

LARGE SCALE COORDINATION: THE STUDY OF GROUPS AT WORK

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Naturalistic decision making (NDM) methods have previously been applied to understand individual and group cognition. The systemic aspects of work that are unavailable through the study of individuals or a single group can be revealed by cognitive research at large scale, *among* and *across* groups. The papers in this symposium explore the use of NDM methods including cognitive systems engineering to reveal how groups of operators have developed ways to perform inter-group work in real world settings. Insights from such studies inform the development of system-level products, including safety counter-measures and information and communication technology (ITC) that is intended to support this work.

INTRODUCTION

For the human factors professional, collaboration among workers is “large” in scale when it takes place beyond small, stable groups that can accomplish their work within limited time spans. Complex work is typically divided into subtasks and assigned to individuals who interact with one another when their subtasks interact. (Obradovich and Smith, 2003) This is *joint activity*, an extended set of actions that is carried out by an ensemble of people who are coordinating with one another. Joint activity participants must intend to work together, be mutually predictable and directable, and maintain a common ground. (Klein, *et.al.*, 2004) High-level performance of the cognitive work that is involved in these work settings depends on the provision of support for both resilience (the ability to anticipate and adapt to potential surprise and error) and coordination (the ability to synchronize activity across agents). (Woods, 2005). Individuals’ *ad hoc* networks (Nardi, *et.al.*, 2002), time, and distance influence work relationships across groups.

COORDINATION RESEARCH

Both the real world of work and the information and communications technology (ICT) that is available to support it are in constant flux. Operators adapt to changes in the environment. Interactions occur within groups, among groups, between operators and the ICT systems that are intended to support them, and with the environment in which they operate. Technology evolves on its own path of opportunities based on new conceptions, software, materials, and production processes. The interaction of these elements, or *agent-environment mutuality* (Woods, 2000), challenges the researcher in complex settings to look past a work domain’s available (but ultimately superficial) traits in order to discover its deeper, durable aspects. The use of cognitive engineering methods (Woods and Roth, 1988) enables the researcher to confront and make sense of what has been referred to as the “messy details” of each work domain (Nemeth, Cook and Woods, 2004). Cognitive research using this approach at large scale, among

and *across* groups, reveals systemic aspects of work that are unavailable through the study of individuals or a single group. The papers in this symposium explore the use of NDM methods to reveal how groups of operators have developed ways to perform inter-group work in real world settings.

The symposium’s authors studied a diverse selection of applications, including train dispatching, disaster response, and surgical operating room management. The workplace studies tradition (Heath, Luff, Hindmarsh, 2000; Heath, 2000) recognizes and reveals the sophisticated approaches to work that individuals and groups develop. This is particularly well demonstrated by Roth, *et.al.* in their paper on fostering shared situation awareness and on-track safety. Insightful interviews and observation of crews at work discovered informal, distributed, cooperative practices such as “courtesies” and “party line” use of communication networks. These initiatives extended team member peripheral awareness, keeping others on the track right of way aware of approaching trains. This appreciation of rail worker cognition lays the groundwork for development of an ICT device to support the real-time cognitive work of track maintenance and inspection.

The density, specificity, and tempo of their work can make it difficult for operators at the sharp end to objectively assess their own work processes. Cognitive studies can benefit operators simply by making them aware of the work that they perform. This makes it possible for the workers to reflect on what they do and how they do it more objectively, and make changes without exhaustive rationales. This approach is described by Millitello, *et.al.* in their paper on the exercise of an county-level emergency services control center during a simulated large tornado incident. Researchers were able to observe how participants gravitated to and used pertinent information as the incident and deployment of resources evolved. Participant comments demonstrate how their perceptions change when the focus shifts from one, to multiple, agencies.

Simulation is a proven approach to explore the implications of trial solutions through practical application. New

lenge is to focus on cognition, how it changes as a result of new ICT, and why that is. Mackenzie, *et. al.*, used adverse event simulation as a means to examine the degree to which various media could support cognition among distributed collaborators. “Large scale” coordination in this instance spanned continents, introducing issues such as language that the other studies did not engage. This study points to further opportunities to learn how the different media did or did not affect situation awareness, perception, ability to make decisions, and recollection of circumstances at the incident site. It also shows the difficulties that teams experience when fragile interlaced ICT systems do not operate as planned.

Artifact analysis, observation and interviews can be used to reveal cognitive work that is performed in the healthcare setting. (Nemeth, 2003; 2004) Xiao, *et. al.*, uses these methods to explore the the management of scheduling conflicts, discovering the role of negotiation and norms such as fairness and commitment. They point to the implications that ITC systems pose, such as the erosion of control, or providing some workers with a real or perceived advantage.

ISSUES

The symposium’s authors have identified interactions that occur in response to the inclusion of ICT as a member of the work team. (Christoffersen and Woods, 2002) Despite the particular details of each application, authors discovered interactions among people, technology and work (Woods, 2000) that were common traits in the organizational environments that were studied: nested short-term and long-term goals, competing interests among stakeholders, intertwining organizational and professional structures, and blurred organizational boundaries. Further research activity would help to understand these implications of how group work changes in response to the introduction of ICT:

Social and political processes—Improved access to information may subvert expectations of privacy, autonomy, fairness, and authorities’ ability to exert control.

Work redistribution—How much data entry is needed, and who should perform the task in a system, change.

Complexity—Work is fragmented, not simplified, requiring more coordination. Organizations must constantly adapt to ICT’s uncertain reliability, rapid advances, and introductions over time.

Flexibility—Fragmented work roles and workload can be difficult to reorganize in reaction to unexpected events.

Procedures, people and technology do interact. Understanding how they interact and what the implications are for future ITC systems flows from NDM research. Additional inquiry into this rich and challenging field can address questions of what it means be a “team,” how IT can aid cognitive work, and how IT can be used to enrich cognitive work within and among groups.

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