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Technologies for Augmented Collaboration

Social Domain Issues

Linda Pierce, Janet Sutton, Peter Foltz, Noelle Lavoie, Shelly Scott-Nash, and Ursula Lauper,

Linda Pierce
U.S. Army Research Laboratory
AMSRD-ARL.HR-S
Bldg 459, Rm 233
Aberdeen Proving Ground, MD 21005-5425
410-278-5846/5858
lpierce@arl.army.mil

Janet Sutton
U.S. Army Research Laboratory
Bldg 3040, Rm 220
Fort Sill, OK 73503-5600
580-224-3354
janet.sutton@us.army.mil

Peter Foltz, Noelle Lavoie
Pearson Knowledge Technologies
4940 Pearl East Circle
Boulder, CO 90301
303-545-9092
pfoltz@pearsonkt.com, nlavoie@pearsonkt.com

Shelly Scott-Nash, Ursula Lauper
Micro Analysis and Design, Inc.
4949 Pearl East Circle, Suite 300
Boulder, CO 80301
303-442-6947
ssn@maad.com, ulauper@maad.com

Technologies for Augmented Collaboration

Abstract

Teams have always been important in military operations, but the nature of military teamwork is changing to accommodate an increasing number of missions in stability, security, transition, and reconstruction (SSTR). These missions often require that diverse, distributed experts from multinational forces, non-governmental organizations, and other government agencies work together. Although team member diversity should improve mission performance by increasing access to a broader pool of knowledge, it is more likely to increase conflict and decrease trust, which may result in less information exchange, a lack of shared situation awareness, little team commitment, and ultimately poor team performance. Collaborative technologies generally focus on establishing physical interoperability among distributed team members, to the exclusion of technologies that promote cognitive interoperability. The Army Research Laboratory is investing in technologies to augment collaboration. The first tool is diagnostic, designed to assess cultural preferences and provide instruction on effective interaction strategies. The second tool uses Latent Semantic Analysis, a natural language and machine learning technology to monitor, moderate, evaluate, and provide feedback on team processes based on team communication. An initial capability of these tools was demonstrated in a Sudanese simulation; a revised system will be used in U.S. and Singaporean experiments.

Technologies for Augmented Collaboration
Outline

The Army conducts missions ranging from combat to peacekeeping and humanitarian assistance as a member of a diverse, often distributed, yet interdependent team. These missions are highly complex and dynamic and the teams needed to perform them are generally multi-service and increasingly have been multinational. Joint and multinational operations have been the norm in military command for the past 10 years. Evolving doctrine in response to lessons learned in Afghanistan and Iraq is expanding the military team and increasing the likelihood that the military will work with non-military agencies to plan and conduct operations currently being referred to as stability, security, transition, and reconstruction (SSTR) operations.

SSTR operations were recently established as a core U.S. military mission (United States Department of Defense, 2005). The objective of these missions is to help establish order with the aim of attaining a sustainable peace while advancing U.S. interests. U.S. policy on SSTR operations states that team membership shall be open to representatives from other U.S. departments and agencies, foreign governments and security forces, international organizations, U.S. and foreign non-governmental organizations (NGOs), and members of the private sector with relevant skills and expertise.

The key to successful performance in SSTR operations is the integration of civilian and military experts. In SSTR operations, each member of the team will be an expert in some aspect of the problem. Also, each team member will be advancing a particular agenda or, at least, likely to have a preferred approach to solving the problem. For example, is looting stopped by increased police patrols or more humanitarian relief? The military and NGO team member will probably vary in their approach to this problem. Team members may also differ in how they define the role of the military in performing critical SSTR functions like reestablishing basic services such as a sewage system, a functioning fresh water system, electricity, and trash removal.

