

CONTINUOUS DISTRIBUTED PLANNING IN THE ARMY: ARRIVING AT DESIGN CONCEPTS THROUGH OBSERVATIONAL STUDIES¹

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ABSTRACT

Coordination and collaboration across distributed teams during planning, preparation, and execution activities present many challenges to military command and control. One of these challenges is supporting distributed work during continuous planning events that occur prior to and during the execution of an operation. This paper discusses observations made during field studies of exercises and experiments conducted over the past year, as well as design concepts arising out of these observations.

INTRODUCTION

Coordination and collaboration across distributed teams during planning and execution activities present many challenges to organizations and operations, including military command and control. A critical challenge for the United States Army is supporting distributed work in the initial development of robust plans, as well as in the adaptation of these plans in the face of unanticipated events. Because advances in information and communications technologies are creating the ability for planning to be accomplished by team members who are geographically and temporally dispersed, it is important to understand how such distributed work can be most effectively supported.

The U.S. Army context shares many abstract characteristics with other complex, dynamic domains that use distributed teams, which include the following:

- High cognitive complexity
- Distribution of work (and associated responsibilities) among many people to deal with the high complexity. This distribution of the work includes

planning, monitoring and execution of tasks

- Distribution of data and knowledge among many people to deal with the high cognitive complexity
- Uncertainty about how scenarios will actually play out
- Geographic and temporal distribution of the participants
- A variety of tasks across individuals and organizations, some of which are independent (can be completed without any need for interaction among the different individuals) and some of which are interactive (requiring interactions among the different individuals as they perform their own individual tasks)

As a result of our observational studies during various Army exercises over the past year, we have arrived at a corpus of cases and associated design concepts for distributed work systems. This paper discusses some of these observations, case studies, and design concepts.

DECOMPOSITION OF TASKS TO REDUCE COMPLEXITY

Traditionally the way that organizations deal with complexity in work is to divide the task of managing the overall system into subtasks, and then to assign these subtasks to different individuals. The assumption behind this division of labor is that there is a sufficient degree of independence among the subtasks, so that when each subtask alone is performed well, the combined effects will produce acceptable (rather than optimal) levels of performance for the system as a whole. Because few systems are able to be decomposed into fully independent subtasks, it is often necessary that individuals responsible for particular subtasks interact

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and the initiative of the 3BCT commander, the team members were able to assume the role of the main effort for the Division. This resulted in a situation in which the 1BCT and 3BCT were expected to achieve objectives that were not in their original execution plan. The 3BCT was able to maintain efficient crosstalk with its adjacent unit (1BCT) while keeping the higher commander informed, and this enabled the First Calvary Division to get all of their elements across the river successfully. This crosstalk was achieved via the radio net.

Distributed Work Systems – Design Concept 1. If an abnormal situation arises where the shared script from which everyone is operating no longer applies, reliance on traditional ways of operating may no longer be adequate and verbal interactions and different patterns of interaction may need to be triggered and supported.

TEMPORAL COORDINATION OF A DISTRIBUTED TEAM

The temporal coordination that is required for successful operations is a critical issue when considering the current emphasis in the Army for subordinate commanders to seize the initiative. The concept of temporal coordination is defined as “an activity with the objective to ensure that the distributed actions realizing a collaborative activity takes place at an appropriate time, both in relation to the activity’s other actions and in relation to other relevant sets of neighbor activities” (Bardram, 2000, p. 163).

Three types of coordination that can be differentiated in the above case study are communicative, instrumental, and scripted coordination (Bardram, 2000). Communicative coordination occurred when the commanders of the 1BCT and 3BCT discussed how to go on with their mission given that the Division plan was no longer viable. Communication was mediated through the radio net, allowing for the continuous synchronization with 1BCT that was required for 3BCT to pursue the plan they were initiating.

Instrumental coordination is coordination according to an awareness about the activities of others. This coordination was maintained by the BCTs as they updated their mapboards with respect to where each was both geographically and temporally, as well as keeping updated on the reported enemy locations.

Scripted coordination is coordination according to a script for action, in this case the Warning Order (WARNO) that was issued and distributed to those

affected by the changed plan. Where the temporal coordination was not sufficient in this Warfighter Exercise and where that poor coordination caused a pause in the execution of the operation was what occurred after the Division elements had successfully crossed the river. Because the plan and its execution was derived at the brigade echelon, the brigades were “ahead” of the Division planners, and thus, once across the river they had to wait for Division to issue a Fragmentary Order (FRAGO) for how to proceed. The concern of the brigade commanders was that they did not want to act independently of the Division and risk de-synchronizing the rest of the Division plan.

Distributed Work Systems – Design Concept 2. When coordination must occur to ensure that distributed actions of a collaborative activity take place at an appropriate time, design the system so that agents have the appropriate tools available so that if an abnormal situation arises where the shared script is no longer relevant, coordination is supported across several mediums (e.g., across verbal channel, activity monitoring in a shared event space, and visual aids).

EXPLORATION OF CONTINGENCIES IN CASE ASSUMPTIONS PROVE FALSE

Another approach we can take in examining this replanning episode is to look at the factors that contributed to the failure of the original plan. Specifically, one such event was the assumption made by 1CD planners that the 3rd ACR would be successful in their mission to cross the Namhan River, clearing the way for the Division.

Because of this assumption, they failed to consider a contingency in the form of a branch or sequel which could have resulted in a more robust plan.

