

Virtual Teams as Sociotechnical Systems

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INTRODUCTION

A virtual team can be described as an organizational unit unconstrained by geographical, temporal, organizational, and/or national boundaries (Townsend, DeMarie & Hendrickson, 1998). Despite their rising popularity, numerous issues exist surrounding how virtual teams can productively coordinate their resources, activities, and information, often in dynamic and uncertain task environments (Fiore, Salas, Cuevas & Bowers, 2003; Townsend et al., 1998). With organizational structure increasing in complexity to include both co-located and virtual team members, explicit linkages between theory and practice are critically needed to mitigate the negative effects that technology-mediated interaction may have on virtual team productivity. Our goal here is to demonstrate how classic and current theories and principles from organizational psychology can be effectively integrated within a sociotechnical systems framework to address the unique challenges faced by this subset of teams. Specifically, we analyze the effects that collaborative information technology and lack of co-location may have on virtual team members. We conclude with suggested interventions for organizational practice.

BACKGROUND

Open Sociotechnical Systems

Radical changes in organizational structure brought about through advances in technology represent a critical challenge for the appropriate application of theoretically-based principles in system design. Researchers and practitioners need to focus on system design issues not only at the individual or task level, but also at the team and organizational level. This involves a system-level analy-

sis (Hendrick, 1997) of the following sociotechnical factors that interact to shape organizational outcomes and may hinder attainment of organizational goals:

- (1) *Personnel subsystem*: comprised of the organizational unit's members
- (2) *Technological subsystem*: representing the technology available to the organizational unit
- (3) *External environmental variables*: which act upon the organizational unit

Taken as a whole, these subsystems collectively represent the organizational unit as a *sociotechnical system*. Because the organizational unit both acts on and is acted upon by external forces, it would be considered an *open* sociotechnical system (Emery & Trist, 1960). Thus, the organizational unit can be viewed as a complex set of dynamically intertwined and interconnected elements, including inputs, processes (throughputs), outputs, feedback loops, and the environment in which it operates and interacts (Katz & Kahn, 1966).

Team Opacity in Distributed Environments

The technological component, in particular, plays a key mediating role by setting limits upon the system's actions as well as by creating new demands that must be reflected in the internal structure and goals of the organizational unit (Emery & Trist, 1960). In distributed environments, the technological subsystem may have a potentially greater effect on team member interactions than would be expected in traditional co-located task environments. Virtual teams rely primarily on electronic communication processes to work together both synchronously (e.g., video conferencing, Internet chat rooms) and asynchronously (e.g., electronic mail, bulletin boards) to accom-

Table 1. Factors influencing virtual team productivity

Factor	Definition/Description	Impact on Virtual Team Productivity
INPUT FACTORS		
<i>Resources</i>	Personnel subsystem: <ul style="list-style-type: none"> Individual member knowledge, skills, attitudes Team size, composition 	<ul style="list-style-type: none"> May be differentially affected by technological subsystem limitations (e.g., media richness, information synchrony) With low media richness, team opacity may: <ul style="list-style-type: none"> filter out critical paralinguistic cues hinder development of mutual trust (Avolio et al., 2001; Fiore, Salas & Cannon-Bowers, 2001) Conversely, lack of visual cues may lead to: <ul style="list-style-type: none"> greater focus on task-relevant member attributes (e.g., skills) less focus on task-irrelevant stereotypical attributes (e.g., race) selection of leaders that more closely embody team values, ideals, and goals (McKenna & Green, 2002)
<i>Task Demands</i>	Nature of task (e.g., task complexity) and other work structure factors (e.g., communication channels) that form technological subsystem and external environment	<ul style="list-style-type: none"> Team opacity may lead to: <ul style="list-style-type: none"> limited ability to monitor task-relevant cues provided by geographically dispersed teammates over-reliance on explicit communication strategies, resulting in poor task performance under conditions of high workload and task complexity (Entin & Serfaty, 1999) additional cognitive workload upon memory processes, inducing greater occurrence of memory failures (Fiore, Cuevas, Schooler & Salas, in press)
THROUGHPUT FACTORS		
<i>Combination Processes</i>	Various <i>implicit</i> (i.e., tacit) and <i>explicit</i> (i.e., overt) team processes and/or behaviors (e.g., communication, coordination, decision making) necessary to accomplish team's goals and/or task objectives	<ul style="list-style-type: none"> With low media richness (e.g., electronic mail), team opacity may limit or altogether eliminate use of: <ul style="list-style-type: none"> nonverbal, paralinguistic cues (e.g., hand gestures) when conveying information crucial to completion of complex tasks (Tang, 1991) beneficial information yielded in <i>process</i> artifacts emerging from collaborative work (Tang, 1991) implicit communication and/or coordination strategies (Fiore et al., 2003)
<i>Process Losses</i>	Loss in team productivity resulting from poor coordination among members (i.e., lack of simultaneity of effort) and/or decreased social motivation (Steiner, 1972)	<ul style="list-style-type: none"> Due to lack of nonverbal cues, ambiguous nature of distributed interaction, and subsequent over-reliance on explicit strategies (Fiore et al., 2003), team opacity may: <ul style="list-style-type: none"> negatively impact execution of combination processes needed to attain desired outcomes impede evolution of mutual trust, collective efficacy, and group cohesion, leading to poorly developed team attitudes and decreased social motivation
<i>Motivation</i>	Intrinsic and extrinsic factors that lead an individual to engage in a particular behavior or choose one course of action over another (Locke & Latham, 2002); motivation theories (e.g., goal-setting, self-regulation) focus on the underlying behaviors necessary to accomplish set goals (Bandura, 1986; Locke & Latham, 2002)	<ul style="list-style-type: none"> Team opacity may negatively impact: <ul style="list-style-type: none"> <i>goal commitment</i> due to impoverished nature of interaction and lack of motivating influence of paralinguistic cues inherent in face-to-face interactions (Teasley, Covi, Krishnan & Olson, 2000) development of common, engaging <i>direction</i> for virtual team, depending upon information flow (i.e., synchronous or asynchronous), resulting in poor motivation to meet training and/or performance objectives (Fussell et al., 1998) <i>collective efficacy</i> (i.e., members' belief in their team's ability or competence to attain desired outcomes; Bandura, 1986) due to limited opportunities for monitoring and evaluating other members' performance (Fiore et al., 2003)
<i>Shared Mental Models (SMMs)</i>	Shared understanding among team members of each member's roles and responsibilities, task demands, and team-level interactions required to meet these demands (Cannon-Bowers, Salas & Converse, 1993); SMMs improve team's ability to coordinate efforts, adapt to changing demands, anticipate needs of task and other members, and foster development of mutual trust (Avolio et al., 2001; Entin & Serfaty, 1999)	<ul style="list-style-type: none"> Team opacity hinders SMM development due to decreased awareness of team member actions and expectations, resulting in: <ul style="list-style-type: none"> increased communication and coordination overhead due to over-reliance on explicit strategies (Entin & Serfaty, 1999) uncoordinated efforts, low team productivity, and unsuccessful attainment of organizational goals (Espinosa, Lerch & Kraut, 2004) diminished identification of role knowledge and poor source monitoring (Durso, Hackworth, Barile, Dougherty & Ohrt, 1998) poorly developed team attitudes (Fiore et al., 2001)

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