The U.S. Army has prepared for and is comfortable with combat. However, the challenges currently facing the U.S. Army in Iraq and the missions it is likely to perform in the future require a different approach, one that is oriented toward achieving long-term regional stability. Consider the issues involved in determining the best method to defeat improvised explosive devices (IEDs). The U.S. military forces clearly have the training and the technology to find and kill at least some of the insurgents in Iraq before they can emplace IEDs, but to achieve long-term success requires the support of the local populace and that is best achieved by establishing or reestablishing security, basic services, and opportunities for growth (Chiarelli & Michaelis, 2005). Chiarelli and Michaelis (2005) state that "if there is nothing else done other than kill bad guys and train others to kill bad guys, the only thing accomplished is moving more people from the fence to the insurgent category—there remains no opportunity to grow the support base" (pg. 6). Current operations are more about winning the peace than winning the war. Thus, a combined approach, agreed upon through discussion and negotiation among experts in a variety of fields (U.S. and multinational military forces, other government agencies (OGAs), NGOs, and local community and political leaders), will be required to address the complex, socially-oriented problems characteristic of SSTR operations.

These complex social problems are “wicked” problems in that there is no known solution and, in fact, merely defining the problem becomes a negotiation among experts (Buckingham Shum, 2003; Rittel & Webber, 1973). A wicked problem is characterized by an evolving set of interlocking issues and constraints and a problem solving process that is fundamentally social. There is no single “right answer,” and often it is more important to develop a solution that diverse stakeholders can accept and modify as the constraints on the solution change over time than to identify the best solution.

While team diversity is needed to perform the variety of tasks inherent in SSTR operations, if not supported the diversity of the team can actually interfere with collaboration to such an extent as to make the inclusion of additional expertise more a hindrance than a help in team performance (Panteli & Sockalingam, 2005). Therefore, researchers at the Army Research Laboratory Human Research and Engineering Directorate are leading a research program to develop technologies to augment collaboration among highly diverse, often distributed team members planning and executing SSTR operations.

Foundation Research in Bosnia-Herzegovina

The research program began in 1999. The focus of the research at that time was to better understand how U.S. Army forces were being prepared for deployment to Bosnia-Herzegovina (B-H), and to use that knowledge to develop technologies to support military training and operations for peacekeeping missions (Pierce & Pomranky, 2001). Based on interview and observational data captured during the training phase of a unit deploying to B-H and post-deployment operations, several barriers to performance (Klein & Pierce, 2001; Pierce, 2002a; Pierce, 2002b) were identified. This work is reviewed here as the basis for the development of collaborative technologies to support the formation, preparation, and operations of military and civilian teams planning and conducting the highly uncertain missions characteristic of SSTR operations.

First among the barriers to performance was an assumption that an army prepared to fight could adapt its warfighting skills for peacekeeping. This assumption led to a “warfighting” mindset that influenced how training was conducted, the level of readiness the unit was able to achieve prior to deployment, and what tasks were given priority once the unit deployed. For example, rather than focusing on the unique skills needed in peacekeeping, pre-deployment training was designed to prepare the unit to respond to threatening situations that could occur in the area of operations, and once deployed the unit continued to plan for low probability, high threat events.

The mission of the sustainment force (SFOR) in B-H as defined by the General Framework Agreement for Peace (GFAP) was to insure a safe and secure environment. However, how best to achieve a safe and secure environment was subject to interpretation. The U.S. forces, leading Multinational Division North (MND(N)), tended to maintain a high force protection posture and minimize risk by adhering to a narrow interpretation of the GFAP, whereas NGOs and other multinational forces supported a more liberal interpretation of the mission. A lack of agreement among team members on how best to achieve the mission led to a splintering of the command team with civil military operations tending to separate from the core Division staff which continued to plan for the worst case scenario. This separation was also seen between the staffs at Division and the Battalions, with the Battalions able to modify their approach based on their experiences in the communities they patrolled. The Division, however, operated from "behind the wire" at Eagle Base and were not able to gain the real world experiences needed to change their initial understanding of the area of operations and operational mindset which was incorrectly established during pre-deployment training.

