Exploring Communication in Remote Teams: Issues and Methods

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Teamwork in many operational settings, such as air traffic control or telemedicine, involves members who are at different locations and, as in space exploration missions, may communicate under time-delayed conditions. Collaboration and coordination in distributed teams differ from face-to-face interactions in a number of important respects (Brennan & Lockridge, 2006). Remote communication eliminates visual cues and thus requires more effort to establish common ground. Unlike co-present partners, distributed team members cannot rely on gestures and facial expressions to direct the other's attention and provide feedback on their understanding. Voice communication between remote partners maintains the meaning nuances of face-to-face interactions that is lacking in text-based conversations. On the other hand, writing enables partners to re-read and thus to remember past communications, and to review and revise their messages prior to sharing them with others. These resources are not available in spoken discourse where participants have to rely on their memory or external aids (e.g., note pads) to keep track of the flow of the conversation and to compose their contributions. Transmission delays between partners' contributions further complicate grounding (Olson, G., & Olson, J., 2000). The timing of turns is challenging, and individual contributions may be out of sequence, making it difficult for team members to follow the thread of a conversation and thus to develop shared situation models. Moreover, distributed teams frequently consist of individuals with different expertise and different goals, differences that may hamper mutual understanding and collaboration (Bearman, Paletz, Orasanu, & Thomas, 2010).

This panel brings together researchers who have examined team communication in a variety of domains: healthcare (Morrow), aviation (Mosier), Navy (Miller), disaster response (Veinott), and space missions (Fischer, Miller). Panelists will be asked to characterize the constraints faced by conversational partners in these domains, to present analytic tools for studying remote communication and to discuss procedural or technological solutions to facilitate collaboration and coordination in distributed teams.

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MISSION CONTROL–SPACE CREW COMMUNICATION: CHALLENGES OF TRANSMISSION DELAYS

Ute Fischer

Effective and efficient communication between Mission Control and space crews is essential for successful task performance and mission safety. The importance of team communication is heightened when unforeseen problems arise, such as system failures or medical emergencies that are time-critical and require extensive coordination and collaboration between space and ground crews. During long duration space missions and missions beyond Low Earth Orbit, space-ground interactions will involve delays up to 20 minutes one way, a reality that poses a formidable challenge to team communication and task performance.

For this panel I will initiate the discussion of time delay in communications by providing a brief overview of two ongoing research efforts examining the impact of transmission delay on space-ground interactions. In one study we analyzed the communications between four flight control–space crew teams during simulated missions in a space analog, the Deep Space Habitat at Johnson Space Center (Frank et al., submitted). Teams participated in two 2-hour sessions, one presenting participants with a communication delay of 50 seconds, the other involving a 300 second delay. Audio recordings of space-ground communications were transcribed and their structure and content examined using Common Ground Theory (Clark, 1996) as a theoretical framework, and adopting analytical tools of past research on communication in distributed but temporally co-present teams (Fischer, McDonnell, & Orasanu, 2007; Morrow & Fischer, 2013).

Analyses revealed that both time delays disrupted the communication flow between space and ground teams. Communications by flight controllers and astronauts overlapped, rendering contributions inaudible and requiring costly repair sequences. Transmission delays also resulted in contributions being overtaken by the course of events and likely increased cognitive workload as team members had to keep track of multiple threads of conversations while completing ongoing tasks. Adherence to communication procedures that could facilitate grounding was surprisingly low, given the professional sample in this study. Flight controllers and astronauts did not consistently mark the end of their contributions to support turn taking, or identify themselves and specify the addressee of their communication, thus requiring additional inferences by the recipient to establish the identity of a speaker and his or her intended audience. Moreover, listener feedback was frequently not optimal as space crews and flight controllers provided minimal evidence of their understanding, or failed to respond altogether to a partner's communication. In issuing minimal responses (e.g., *copy all*), team members acknowledged hearing a communication but the accuracy of their understanding could not be established and occasionally resulted in misunderstandings and incorrect crew actions. Several strategies—timing of contributions, chunking of complex information, repetition of critical items and starting a communication with a summary akin to a subject header –were observed that could support team communication under time-delayed conditions.

The second, ongoing study is a lab experiment designed to determine the impact of transmission delay on team communication. Adult participants work in teams of three (one as flight controller and two as space crew) on a computer-based micro-world (AutoCams; Manzey et al., 2008), which simulates the life support system of a spacecraft and requires team members to monitor and control different subsystems, to diagnose failures and to repair them. The impact of communication delay (no delay vs. 5 min. delay) is explored under different media conditions (voice vs. text) and in relation to different task characteristics (procedural vs. ill-defined).