Distributed Work Systems – Design Concept 3. When a system has been designed so that certain assumptions are made on which action is based, one common cause of problems is that an assumption is treated by the agents as fact, and alternative actions are not explored in case the assumption proves to be false. Technology (critiquing and alerting systems) can sometimes be used to help ensure that when a critical piece of information or knowledge is not used, or a potential path for success is not taken (e.g., no branch plan), that the planning agents are made aware of this so they can revisit the issue prompted by the alert and alter their decisions as they deem appropriate.

SHARED VIRTUAL SPACES

In the analog Legacy Force of today's Army, a predominant artifact that we observed is the large situation map around which teams gather to collaborate and coordinate their work. Within the Brigade Tactical Operation Centers (TOCs) that we observed, this large mapboard containing the situation map and a variety of acetate overlays was situated in the Commander's Information Cell (CIC), and it is around this map that all principal members of the battle command team, the supporting liaison officers, and the commander were positioned. In the planning cell a similar arrangement was seen, where the center for the interaction among the planning team members was the mapboard. (See Figure 2.) The face-to-face collaboration occurring around a single large display creates an environment that enables the ability for the staff members to monitor and assess all relevant visual and verbal tactical information that flows into the TOC.



Figure 2. Planning during recent 1Bde/1CD rotation at NTC.

Interestingly, at the recent Unit of Action Battle Command Experiment at Ft. Leavenworth, much of the collaboration that occurred in the planning phases took place with the team members gathered around a large display of the situation map, or around a white board where the members sketched plans, exchanged ideas, and recorded important information (e.g., synchronization matrix, required documentation). Certainly, this was in part a result of having insufficient collaboration software during this experiment, but it is worth noting that their preferred mode of coping with this deficiency was to gather around the large map display. (See Figure 3.)

As the Army evolves to its Objective Force structure the distributed nature of the work will obviate the ease with which the team members will be able to gather around a physically co-located shared display.



Figure 3. Planning during recent UA CEP.

Recent research investigating synchronous (but geographically separate) and asynchronous communication and problem solving has demonstrated the value of having a shared workspace (Chapman, 2002; Obradovich, 2001). Obradovich and Chapman both found that a shared workspace consisting of a shared visual display, annotation tools, and an auditory channel mediate and enable interactions and can serve as aids to the collaborators in establishing common ground and building shared perspectives. An environment that provides a shared visual display with a capability for telepointing and two-way audio communication may ease the effort that a team, engaged in a spatially distributed, collaborative problem-solving task, must use to build shared perspectives. Through the use of a shared display and audio communication the team members have the opportunity to establish a virtual copresence (enabled by the physical copresence of the display with each dyad member and the linguistic copresence established through use of the telephone and/or command net), which can facilitate the collaborative interaction. These artifacts enable the giving and taking of perspectives, and a free flow of task- and team-relevant knowledge among the members, and a culture of collaborative teamwork.

Distributed Work Systems – Design Concept 4.

When team members need to work together to solve some problem, but:

- They are physically separated and must work asynchronously;
- The product of one team member or group serves as the starting point for the work to be accomplished by the second team member or group;
- The intermediate steps taken by the first team member or group can be displayed visually (such as showing intermediate steps as a design is created and refined by the first team member or group, or showing a sequence of “moves” as a battle is played out by the first team member or group),

a shared virtual workspace that allows the second person or group to view this sequence of visuals may be more effective in allowing that person to understand both the current state of the product and the reasons or steps that led to the current state than simply showing the second person or group the end-product produced by the first person or group.

Showing such an asynchronous message that consists of a sequence of visuals to implicitly communicate how and why the first person or group acted as he or they did may not be sufficiently informative in all cases. Allowing the first person or group to more explicitly communicate by supplementing the visuals with synchronized voice, telepointing and dynamic annotations can provide a richer medium in which to communicate thoughts and intentions.

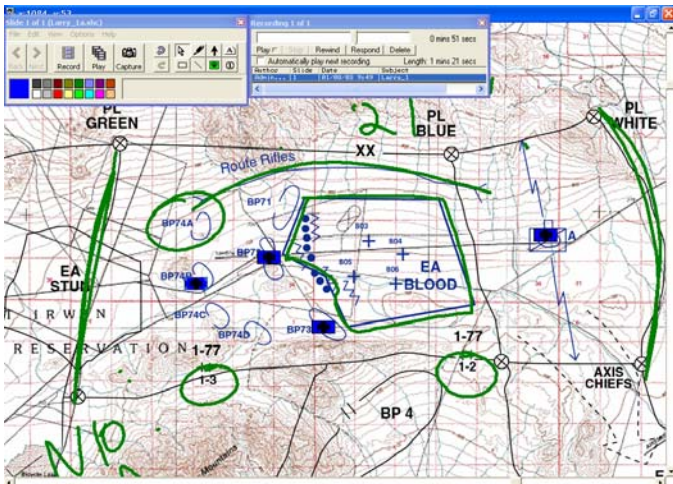


Figure 4. Example of annotations made on a rich multimodal communications tool.

Such communication tools can also be valuable in support of synchronous interactions, allowing the speaker to use pointing and annotations to focus the listener's attention and to help communicate a message.

CONCLUSION

Coordination and collaboration during continuous distributed planning events is a complex, cognitive activity performed by many team members who are both co-located and geographically dispersed as they do their joint work. As a result of our field studies conducted over the past year at a Division Ramp-Up and Warfighter Exercise, a Brigade NTC rotation, and a UA Battle Command Experiment, we have arrived at design concepts for distributed work systems. These concepts include suggestions for requirements of tool design, as well as suggestions for process and interaction design.

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