In addition to the warfighting mindset, training was done without meaningful representation from other groups that the unit would be working with at MND(N). These groups included a Civil Affairs Battalion from the National Guard, multi-national forces, NGOs, and local political and military leaders. In interviews with the research team at 1, 4, 6, and 10 months post-deployment, many of the unit members reported that their training had not given them an accurate picture of their steady-state peacekeeping mission, nor did it prepare them to work as a member of a diverse team. A lack of interpersonal skills necessary to work with local community and political leaders and aid agencies was reported as the most significant training shortfall.

MND(N) was led by the U.S. forces and although there were multinational forces in MND(N) from Russia, Turkey, and a NordPol group that included a combination of Nordic and Polish forces, interaction between the U.S. and these multinational units was minimal. During the time that the ARL research team was interviewing unit members and observing operations, the only non-U.S. staff member, was the G-5, Civil Affairs, chief. He was supported by a U.S. deputy and due to rules excluding foreigners from key intelligence briefings, the deputy became the primary interface with the Division staff, further marginalizing the impact of non-U.S. team members on MND(N).

To better understand the impact of cultural diversity on military command and control, the research effort was expanded to SFOR headquarters. At SFOR headquarters, the U.S. led a multinational command group of more than 30 nations. The research team's focus at SFOR headquarters was to better understand the cultural barriers to teamwork in a multinational military setting and to identify methods to overcome these challenges (Bowman & Pierce, 2002). Using a combination of structured interviews, focus groups, and observations, the research team found culture to affect communication and coordination within and across command cells.

Based on the research conducted at MND(N) and SFOR headquarters, the research team concluded that a warfighting mindset and a lack of skill in working with organizationally and nationally diverse team members caused peacekeeping expertise to develop slowly, if at all. Decision-making tended to be reactive and risk averse. Teams were not adaptable and there was a planning focus on efficiency which emphasized product completion over inclusiveness. The bottomline was that core U.S. forces did not exploit the expertise of multinational partners or civil-military staff members. To address these challenges a research program was initiated to develop technologies to prepare and support culturally adaptable teams, with cultural adaptability being comprised of teamwork, adaptability, and culture (Sutton, Pierce, Burke, & Salas, 2006).

Teamwork

Team performance results from individual competence plus team competence, individual and team accountability, and team reward. Team competence is determined by the ability of the team to assign roles and responsibilities, exchange information, coordinate actions, error check or provide supporting behavior, and act as a source of motivation (Fleishman & Zaccaro, 1992; McGlynn, Sutton, Sprague, Demski, & Pierce, 1999). Using a purely additive approach to determine the potential for team productivity, researchers have found that teams often perform worse than would be expected by the ability of the individual team members. Steiner (1966, 1972) called the discrepancy between potential productivity and actual team performance "process loss." Process loss can be due to either poor coordination or a lack of motivation. Coordination losses occur when group members do not optimally organize or combine their responses. Motivation losses result when team members work less hard in a group than they would if they were alone.

Steiner's model assumes that team performance cannot exceed the sum of individual performances. In actuality, team performance often surpasses Steiner's potential productivity equation (Beck & Pierce, 1996). Teams may do better than expected for a variety of reasons. Team members may catch one another's mistakes or assist teammates with excessive workloads. Team membership may also heighten, rather than reduce motivation. Teams are needed to share their expertise and the workload, and monitor and help one another (Smith-Jentsch, Mathieu, & Kaiger, 2005). However, for process gain to occur requires that the team engage in team process behaviors that promote team competencies such as information exchange, coordination, error checking and motivation among team members. As an example, Cannon-Bowers, Salas, and Converse (1993) have demonstrated that coordination among team members is facilitated by a clear understanding or team mental model of the knowledge shared by team members. Collaborative technology that not only supports information exchange, but also aids in the development of a good team mental model should improve team performance.