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SMART INFORMATION FLOW TECHNOLOGIES

Christopher A. Miller

Teams exchange information via communications, of course. Communications enable the flow of task-related information between individuals, thereby achieving any workload distribution, awareness enhancement or sense-making benefits that the multiple team members will provide. But team communications also provide the source and flow of interpersonal cues that establish and maintain relationships which enable the team to identify and maintain itself as a team, as well as the cues about personality, attitude, emotion and even cognitive state of each individual that allow the team to adapt to its members' ever-changing capabilities. In fact, it is not unreasonable to take the position that the "team" exists only in the interactions between its individual members. Therefore, it seems quite sensible, as most researchers have done, to study team communications as a primary indicator of team function, health, dynamics and status.

In recent work for the U.S. Navy, and ongoing work for NASA, we have been developing tools and techniques for the automated, non-intrusive assessment of psycho-social states from team interactions. We are leveraging word counting and categorical scoring techniques (Pennebaker, 2011) to infer attributes such as emotional positivity or negativity or temporal focus, and Latent Semantic Analysis (Landauer, Foltz & Laham, 1998) to infer the overall valence of all words used in interaction or similarity of utterances over time. In addition, we are applying our own novel techniques (Miller & Rye, 2012) focused on politeness behaviors in interactions (e.g., the use of please and thank you, but more usefully, the use of unredressed directives and first person vs. second person verb forms) to deduce power relationships and their dynamic shifts over time.

Another recent innovation is the assembling of a mixture of linguistic behavior recognizers to detect cognitive and emotional indicators of a team behaving in a “comfortable routine” vs. not. This detector, for example, relies on the recognition and weighted scoring of cognitive mechanism terms indicative of reflection, diagnosis or thought (e.g. “think, believe, understand,” etc.), those indicative of causal thinking (e.g., “because, due to, therefore,” etc.), past tense (since reference to past events is generally not compatible with pure routine behaviors), and negative emotion and dispute to provide a probabilistic assessment of “comfortable routine” over multiple utterances.

Other team and interaction-based recognition strategies are clearly possible, and we are currently working on detecting emotional relationships, team roles and performance vs. procedural expectations. While past work has been conducted entirely with text or hand-transcribed speech records, we are beginning work with automated speech-to-text transcription.

We are not yet at a point to be able to make general claims about team communications and team relationships and performance. Instead, our focus is on the development of valid tools to make the study of such phenomena easier and more powerful. Our power detectors have been developed and tested on datasets ranging from corporate emails, to hacker network chat, to transcripts of telephone wiretaps from Mafia trials. In the final demonstration from our Navy program, we collected a week’s worth of chatroom exchanges from multiple groups of U.S. Marines and contractors within a large joint forces exercise. Each chatroom had a defined power hierarchy (an “org chart”) and we were 100% successful at detecting key power relationships within those power networks over the week and showed hints of the sensitivity of our analysis—including identifying a visiting intern on one team as having less power than the long term team members. More recent work is analyzing transcripts of the Apollo moon missions and team interactions in space exploration simulation for interesting variations in the power and “routine” behaviors of the participants in those missions. For example, our Apollo analyses showed both less “comfortable routine” and a very different pattern of involvement and power assertion for the Apollo 13 mission (with its nearly disastrous Oxygen tank explosion) compared to the other Apollo missions.

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LEVERAGING HEALTH INFORMATION TECHNOLOGY TO SUPPORT PATIENT/PROVIDER COLLABORATION

Daniel Morrow

Collaboration between patients and providers is essential to patient-centered health care, especially for older adults who manage demanding self-care tasks such as taking multiple medications. Unfortunately, inadequate collaboration often undermines patient-centered care. Collaboration requires conversational partners to coordinate communication processes and content: Speakers present information (nonverbally or verbally) and listeners signal that they understand, either implicitly with a relevant response or explicitly by nonverbal or verbal acknowledgment. Thus, speakers and listeners are jointly responsible for ensuring that information is mutually accepted as understood and relevant to shared goals, or in common ground; that is, they must ‘close the communication loop.’ Face-to-face communication during clinical visits affords many resources for grounding information (e.g., nonverbal cues such as facial expressions and speech prosody help speakers and listeners). Nonetheless, critical health information is often not presented or is presented in ways that are difficult to understand. Most important, health care providers and patients often do not work together to explicitly ground presented information, so that patients leave visits without a clear idea of how to act on the information. These 'collaborative lapses' are caused by many factors, including limited communication time and training, and especially the cognitive load associated with presenting and understanding complex and often emotionally charged information through transient speech modality by partners who may have differing agendas.

Health information technology (HIT) has the potential to address these collaborative lapses and improve patient-centered care. For example, Electronic Health Record (EHR) systems can provide patients direct access to large amounts of health information and services through patient portals. However, HIT may erode rather than enhance collaboration if it expands access to health information without supporting patients and providers' ability to ground this information.

