The Impact of Team Mental Models on IS Project Teams' Information Processing and Project Performance

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ABSTRACT

Information system development (ISD) team processes are often driven and constrained by the diversity of team members. Diverse background not only broadens knowledge available but can also lead to conflict and miscommunication. Although the literature indicates that a common understanding is required for diverse group of people to work together - by improving communication efficiency - more research should focus on what can be done to generate common understanding and how to get a diverse group of people working together effectively. Based on team mental models (TMMs) and an information processing perspective, we hypothesize that team building facilitates the formation of TMMs. In turn, TMMs improve team information processing and overall team performance. Data from different ISD teams in outsourcing firms in India confirm most of our hypotheses, except a final link between one subset of TMM and team performance.

KEYWORDS

Team mental models, knowledge management, project management, information system development

INTRODUCTION

An information system development (ISD) project is a series of uneasy decisions and complex problem solving activities. People with diversified knowledge and expertise are gathered together as a team to accomplish those complex tasks. During the teamwork process, knowledge possessed by individuals is exchanged and combined to discover problems, to diagnosis the components of problems, and to generate solutions to problems. The final team performance is largely determined by the degree of exchanging, organizing, and utilizing diversified expertise effectively without conflict and miscommunication.

The key for a diverse team to process information more effectively is to generate common understandings (or Team Mental Models - TMMs) of a team task. Common understanding is the basis for exchanging unique information (Dennis, 1996; Nonaka, 1996). It can also facilitate information processing and team member coordination (Klimoski and Mohammed, 1994).

Compared to permanent business functions or a team with a long history where members interact with each other more completely, a temporary work team presents more difficulties forming TMMs. For example, in the context of outsourced IS development projects, where IS development teams are constituted for the duration of the project life cycle and dissolved once the project is implemented, a TMM is difficult to form since there is only limited time for team members to interact with each other. In addition, according to the study conducted by Deutsche Bank Research (2005), among IT providers in India, the turnover rate is 15-30%, while in the BPO segment the rate has risen to no less than 40% in some cases. We believe, under this condition, familiarity among team members is limited and certain managerial interventions are required to form common understandings.

Team building (a type of managerial intervention) is often adopted by managers during the team formation stage. It enhances teamwork and improves the quality of interaction among team members. In this study, we propose that managerial intervention (team building) is required to build common understandings for a temporary team. In addition, those common understandings facilitate team processes (information processing) and lead to a better outcome (project performance). Survey data of 180 IS developers from IT service firms located in India was collected to validate the model.

In the following sections, we first review the literature on teamwork, TMMs, and team information processing. We then build hypotheses based upon the literature. Research methodology and data analysis are followed by implications for researchers and practitioners.

BACKGROUND

ISD Team

An ISD project team is one type of team that gathers people from different functional units for a time-limited and non-repetitive information system development task (Cohen and Bailey, 1997). Project members with varied roles (e.g. users, line managers, programmers, system analyst, project manager, and database administrator) and different background knowledge, (e.g. domain knowledge, programming knowledge, system analyzing knowledge, project managing knowledge and database managing knowledge) gather together. Project leaders or managers need to take steps to make the team work. For example, team building, member socialization, or autonomy can be adopted to generate norms, cultures, or even common understandings for the project tasks.

A temporary project team is different from traditional MIS/IT department operations. In the traditional department, members are familiar with each other and a common understanding of each other's expertise, background, and job responsibilities is formed during daily operational interaction. For a project team, especially a cross-functional team or project based organization such as ISD vendors, insufficient interaction limits familiarity. Members are largely unaware of others' background, expertise, ability and working style. Effective communication is difficult to reach and conflicts and miscommunication situations tend to be worse when team members are from different functional, social or educational backgrounds and have different goals. Therefore, it is important for team members to be aware of each other's expertise and roles, suggesting certain managerial intervention be done first.

Team Mental Model

Team mental models (TMM) are critical when two or more people work together as a project team. A team's mental model refers to "an organized understanding of relevant knowledge that is shared by team members" (Klimoski and Mohammed 1994). With shared understanding, team members have similar ways of thinking while facing problems. It means that team members have compatible, but not identical, mental models (Cannon-Bowers et al., 1993). There are several similar terms used in past research (group map, team schema, cognitive consensus). Theoretically, TMMs are hypothesized directly or indirectly, through team processes, and related to team performance. Empirical studies provide substantial support to indicate how TMMs can improve the team processes (e.g. communication, adaptation, and coordination) and team performance of geographically centralized and diversified teams (Rentsch and Klimoski, 2001; Webber et al., 2000; Marks et al., 2000; 2002; Mathieu et al., 2000; 2005; Swaab 2002; Espinosa, 2002).