Adaptability

Burke, Stagl, Salas, Pierce, and Kendall (in press) have defined team processes for adaptable team performance. They define team adaptation as "a change in team performance, in response to a salient cue or cue stream, which leads to a functional outcome for the entire team" (Burke et al., in press). Generally speaking, carrying out a new plan requires communication and coordination of actions, while monitoring and back-up behavior assist team members when cognitive or physical resources become depleted (e.g., in high stress situations). The complexity, uncertainty, and dynamic nature of SSTR operations makes adaptability an essential element of team performance (Burke et al., (in press); Burke, Salas, Estep, & Pierce (in press)).

As described by Burke, Stagl, Salas, Pierce, and Kendall (in press) the adaptive cycle includes situation assessment, plan formulation, plan execution, via adaptive interaction processes, and team learning. In addition to these process variables, team adaptation is affected by emergent cognitive states such as shared mental models, team situation awareness, and psychological safety. Process variables describe team member interaction, while emergent states describe the cognitive, motivational, and affective state of the team (Marks, Mathieu, & Zaccaro, 2001). It is proposed that measures of emergent states such as shared mental models, team situation awareness, and psychological safety, can provide the predictive link between team processes (establishing roles and responsibilities, information exchange, coordination, error checking, and motivation) and mission performance (timeliness, accuracy, etc.).

A team has a shared mental model to the extent that they have a common understanding of how the team operates (Smith-Jentsch, Mathieu, & Kraiger, 2005). Team situation awareness (TSA) is a shared awareness of the current situation at a given point in time (Salas, Prince, Baker, & Shrestha, 1995). TSA is comprised of perception of environmental elements in relation to time and space, understanding of which of these elements are noteworthy in relation to the team's goals, and the ability to forecast future events in light of the current situation" (Endsley, 1995). In team operations, shared mental models and team situation awareness can be measured using a variety of techniques to assess operational awareness of the team and the situation at pre-determined intervals.

The third emergent state that is especially important in multicultural teamwork is psychological safety. Edmondson (1999) defined team psychological safety as the shared belief that the team is safe for interpersonal risk taking. Psychological safety is characterized by a team climate of interpersonal trust, mutual respect, and a feeling of comfort with interpersonal risk taking (Edmondson, 1999; Schein & Bennis, 1965). Psychological safety does not play a direct role in team performance, but rather facilitates team members taking appropriate actions to accomplish work. Teams are needed in part because members have different vantage points, as well as different levels or types of expertise and knowledge that can be called upon to address problems as they arise. This is especially important in cognitively complex, uncertain environments. Teams will only be effective to the extent that their diversity is tapped in problem solving.

Trust, an aspect of psychological safety, enables conflict, and conflict if used constructively, can help teams to explore differences, promote greater knowledge sharing and more importantly stimulate knowledge creation which stems from learning and leads to innovation (Panteli & Sockalingam, 2005). Trust changes over time through phases depending on the need for trust, the type of conflict experienced by the team, and how conflict is managed. Panteli and Sockalingam (2005) describe three types of trust and three types of conflict. Types of trust are calculus-based, knowledge-based, and identification-based trust. Types of conflict include relationship or affective, task or cognitive, and process. A high level of trust can be achieved by resolving or managing conflict due to relationships and processes and by promoting the safe expression of task or cognitive conflict. For command teams to be adaptable in planning and conducting full spectrum missions they will at least need to achieve knowledge-based trust, but performance will be improved if the team is able to achieve identification-based trust.

Culture

The final component of cultural adaptability is culture. Culture is the framework within which experiences are interpreted and values are formed. Culture influences behavior, to include team behavior (Sutton & Gundling, 2005; Sutton & Pierce, 2003; Sutton, Pierce, Burke, & Salas, 2006). Among other things, cultural norms can determine who can and can not speak to whom, what information can be shared up and down the chain of command or among ones' peers, how much information is needed to make a decision, and who does what task. Klein, Pongonis, and Klein (2000) propose that interactions among members of multinational teams will improve if team members see the world through each other's eyes (i.e., through a "cultural lens"). Sutton, Pierce, Burke, and Salas (2006) call this cultural competence, stating that culturally competent teams understand the dominant values and orientations of other team members and recognize that the thoughts and behaviors of others may be influenced by culture.

