer on a per project basis Dr. Terry Cobb
Responsibilities/activities:	Literature searches and reviews, conduct training sessions
Farradyne Systems, Inc.	Human Resource Consultant on a per project basis
Responsibilities/activities:	Review of human resource procedures and policies