The content of a TMM includes task work and teamwork (Cannon-Bowers et al., 1993). Taskwork MM refers to the knowledge and skills related to the accomplishment of task. Different projects have different task and domain content and task analysis is required to study it. A teamwork MM refers to how team members should interact with each other to accomplish the task and is adopted by many researchers to represent TMMs because different types of projects have similar teamwork MM content. By having shared teamwork MMs in mind, team processes can be more efficient and effective.

Team Building

Team building, one of the most popular managerial interventions in a group setting, is designed to improve teamwork and increase group effectiveness by promoting trust and cooperation among members (Porras and Berg, 1978; Gilbert and Tang 1998). Team building is defined as "activities aimed at enabling a group to become a cohesive working unit capable of functioning at the highest performance levels" (Constantine, 1993). Some of the major components mentioned in the team building literature are goal setting, interpersonal relations, problem solving, and role clarification (Salas et al., 1999). These activities enlist the participation of a group in planning and implementing change - which will be more effective than simply imposing change on the group from outside (Salas et al., 1999). In the IS development literature, team building has a strong impact on IS success, work performance, and member satisfaction (Nath and Lederer, 1996; Janz, 1999; Janz et al., 1997).

Teamwork MMs include two major components: teammate and team interaction MM. Teammate MM refers to familiarity of each other's skills and knowledge. This can be formed through socialization activities which improve the understanding of each other and enhance interpersonal relations. Team interaction MM refers to understanding how teammates interact with each other. The basis of effective interaction is to know each other's role and responsibility. Activities such as role clarification and interchange training can be used to establish a common goal and define the role of each member. Therefore, we hypothesize that team building enhances TMMs.

H1a: *Team building will lead to an increase in the similarity of members' interaction mental model, and*

H1b: *Team building will lead to an increase in the similarity of member's teammate mental model.*

Team Mental Model and Information Processing

A collection of individuals transforms into a team through interaction, coordination, and information exchanging process. The sharing and integration of information among team members are critical for group and individual performance (Deeter-

Schmelz and Ramsey, 2003). In an ISD team, each member possesses special knowledge and information useful for different tasks. To accomplish those tasks, a team must function as a processor so that different information can be exchanged within the team and be integrated and utilized to the specific problem.

Group performance depends on member awareness of the sources of information and the extent to which it is accessed. Based on individual information processing theory, Hinsz et al. (1997), viewed group information processing as the extent that information is shared among team members. Their model provides the support for how convergence of representations among members and member diversity affect information processing. A converged, or shared, mental model is required for efficient information processing by knowing the location of knowledge and the way to access it. Similar mental models allow individuals to process more information more quickly and prevent individuals from getting distracted by irrelevant information (Fiske and Taylor 1991). Therefore, information is easier to recognize, encode, and retrieve from group memory. Hence we hypothesize that,

H2a: *Team interaction mental models will increase information processing, and*

H2b: *Teammate mental model will increase information processing.*

Team Mental Models, Information Processing and Team Performance

Differences in the mental models of team members can constrain progress and lead to conflict (Klimoski and Mohammed 1994). In addition, TMMs are assumed to enhance the quality of teamwork skills and team effectiveness (Cannon-Bowers et al. 1990; Cannon-Bowers et al., 1993). Previous literature found support that greater overlap or commonality among team members' mental models, leads to greater likelihood that team members will predict the needs of the task and team, adapt to changing demands, and coordinate activity with one another successfully (Cannon-Bowers et al., 1993; Converse et al. 1991). Teams who share mental models are expected to have common expectations of the task and team, allowing them to predict the behavior and resource needs of team members more accurately (Cannon-Bowers et al. 1990). Understanding other members' roles and knowledge possessed results in team members becoming more effective in drawing on their skill reservoir to create a better solution. (D'Andrea-O'Brien and Buono 1996). Hence our hypotheses,