Cultural Adaptability

Technologies that promote cultural adaptability (teamwork, adaptability, and cultural competence) among nationally and organizationally diverse team members solving complex (ill-structured, ill-defined) problems in uncertain and dynamic environments are needed. We propose that cultural adaptability can be achieved by technologies that facilitate the development of shared mental models and team situation awareness. In addition, these technologies should increase psychological safety as measured by decreased relationship and process conflict, increased trust, and increases in the healthy forms of task or cognitive conflict which have been found to result in more creative, innovative solutions and adaptable teamwork. The GlobeSmart® Commander and Latent Semantic Analysis are two technologies being developed to promote cultural adaptability in SSTR operations.

GlobeSmart® Commander

GlobeSmart® Commander is an instructional tool designed to provide military teams performing command and control functions the information and skill they need to adapt to cultural influences on teamwork at the operational level (Sutton, 2003; Sutton & Cosenzo, 2004; Sutton & Edelmann, 2005; Sutton & Pierce, 2003; Sutton, Pierce, Burke, & Salas, in press). Six cultural dimensions are assessed by GlobeSmart® Commander (Sutton & Gundling, 2005). These dimensions reflect basic culturally-based values or orientations identified in the culture literature (e.g., Hofstede, 1980; Schwartz, 1992; Triandis, 1989; Trompenaars & Hampden-Turner, 1998). Following is a list of the dimensions included in GlobeSmart® Commander along with a short description of each dimension.

Dimension	Practical Implications
Independent – Interdependent	Shapes a preference for individual initiative and action, or for a more group-oriented approach that emphasizes the interests of the team as a whole.
Egalitarian – Status	Shapes a preference for mutual consultation in decision-making, or for greater deference to rank and hierarchy.
Risk – Restraint	Shapes a preference for rapid action and risk-taking, or for more cautious and calculated actions based on ample information.
Direct – Indirect	Shapes a preference for open and explicit communication, or for careful attention paid to context or to implicit meanings in a given message.
Task – Relationship	Shapes a preference for immediate attention to getting the job done, or for establishing strong and trusting personal relationships first.
Short Term – Long Term	Shapes a preference for making choices based upon a narrow time horizon, or for considering the impact that choices will have over a longer span of time.

While each of these dimensions was considered important in multinational team operations to operational level staff members in B-H, reported critical incidents tended to focus on the dimensions of independent-interdependent, egalitarian-status, and risk-restraint. These three dimensions, slightly redefined, seemed to be especially important in team performance (for a detailed review see Sutton & Pierce, 2003; Sutton, Pierce, Burke, & Salas, 2006).

The GlobeSmart® Commander tool includes an introductory lesson and ten learning modules. The first lesson is an introduction to the importance of culture and a description of its impact on teamwork. This lesson includes examples taken from the field in B-H and at subsequent multinational exercises. The intent of the introduction is to raise awareness of the impact of culture on individual and team performance. Following the introduction is a 32-item survey pertaining to one’s preferred work style. The survey and the survey algorithm were developed by MeridianEaton Global with the assistance of Dr. David Matsumoto at San Francisco State University (Sutton & Gundling, 2005). Based on the survey, an individual's profile representing each of the six dimensions described above is created. Throughout the instructional session, the user can compare his or her profile to that of national averages for many nations represented in the National Atlantic Treaty Organization and Partnership for Peace in addition to selected Asian nations. The first six modules introduce the topic of cultural differences and provide an orientation to each of the six dimensions of culture designed to build awareness of how culture impacts teamwork.