My colleagues and I are investigating HIT-based tools that are designed to support patient/provider collaboration during face-to-face clinical encounters, and that may support collaboration during asynchronous communication. I will briefly summarize evidence that the tools improve performance on a simulated collaborative medication planning task, as well as describe an ongoing clinical trial that investigates effects of an EHR-based version of the tool on medication knowledge and use among older adults with diabetes. I conclude by considering how to support patient/provider collaboration during asynchronous communication, such as patient portals to EHRs.

COMMUNICATION ISSUES IN DISTRIBUTED AIR-GROUND TEAMS

Kathleen L. Mosier

Maintaining flight safety in aviation operations is a team effort and depends crucially on effective crew communication. In aviation flight simulations poor task performance by crews has been associated with specific communication defects that are consistent with a loss in team perspective. Members of high-error crews shared less information than more successful crews, in particular concerning their plans and task management (Orasanu & Fischer, 1992). Analyses of aviation accidents isolated further problematic aspects of crew communication, especially indirect speech and ambiguous references (Fischer & Orasanu, 2000). Intra-cockpit communication failures may jeopardize crew decision making in significant ways. For example, when critical information is not clearly communicated or shared at all, team members may not develop a common understanding of their situation and available options.

In this panel, I will discuss potential conflicts related to information sharing and interpretation, especially when team members have differing goals and priorities. As we move into Next Generation (NextGen) operations, it will be critical to ensure common situational understanding and effective communication not only within the cockpit, but also between aircrews and ATC. The NextGen air transportation system will be characterized by re-distributed roles and responsibilities for decision making, and cooperative and collaborative problem solving among distributed teams comprised of air and ground team members. Problematic aspects of intra-cockpit communication may be exacerbated in these distributed teams. For example, although information availability will be increased, theoretically giving pilots and ATC access to the same information, differing priorities and goals may impact the way team members access, interpret and use information to make decisions. Conflicts may occur as a result when decisions and requests are based on different information, or different versions of information (Bearman, et al., 2010). In particular, conflicts arising from different interpretations of the same information (e.g., weather, traffic) in terms of its implications for safe and efficient operations may surface more frequently than in current operations.

The phases of flight that occur near airports, that is, departures and arrivals, will be those with the highest workload for pilots and controllers, and will also be the phases with the greatest potential for different perspectives and conflicting goals. For example, ATC may need to focus on efficiency and expediency of operations for all aircraft, while pilots may be focusing on navigating their own aircraft safely through the heavy traffic volume. These different perspectives may in turn lead to different priorities, different plans for a given aircraft, and distinctly different responses to traffic conditions. Communications may falter when the priorities of one team member do not match those of the other team member. For example, in a study of ASRS reports involving communication breakdowns between flight crews and ATC, a specific problem was noted when a reporter (usually a pilot) felt that the affective response of the other party (ATC) did not reflect the same safety concerns or was not appropriate to the situation (Mosier et al., 2010)

The move to datalink communications may have a positive impact on distributed team dynamics in that communications will be scripted. However, other sources of communication conflict such as delayed clearance delivery, repeated uploading of requests, or providing incomplete information may surface. Additionally, voice communications in NextGen are likely to be used primarily in off-nominal or emergency situations – precisely the situations likely to evoke affective reactions – increasing the potential for communication failures.

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COMMUNICATION IN DISASTER RELIEF OPERATIONS

Beth Veinott

Disaster relief operations involve a need for rapid information processing and dissemination, decision making, distributed collaboration, and joint operation teams. Large-scale collaboration efforts involving multiple agencies are particularly challenging and important for effective disaster response. Social media and other collaborative tools have been prominent in several of these disasters. This area of research has been coined ‘crisis informatics’ (Palen & Liu, 2007).

The design and use of social media naturally co-evolve. For an example case, early use of Twitter by civilians to map fire locations during the 2007 Southern California Wild Fires (Palen & Liu, 2007), supported some aspects of distributed collaboration well, but not others (Veinott, Cox, & Mueller, 2009). Consequently, a lot is learned about the emergent properties of collaboration by studying how ad hoc teams use social media systems to augment other collaborative tools.

Technology changes the way people work in interesting, complex, and sometime unpredictable ways. This is often because the technology and users are embedded in a social context, and the system designers and researcher focus on either the technology or the user, but not both in context (Dourish, 2001). In order to design better collaborative systems, one needs to understand the user’s experience in context. Studying large-scale collaboration during disaster response provides such an opportunity and is a good analog for other domains.

For this panel discussion, I will present data on the emergent strategies for social media use during a successful large scale and distributed response to a 100-year flood. Structured interviews were conducted with seventeen personnel from different operational teams involved in the flood response (e.g., national guard, state and local government, and non-government organizations). We identified the collaborative networks and communication tools used to accomplish their disaster response coordination. Social media were used to both push information out to the public and pull information from them. Studying this event can provide insight into how an effective collaboration works from a socio-technical standpoint. Understanding how and why these tools were used will inform the evaluation of social media and other communication technology for disaster response and other analog domains.

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