H3a: *Teammate mental model will improve project performance, and*

H3b: *Team interaction mental model will improve project performance.*

According to Hackman and Morris (1975), understanding the interaction processes that take place between team members is the key to understanding team effectiveness. Through the intra-team interactions between team members that occur when performing team activities such as planning, exchanging, and coordinating information, teams can transform requirements into deliverables that affect overall project outcomes. Empirical studies confirmed that team performance is greatly influenced by interaction processes such as coordination, communication, and information sharing (Salas et al. 1992; Tannenbaum et al. 1992; Yeatts and Hyten, 1998). Drawing from these findings, we expect that team members focused on sharing, discussing, and evaluating information as a group is more likely reduce various uncertainties. By capitalizing on the interaction synergies occurring during team information processing, the team's efforts can be translated into better project performance. Hence our hypothesis:

H4: *Increased information processing among team members will improve project performance.*

METHODOLOGY

Survey methodology is selected to validate the hypotheses. A package includes a cover letter and questionnaires for all variables were sent to 500 randomly selected IT teams in India. IT outsourcing companies were selected because, in the outsourcing context, a project based organization develops the system for clients and people who are not familiar with each other are gathered together temporarily for one project. In addition, one item in the questionnaire was used to understand the background diversity and more than 96% respondents reported a moderate to high diversity (low: 3.9%; moderate: 63.7%; high 32.4%). We believe that, under this condition, team building is critical for forming common understanding which is critical for team work process. A total of 190 surveys are returned and, after removing unusable samples, a total of 180 were used for the analysis. The final response rate is about 36%.

Among respondents, more than 75 percent of them are male in the IT service industry. More than half respondents are in firms with more than 50,000 employees. Twenty percent of the respondents are technical leaders or module leaders and the rest are programmers, software engineers, and system analysts. Half of projects have a duration under 2 years. More than 75 percent of the teams have less than 25 people.

Table1. Demographic

Variables	Categories	#	%	Variables	Categories	#	%
Firm size	<= 100	3	1.7	Gender	Male	139	77.2
	100 ~ 1000	12	6.7		Female	37	20.6
	1k~ 10k	60	33.3		Missing	4	2.2
	10k~50K	11	6.1	AVG project duration	<= 1 year	35	19.4
	>= 50k	95	52.2		1-2 year	55	30.6
Team Size	<=7	52	28.9		2-3 year	21	11.7
	8~15	58	32.2		3-5 year	22	12.2
	16~25	27	15.0		>= 6 year	14	7.8
	>=26	21	11.7		Missing	33	18.3
	Missing	22	12.2	Position	Programmer	46	25.6
In this team (Month)	Min	1			System Analyst	26	14.4
	Max	48			Module Leader	14	7.8
	Average	13.8			Software Engineer	53	29.4
	S.D.	10.3			Technical Leader	23	12.8
					Others	18	10.0

Constructs and Measurement

Team Building.

Team building refers to "*activities aimed at enabling a group to become a cohesive working unit capable of functioning at the highest performance levels*" (Constantine, 1993). The measurement of team building includes 4 items adopted from Salas et al. (1999).

Team Mental Model (TMM).

Team interaction model refers to whether team members have similar understanding of how team collectively works to accomplish the task. ***Teammate model*** refers to whether team members have the same understanding toward each team member's knowledge, skill, ability, believe, preference, and attitude. A total 6 items, from Cannon-Bowers et al. (1990) and Millward and Jeffries (2004), are used for team interaction MM and teammate MM.

Information Processing.

Information processing is a second order construct which includes information exchange and information utilization (Deeter-Schmelz and Ramsey, 2003). *Information exchange* refers to the sharing, discussing, and evaluating of information between team members. *Information utilization* refers to the use of information transformed by the team. A total of 8 items were adopted from Deeter-Schmelz and Ramsey (2003), four for information exchange and another four for information utilization.

Project Performance.

Team performance refers to how **efficienctly** a team can complete the task. The team's efficiency is assessed in terms of adherence to schedules, e.g., starting the manufacturing and/or marketing on the target date, and budgets, e.g., staying within target costs with both the project and the finished product (Hoegl and Gemuenden, 2001). A total of 5 items adapted from Hoegl and Gemuenden (2001) were used to measure team performance. Likert scales (ranging from 1 to 7), with anchors ranging from ''strongly disagree'' to ''strongly agree'' were used for all questions above.