Each instructional module begins with a video scene in which cultural differences are having a negative impact on team performance. At the conclusion of the video, a narrator explains the key differences between the two sides of the dimension represented in the situation. This is followed by a presentation by the two actors representing the opposite extremes of the dimension and a discussion by the narrator on the importance of people with differing styles being able to work together. This allows the user to see the situation from both perspectives. The final component of the dimension modules is a series of interactive exercises to insure the user understands and can apply the lessons learned about cultural differences.

The final four modules of the GlobeSmart® Commander cover several aspects of multicultural teamwork that correspond with the "Forming," Storming," and "Norming" phases of team activity. These modules use the same general approach as the dimension modules, beginning with a video scene, followed by the actors presenting their perspectives and challenges in team formation. The discussion references learning from the previous dimension modules, with several key points pertaining to the importance of developing relationships and the impact that the perceived lack of trust based on cultural differences has on overall team performance. After the perspectives and challenges sections, the instruction moves to techniques that can be employed to improve the functions of the team. Each technique is demonstrated so the user can see the difference it has on the situation. For example, the techniques in the team start-up module include: create a structured meeting process; implement turn-taking to provide the opportunity for each person to contribute; find ways to build relationships; facilitate communication so non-native English speakers understand what is being said; and build trust through careful hand-offs and systematic instruction. After watching each technique separately, the entire scene is played out using the new techniques so the user can clearly see how the situation is improved from the first scene.

Significant cultural differences have been found to interfere with mission success when cultural knowledge is lacking (McFarland, 2005). The inability to adapt, as necessary, to the influences of culture on thoughts and behavior can result in imperfect situational awareness, which can lead to inaccurate situations assessment, and flawed or delayed decision making. We propose that cultural adaptability is critical to mission success in multicultural military environments, particularly at the operations level. Cultural adaptability includes the ability to recognize the influences of culture on teamwork, understand how best to act and react to those influences, and, most importantly, take action by choosing to adapt.

Latent Semantic Analysis

The communication among team members is one of the richest sources of data about the team's performance and process. However, the use of communication data to predict team performance has been limited due to the labor intensive and time consuming processes involved in both capturing and analyzing the data. Natural language and machine-learning technologies have strong potential to be used for analyzing spoken and written communication among team members. Technologies for analyzing the semantics and syntactical properties of language can be combined to provide tools that can characterize the quality and content of information being conveyed in these communication streams (Foltz, 2005). Using the verbal content of spoken and written communication, such a toolset can be used to improve ad hoc team formation and functioning and has the potential for providing near-real-time assessment (within seconds) of individual and team performance including measures of situation awareness, knowledge gaps, workload, as well as predictions of future performance based on analyses of the current context.

Latent Semantic Analysis (LSA) is a machine learning algorithm that understands the meaning of words and text in much the same way as humans (Landauer, Foltz, & Laham, 1998). LSA uses a fully automatic mathematical technique to extract and infer meaning relations from the contextual usage of words in large collections of natural discourse. LSA has been applied to a wide range of domains, including cross-language information retrieval systems, automatic essay scoring systems, as well as in systems for monitoring and providing feedback based on spoken and written team communications.

Initial tests of LSA-based team communications analysis methods have shown great promise. Using existing command and control communication data sets, the technology is able to provide accurate predictions of the overall team performance, make reliable judgments of the type of patterns of communication among team members (Foltz, 2005; Foltz & Martin, 2004; Gorman, Foltz, Cooke, Kiekel, & Martin, 2003; Kiekel, Cooke, Foltz, Gorman, & Martin, 2002).

LSA technology has been incorporated into online collaborative environments that can monitor, moderate, evaluate contributions, and provide feedback to users and access to hundreds of digital material (e.g., books, doctrine, and manuals). Tests of the technology on U.S. military officers and cadets show that they make measurably higher quality contributions using the technology than when discussing the same issues face-to-face. When the system automatically interjects expert comments into the discussion by the automated moderator, cadet contributions are of significantly higher quality than in instructor led classes or electronic discussion groups without the feature (LaVoie, Streeter, Lochbaum, Wroblewski, Boyce, Krupnick, & Psotka, submitted).