Validity and Reliability

Item reliability, convergent validity, and discriminant validity tests are often used to examine the measurement model in PLS. In table 2, the loading of all indicators are larger than 0.7, which indicates they are significant. Composite reliability and Cronbach's alpha are also above 0.7 which indicate high internal consistency. Convergent validity is assured in our study because the correlation between indicators in the same construct is high and the average variance extracted for each construct is larger than 0.5. Correlation between pairs of constructs is below 0.9 and the square root of AVE is larger than the correlation between constructs indicate high discriminant validity.

Variables	CR	AVE
Team Building	0.89	0.67
Interaction MM	0.84	0.63
Teammate MM	0.79	0.55
Information exchange	0.88	0.66
Information utilization	0.91	0.71
Project performance	0.91	0.68

Table 2. Reliability and variance extracted

Variables	Mean	Std	M3	M4	**TB**	**IM**	**TM**	**IE**	**IU**	**PP**
Team **B**uilding	5.06	0.84	-0.17	-0.14	**0.81**					
Interaction **M**M	5.42	0.95	-0.72	0.39	0.41	**0.79**				
Teammate **M**M	5.00	0.82	-0.05	-0.65	0.37	0.48	**0.74**			
Information **E**xchange	5.08	0.92	-0.56	-0.01	0.51	0.36	0.41	**0.81**		
Information **U**tilization	5.13	0.96	-0.66	0.03	0.55	0.44	0.34	0.70	**0.84**	
Project **P**erformance	5.32	1.08	-0.82	1.38	0.32	0.51	0.24	0.42	0.40	**0.82**

Note: the diagonal line of correlation matrix represents the square root of AVE

Table 3. Basic information and correlation between variables

Constructs	Items	Factor Loading	t-value
Team Building	There was lots of communication among group members regarding their respective roles within the group.	0.76	12.58
	We set objectives to achieve both individual and group goals.	0.83	24.69
	There was a mutual supportiveness, communication, and sharing of feelings among group members.	0.85	33.86
	We were involved in the identification of major problems in the group and implementing solutions for those problems.	0.80	16.69
Team Interaction Model	If asked I could explain all of the roles in the team and how they overlap	0.84	29.63
	The other team members understand my role in the team	0.87	23.61
	All team members are aware of where to go for information when they need it	0.77	10.42
Teammate Model	I am well aware of other team member's skills and abilities	0.80	24.60
	I can usually predict what my team members will do in a particular situation	0.74	10.66
	The team adapts its behaviors to meet the needs of other team members	0.77	10.90
Information Exchange	Sometimes members of my team talk about how we could have handled a situation differently.	0.73	12.80
	Often, members of my team get together to analyze information about the project.	0.89	40.58
	My team usually considers the different perspectives of various team members when deciding how to handle a project-related situation.	0.79	12.47
	Sometimes I sit down with other members of my team to discuss the project.	0.81	18.69
Information Utilization	My team often uses ideas we have developed to improve our performance.	0.88	33.39
	My team often uses ideas developed in team discussions to solve specific problems.	0.89	40.68
	Members of my team try to use the discussions we have about projects as a source of learning.	0.85	28.45
	My team uses ideas developed in discussions about projects to set new team goals	0.77	13.98
Project Performance	Ability to meet project goals	0.85	25.40
	Expected amount of work completed	0.85	21.85
	High quality of work completed	0.85	40.32
	Adherence to schedule	0.79	12.42
	Adherence to budget	0.79	17.07
Information Processing (2^{nd} *order*)	Information exchange	0.92	67.27
	Information utilization	0.92	67.27

Table 4 Factor loadings

Hypotheses testing

PLS is used to perform the path analysis. Because information processing is a second order construct which contains information exchange and information utilization, we used the construct score of the first order construct as indicators of the second order construct (Agarwal and Karahanna, 2000). In this study, resamples of 250 is chosen for bootstrap. In order to prevent possible interferences from contextual factors, team size and work duration were incorporated as control variables. The analysis results are showed in figure 1. Team building can positively predict both types of MM and both of them have positive and significant effect on information processing. The relationship between information processing and project performance is significant. Interaction MM has positive effect toward project performance but Teammate MM. Therefore, only one hypothesis – H3b - is not supported.

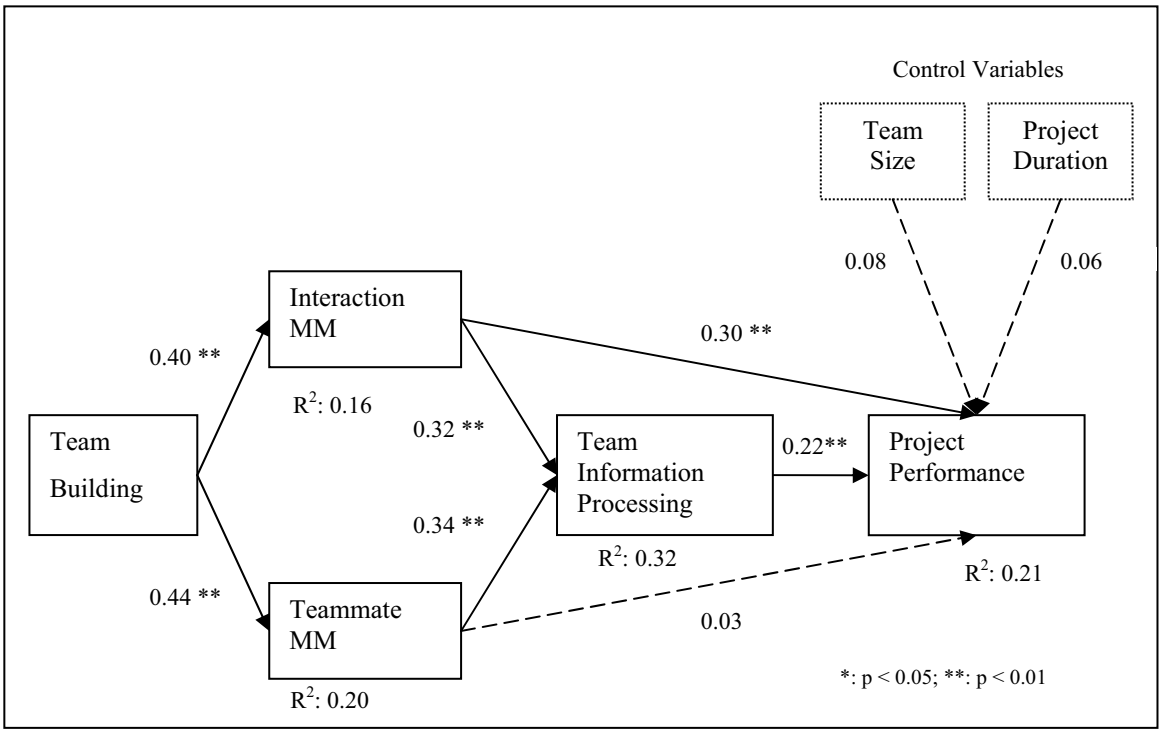

Figure 1. Path analysis result

DISCUSSION

As we hypothesized, team building intervention leads to higher shared TMMs which in turn facilitates better information processing within the team. Meanwhile, performance is affected by interaction MM and information processing. Insignificant relationship between teammate MM and project performance suggests the mediating effect of information processing is a stronger indicator. Although early research proposed teamwork mental model includes teammate and interaction mental models, most empirical studies combine these two and name it as "teamwork mental model" (e.g. Mathieu et al., 2000). In a meta-analysis study conducted by Griepentrog and Fleming (2003), the composite construct "teamwork mental model" is found to have positive and direct effect on team performance. However, after separating them into two separate constructs, we found that teammate and interaction MM do not have a direct relationship to performance. Teammate MM contributes to team performance by enhancing information processing. Knowledge of teammate is not sufficient, information need to be exchanged and utilized so that tasks can be accomplished.

A couple of implications can be garnered from this research. *First*, team building serves as a useful tool for team leader to build a cohesive, temporary ISD team. Team building activities increase the interaction among members and intensive interaction serves as a basis for generating TMMs. Team building includes activities that increase communication, clarify group goal, promote mutual supportiveness, and facilitate group problem solving. Through those interaction processes, team members become familiar with each other and other people's behavior become predictable. Team leaders should perform such activities to improve teamwork climate.