In the present application, LSA-based tools monitor written communication streams from teams. The tools support ongoing collaboration by identifying the quality of the team performance and analyzing such performance measures as convergence of contributions, coherence among team members, degree of topic-related discussion, and identification of critical incidents. The output of the performance measures are then used with visualization tools to provide officers with overviews of the performance of teams in order to enhance overall situation awareness. The output from such a toolset can further be used for tracking teams' behavior and cognitive states, identifying critical incidents, determining when appropriate feedback needs to be given, for generating automated after action reviews, and adapting interfaces to provide relevant data to teams.

The LSA-technology is being developed using a client-server model, with an internet-based server for performing analyses and the ability to receive communication data from clients (e.g., Information Workspace, MissionMate, etc.) and return team and individual performance measures to the clients. As such, the technology has a broad scope of application and can be used for ad hoc team formation, collaboration support, mission planning and information gathering. By providing teams and their commanders with self-monitoring tools, the technology can improve the quality and speed with which teams form and perform.

Technologies for Augmented Collaboration

Technologies for augmented collaboration (TAC) will improve team formation by helping to identify who and what expertise is needed by the team, assessing their availability, and providing instruction on how to facilitate interaction among team members. A team coach module will support team member interactions by providing information on how and what type of information is being shared by the team, identifying gaps in knowledge, and keeping a running summary of the discussions and the discussion themes. A team meter will monitor the extent to which the team is on task and identify new information sources. The final tool will allow the team to visualize interactions and performance and understand when adaptation is needed and how to adapt. A prototype TAC was used in one simulation and will be used in an upcoming battle command exercise between the U.S. and Singapore. Lessons learned from both events will be used to refine the TAC for use in future collaboration information environments.

Darfur Sudan Simulation

An initial TAC capability was demonstrated in a simulation requiring collaboration among diverse, distributed experts. For this demonstration TAC included an LSA-enhanced discussion forum called Knowledge Post (KP) and a technology for dynamic network analysis (DNA). Dynamic Network Analysis (for a review see Carley, 2003) provided an on-going overview of who was connected to whom, what knowledge individual participants had, and what tasks they were responsible for completing. GlobeSmart® Commander was not used in this demonstration.

The scenario, a classic wicked problem, was set in Sudan's Darfur region. As context, a fictionalized mission in which a Joint Task Force commander was deployed to the South Darfur state to assume command of all U.S. forces comprising the Multinational Force (MNF) was created. The civil-military-based scenario was driven by events related to internally displaced persons and security. Team members included the civil-military operations director, the local civil affairs lead, an NGO regional director, a United Nations representative, a refugee camp director, a representative from an oil company working in the region, and a representative from the local community. Five subject matter experts participated in the simulation, assuming these seven fictional roles.

The main goals for running the simulation were to: determine the feasibility of building productive multicultural collaborative teams in an asynchronous online environment; test the ability of TAC to support complex collaborative efforts; identify and test a set of metrics for evaluating the collaboration process; and identify the extent to which the discussion interface met the user requirements for a collaborative tool.

All communications among team members were asynchronous, using KP, a web-based, threaded online discussion interface enhanced with LSA and DNA features designed to support collaboration. For example, the KP responded to group needs by providing data from the library that supported the need for protection of NGOs as requested by the camp director for the United States Agency for International Development (USAID). DNA maps provided an easily interpretable visualization of a prospective group member's social network, including the individual's relationship of connections (who knows whom?) and influence (who has power over whom?).

Participants were provided with a one-hour introduction to the scenario topic, the roles they would play, and the technologies they would use. Participants were encouraged to introduce additional issues as the scenario progressed in order to make the simulation as spontaneous and lifelike as possible. For the demonstration, the participants spent two weeks using TAC to build a collaborative team and to work through the problems presented. Data were collected on each character's participation (comments submitted as well as comments read), the relevance of comments to the topics at hand, and the degree of consensus reached by the group.

Without formal introductions or face-to-face encounters, team members had to rely on the collaborative tools provided to facilitate the team building process. These interrelated processes, which occurred in conjunction with the problem solving activities, included building trust, managing cultural differences, and leveraging areas of common interest. TAC facilitated collaboration in this demonstration by helping the team to quickly understand who was on the team, what their cultural affiliations were, what their perspectives were on issues, and the extent to which there was agreement among the members.

TAC also helped participants to manage the influx of comments and references and the overall flow of the collaboration itself. KP provided summaries of the discussion content, automatically inserted germane texts into the discussion, and identified closely related information, thereby discouraging redundant actions. KP also supported coordination of efforts, identifying implicit tasks and proposing viable solutions (e.g., security needs for food distribution efforts).

TAC was designed to capture team process measures. Some of the measures collected each day were number of comments posted, average length of the comments, number of comments read, number of library interjections read (material identified by KP as important to the discussion), consensus scores, and number of ego nets reviewed. In addition, TAC provided feedback to the team on the semantic relatedness between and among the discussion threads, and on who was replying to whom. TAC also created a set of keywords to summarize the content in the most commonly read notes. Although not done in this exercise, TAC could also have computed the percentage of the discussions that were on or off the topic and the coherence among notes.

Overall, the reaction of participants to the simulation and the technology used was positive. In post-study interviews participants identified the following capabilities as integral to the collaborative problem solving process: getting live updates from the field (i.e., the setting of the problem to be solved); getting background information on potential collaboration teammates, including areas of expertise, social networks, and cultural background; assistance in establishing and building rapport with teammates; and efficient methods of exploring and navigating discussion threads.

US and Singapore Command Exercise

A U.S. and Singapore Command Exercise will be conducted in September 2006 to evaluate the utility of TAC tools GlobeSmart® Commander and LSA, for use in preparing and supporting a multicultural command team. Singapore will develop a realistic, simulation-based scenario, which will include operations other than war such as disaster relief with a counter terrorism or homeland security component.

The independent variables will include type of planning system used and the presence or absence of the TAC tools. The dependent variables will include team processes, emergent states, and outcome measures. The process and emergent state measures will be captured by LSA and using survey instruments administered at pre-determined times during the exercise and at the end of the exercise. The survey instruments will be used to assess shared mental models, team situation awareness, and psychological safety as measured by the degree to which team members trust one another and their commitment to the team and team products. Outcome measures will be mission-based and captured by the simulation and through observation. Results of the simulation will be used to refine the TAC tools.

Summary

In this paper, we achieved three main objectives. First we defined a new type of military command and control challenge, one that requires dynamic, social-negotiation and collaboration among highly disparate multicultural team members. Second, we described a conceptual model of cultural adaptability based on the research literature in teamwork, adaptability, and culture. Finally, we proposed two technologies, GlobeSmart® Commander and LSA and discussed how each could be used to improve and evaluate multicultural team performance.

These technologies can be leveraged to provide recommendations for system requirements that address unmet or, as yet, unidentified needs of multicultural teams at the Joint Task Force level. They can be used to mitigate threats to information sharing and improve decision making performance on interagency task forces. In addition, the embedded survey tool can be used to identify cultural profiles for the purpose of populating cultural variables in a multitude of exiting team performance models or in representing multicultural human behavior in models and simulations.

Of course, the significance of this work is in its relevance to current operations. The U.S. Army maintains its proficiency in "kinetic" warfare, but continues to struggle to define processes and technologies for irregular warfare (Aylwin-Foster, 2005). In SSTR operations, civil-military cooperation is essential. The model of cultural adaptability described above and the technologies proposed to augment multicultural teamwork are representative of the class of models and tools that will be needed in the global war on terrorism, campaigns that may be more about winning the hearts and minds of the local population than traditional, attrition warfare.

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