Second, TMMs increase team performance both directly and indirectly. The direct effect has been supported by prior studies. Our results confirm previous studies by showing the direct effect of TMM on project performance - but only for interaction

MM. The direct effect of interaction MM indicates that the presence of clear roles and responsibilities reduces the ambiguity of work assignment and prevents possible barriers in integrating individual task contributions to the team's deliverable. On the other hand, although previous studies show that knowing teammate's knowledge directly results in team performance; this effect is insignificant in this study. This result may be due to the nature of individual tasks in outsourced IS development. The increasingly modular design of software production (Carmel and Agarwal 2002), has resulted in high levels of task partitioning in offshore, outsourced IS development processes. In an outsourced development environment, each member's work is assigned by a team leader. Based upon the team member's knowledge and abilities, the team leader assigns tasks to the team members. Team members report progress to the leader and seek assistance when problems arise. Project performance is greatly determined by how well the team leader can manage his staff. This reduces the magnitude of the direct effect of teammate MM on performance.

Although teammate mental models don't have a direct effect on performance, they do affect team information processing which in turns affects the performance. Information processing serves as a mediator between TMM and performance. In order to achieve better information exchange and utilization, we found that it is very important for team leader to build a common understanding among members first. Future research should investigate other potential mediators or moderators between TMM and performance.

CONCLUSION

By collecting data from outsourcing vendors, we show the effect of team building on TMMs and how TMMs affect information processing and team performance in temporary teams. This study is not without limitations. First, we surveyed one team member in each team only and used a surrogate construct to measure TMM. Future research should obtain individual mental models and make comparisons to see whether teammates really share a mental model. Second, all data are from one respondent type, common method bias might raise a potential problem. Although we use Harman's single factor test to show CMV is not a problem in our study, data from multiple viewpoints are preferred. Third, task MM is not included in this study, to comprehensively understand the effect of different MMs, future research should incorporate different kinds of mental models.

REFERENCES

1. Blickensderfer, E., Cannon-Bowers, J.A., and Salas, E. "Theoretical bases for team self-correction: Fostering shared mental models," *Advances in Interdisciplinary Studies of Work Teams* (4) 1997, pp 249-279.
2. Cannon-Bowers J. A., Salas E, Converse S. "Shared mental models in expert team decision making." In *Individual and Group Decision Making*, Castellan N. J. (ed.). Lawrence Erlbaum Associates: Hillsdale, NJ; 1993, pp. 221-246.
3. Cannon-Bowers, J.A., Salas, E., and Convers, S.A. "Cognitive psychology and team training: Training shared mental models and complex systems," *Human Factors Bulletin*) 1990.
4. Cohen, S.G. & Bailey, D.E. "What makes teams work: Group effectiveness research from the shop floor to the executive suite," *Journal of Management*, 1997, (23:3), pp. 239-290
5. Constantine, L. "Work Organization: paradigms for project management and organization," *Communications of the ACM* (36:10) 1993, pp 35-43.
6. Converse, S.A., Cannon-Bowers, J.A., and Salas, E. "Shared mental models: A theory and some methodological issues. ," Proceedings of the human factors society: Thirty-fifth annual meeting 1991, pp. 1417-1421.
7. Carmel, E., Agarwal, R. "The Maturation of Offshore Sourcing of Information Technology Work", *Management Information Systems Quarterly Executive*, 2002, (1:2), 65-77.
8. D'Andrea-O'Brien, C., and Buono, A.F. "Building effective learning teams: Lessons from the field," *SAM Advanced Management Journal (07497075)* (61:3), Summer 1996, p 4.
9. Deeter-Schmelz, D. R. and Ramsey, R. P. "An Investigation of Team Information Processing in Service Teams: Exploring the Link Between Teams and Customers," *Journal of the Academy of Marketing Science*, 2003, (31), pp. 409–424.
10. Dennis, A. "Information Exchange and Use in Small Group Decision Making," *Small Group Research*, 1996, (27:4), pp.532-550.

11. Dennis, A. R., Hilmer, K. M., Taylor, N. J. and Polito, A. "Information Exchange and Use in GSS and Verbal Group Decision Making: Effects of Minority Influence," in the *Proceedings of the 30th Hawaii Interactional Conference*, 1997, (2), pp.84-93.
12. Outsourcing to India: Crouching tiger set to pounce, *Deutsche Bank Research*, Oct 25, 2005.
13. Espinosa, J.A., Slaughter, S.A., Herbsleb, J.D., Kraut, R.E., Lerch, J.F., and Mokus, A. "Shared mental models, familiarity, and coordination: A multi-method study of distributed software teams," in: *Twenty-Third International Conference on Information Systems*, 2002.
14. Fiske, S.T., and Taylor, S.E. *Social cognition* McGraw Hill, Inc. , New York, 1991.
15. Gersick, C. "Time an transition in work teams: toward a new model of group development," *Academy of Management Journal* (31:1) 1988, pp 9-41.
16. Gilbert, J.A., and Tang, T.L.-P. "An Examination of Organizational Trust Antecedents," *Public Personnel Management* (27:3), Fall 1998, p 321.
17. Griepentrog, B. K., & Fleming, P. J. (2003). *Shared mental models and team performance: Are you thinking what we're thinking?* Paper presented at the 18th Annual Conference of the Society of Industrial and Organizational Psychology, April 11-13, 2003, Orlando, Florida
18. Hackman, J. R. "The design of work teams". in *Handbook of organizational behavior*, J.W. Lorsch (Ed.), Englewood Cliffs, NJ: Prentice–Hall, 1983
19. Hackman, J.R., and Morris, C.G. "Group Tasks, Group Interaction Process, and Group Performance Effectiveness: A Review and Proposed Integration." in: *Advances in Experimental Social Psychology*
20. Hinsz VB, Tindale RS, Vollrath DA. "The emerging conceptualization of groups as information processors," *Psychological Bulletin*, 1997, (121): 43-64.
21. Hoegl, M., and Gemuenden, H.G. "Teamwork Quality and the Success of Innovative Projects: A Theoretical Concept and Empirical Evidence," *Organization Science* (12:4) 2001, pp 435-449.
22. Holyoak, K.J. "Analogical thinking and human intelligence," in *Advances in the Psychology of Human Intelligence 2*, R.J, Sternberg (ed.), Hillsdale, NJ: Lawrence Erlbaum Associates, 1984, pp. 199-230
23. Janz, B.D. "Self-directed teams in IS: correlates for improved systems development work outcomes," *Information and Management* (35:3) 1999, pp 171-192.
24. Janz, B.D., Wetherbe, J.C., Davis, G.B., and Noe, R.A. "Reengineering the systems development process: the link between autonomous teams and business process outcomes," *Journal of Management Information Systems* (14:1) 1997, pp 41-68.
25. Jeffery, A.B., Maes, J.D., and Bratton-Jeffery, M.F. "Improving team decision-making performance with collaborative modeling," *Team Performance Management* (11:1-2) 2005, p 40?40.
26. Kelly, G.A. "The Psychology of Personal Constructs," (Vols. 1 and 2). New York: Norton, 1955
27. Klimoski, R. and Mohammed, S. "Team Mental Model: Construct or Metaphor?" *Journal of Management*, 1994, (20:2), pp.403-437.
28. Levesque, L.L., Wilson, J.M., and Wholey, D.R. "Cognitive divergence and shared mental models in software development project teams," *Journal of Organizational Behavior* (22:2) 2001, pp 135-144.
29. Marks, M.A., Sabella, M.J., Burke, C.S., and Zaccaro, S.J. "The Impact of Cross-Training on Team Effectiveness," *Journal of Applied Psychology*, 2002, (87:1), pp. 3.
30. Marks, M.A., Zaccaro, S.J., and Mathieu, J.E. "Performance Implications of Leader Briefings and Team-Interaction Training for Team Adaptation to Novel Environments," *Journal of Applied Psychology*, 2000, (85:6), p 971.
31. Marks, M.A., Zaccaro, S.J., and Mathieu, J.E. "Performance Implications of Leader Briefings and Team-Interaction Training for Team Adaptation to Novel Environments," *Journal of Applied Psychology* (85:6) 2000, pp 971-986.
32. Mathieu, J.E., Goodwin, G.F., Heffner, T.S., Salas, E., and Cannon-Bowers, J.A. "The Influence of Shared Mental Models on Team Process and Performance," *Journal of Applied Psychology*, 2000, (85:2) pp. 273.

33. Mathieu, J.E., Heffner, T.S., Goodwin, G.F., Cannon-Bowers, J.A., and Salas, E. "Scaling the quality of teammates' mental models: equifinality and normative comparisons," *Journal of Organizational Behavior*, 2005, (26:1), pp. 37.

34. Millward, L. J., Jeffries, N "The team survey: a tool for health care team development", *Journal of Advanced Nursing,* 2001, (35:2) pp. 276-287.

35. Nath, R., & Lederer, A. L. "Team Building For IS Success," *Information Systems Management*, 1996 (13:2), pp.32-37.

36. Nonaka, I "The knowledge-creating company", in Starkey, K. (Eds), *How Organizations Learn*, International Thomson Business Press, London, 1996.

37. Porras, J. I., & Berg, P. O. "The Impact of Organization Development," *The Academy of Management Review*, 1978 (3:2), pp.249-266.

38. Propp, K. "Information Utilization in Small Group Decision Making: A Study of the Evaluative Interaction Model " *Small Group Research* (28:3) 1997, pp 424-453

39. Rasker, P.C., and Post, W.M. "Effects of two types of intra-team feedback on developing a shared mental model in Command and Control teams," *Ergonomics* (43:8) 2000, p 1167.

40. Rentsch, J. R., and Klimoski, R. J. —Why Do Great Minds Think Alike? Antecedents of Team Member Schema Agreement, *Journal of Organizational Behavior*, 2001, (22), pp. 107-120.

41. Rouse, W. B. and N. M. Morris "On looking into the black box: Prospects and limits in the search for mental models," *Psychological Bulletin*, 1986, (100:3), pp. 349-363.

42. Salas, E., Dickinson, T. L., Converse, S. A., & Tannenbaum, S. L. "Toward an Understanding of team performance and training" in *Teams: their training and performance*, R. W. Swezey & E. Salas (Eds.), Norwood, NJ: Ablex, 1992, pp.3-29.

43. Salas, E., Dickinson, T.L., Converse, S.A., and Tannenbaum, S.I. "Toward an Understanding of Team Performance and Training.," in: *Teams: Their Training and Performance,* R.W. Swezey and E. Salas (eds.), Ablex publishing, Norwood, NJ 1992, pp. 3-30.

44. Salas, E., Rozell, D., Mullen, B., and Driskell, J.E. "The Effect of Team Building on Performance," *Small Group Research* (30:3) 1999, p 309.

45. Smircich, L. "Organizations as shared meanings. ," in: *Organizational symbolism,* L.R. Pondy, P.J. Frost, G. Morgan and T.C. Dandridge (eds.), JAI Press Greenwich, CT 1983, pp. 55-65

46. Sproull, L., and S. Kiesler, *Connections*. Cambridge MA: MIT Press, 1991

47. Sundström, E., De Meuse, K., and Futrell, D. "Work teams: applications and performance," *American Psychologists* (45) 1990, pp 120-133.

48. Swaab, R. I., Postmes, T., Neijens, P., Kiers, M. H., and Dumay, A. C. M. "Multiparty negotiation support: The role of visualization's influence on the development of shared mental models," *Journal of Management Information Systems*, 2002, (19), pp.129-150.

49. Stout, R.J., Cannon-Bowers, J.A., and Salas, E. "The role of shared mental models in developing team situational awareness: Implications for training," *Training Research Journal* (2:85-116) 1996, p 1997.

50. Tannenbaum, S., Beard, R., and Salas, E. "Teambuilding and its infuence on team effectiveness: an examination of conceptual and empirical development." in: *Issues, Theory and Research in Industrial/Occupational Psychology: Advances in Psychology San Francisco, pp. 117-153. ,* K. Kelley (ed.), Jossey Bass, 1992, pp. 34-35.

51. Thomson, L., and Fine, G. A. "Socially Shared Cognition, Affect, and Behavior: A Review and Integration," *Personality and Social Psychology Review*, 1999, (34), pp. 278-302

52. Walsh, J. "Managerial and organizational cognition: Notes from a trip down memory lane," *Organization Science*, 1995, (6), pp. 280-321

53. Webber, S.S., Chen, G., Payne, S.C., Marsh, S.M., and Zaccaro, S.J. "Enhancing Team Mental Model Measurement With Performance Appraisal Practices," *Organizational Research Methods*, 2000, (3:4), pp. 307.

54. Weick, K.E., and Roberts, K.H. "Collective Mind in Organizations: Heedful Interrelating on Flight Decks," *Administrative Science Quarterly* (38:3) 1993, pp 357-381.

55. Yeatts, D.E., and Hyten, C. *High-performing self-managed work teams.* Sage Publications, Thousand Oaks, CA 1998.