COVER SHEET

Inducing Adaptation in Organizations: Concept and Experiment Design

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Abstract

Mission performance is likely to be high when organizational structures are "congruent" with the mission and degraded when organizational structures are "incongruent" with the mission. All else being equal, it is to an organization's advantage to monitor the fit between its structure and mission, and to alter its structure when a misfit is identified. We afforded teams the opportunity to adapt their organizational structure to changes in the mission. In the forced case, teams had to allocate new assets to deal with a SCUD threat entering theater. In another situation, the team could adapt their organizational structure to a mission that had grown incongruent with that structure. Our primary interest was this adaptation process. Results indicate that the teams did adapt; frequently, they made many small changes to adjust workload and to compensate for weak team members. Less frequently, they made major changes in response to changing mission and task requirements. Teams appeared reluctant to make the larger changes necessary to realign organizational structure and mission. This reluctance stems in part from their concern with the cost of change and in part from a difficultly in understanding organizational structures and the ramifications of changes made to the structures. Enhanced training and model driven decision aids may help to ameliorate the problems.

Introduction

Mission performance is likely to be high when command and control (C^2) organizational structures are "congruent" (aligned with) with the mission tasks to be performed (Diedrich et al., 2003). In contrast, if C^2 structures are "incongruent" (misaligned with) the mission tasks, mission performance will likely be degraded. All else being equal, it is to an organization's advantage to monitor the fit between its structure and mission, and to alter its structure when a misfit is identified.

There is empirical evidence that high performing organizations can discern when environmental forces have changed the state of congruence (i.e., the goodness of fit), thus driving changes in the *strategies* (e.g., communication patterns, back-up behaviors) that they employ (Entin & Serfaty, 1999). Rarely, however, do organizations make changes to their organizational *structures* (i.e., asset allocation, team member roles and responsibilities) in order to facilitate congruence (Hollenbeck et al., 1999). There may be several reasons for this reluctance. First, organizations may not feel that they have been empowered to make alterations to their organizational structures. Second, even if an organization has the flexibility to change their structure, they may lack the necessary training to do so competently. Third, organizations may sense that structure and mission are becoming incongruent, but they may have difficulty gauging the nature or severity of the mismatch. Lastly, organizations may feel uncomfortable switching from known structures to those that are less well known and unproven. Given these obstacles to change, organizations may remain in inefficient structures, neglecting opportunities for improved performance. Given the potential benefits of dynamic structural adaptation, it is essential to understand how an organization can be persuaded to adapt. If adaptation is incentivized and obstacles minimized, to what degree and for what reasons will organizations change their structures? The primary purpose of the exploratory study reported in this paper is to address this question.

The work reported here builds on previous efforts that studied the behavior of organizations operating under conditions of incongruence. For instance, Entin et al. (2003) sought to identify the conditions that might be salient enough to cause organizations to alter not only their strategies, but also their structures. This work employed model-based organizational design techniques to create mission scenarios that were either congruent or incongruent with two organizational structures (Kleinman et al., 2003). The two organization structures were "Divisional" and "Functional." In the Divisional organization, each participant controlled a multifunctional platform that was able to process a variety of tasks (e.g., air, surface, strike, etc.) in a limited geographical area. In the Functional organization, each participant specialized in one aspect of the mission (e.g., strike), using assets that were distributed across multiple platforms over the entire battle space. Two mission scenarios were designed by manipulating between-player coordination requirements such that one mission provided a good fit to the Divisional organization but was misfit to the Functional structure; the other mission scenario provided a good fit to the Functional structure but not to the Divisional structure. Results showed that performance was significantly worse in the incongruent conditions as compared to the congruent conditions. Additionally, self-reported workload was higher in the incongruent conditions as was overall communication rate. Importantly, these data pointed toward a set of indicators that have the potential to yield diagnostic information regarding congruence early in a mission scenario. These include performance measures (composite variables such as mission tasks processed, latency, and accuracy), team coordination processes (e.g., communication patterns), and workload levels (e.g., subjective assessments).

In this study, structural adaptation was investigated using the scenarios and structures employed by Diedrich et al. (2003). Six member teams were trained in both the divisional and functional structures. Following an initial training period, the teams participated in two congruent mission scenarios followed by an incongruent mission scenario. After each mission, participants were given detailed information about the characteristics of the next mission, as well as real-time, diagnostic indicators of performance and congruence. They were then given the opportunity to plan and adapt their structures during a facilitated planning session. All changes proposed by team members were accompanied by justifications. Thus, this process allowed the observation of the structural "morphing" process.

For the purposes of this study, team performance was of secondary concern. Of primary interest was the adaptation process itself. The goals for the effort reported here were to:

- Evaluate the ability to induce and support structural adaptation through novel methodology
- Capture and categorize the attempts towards structural adaptation made by teams
- Evaluate the efficacy of proposed changes in relation to optimal organizational designs
- Identify the obstacles for adaptation

Our approach was to facilitate structural change by providing training on why adaptation is beneficial and how it is achieved, supplying the knowledge and tools necessary for

successful adaptation, and by presenting feedback about past performance and expert appraisal of likely future performance with and without changes. It was hoped that these actions would foster observable adaptive behaviors.

Method

Participants

Thirty officers attending the Naval Postgraduate School in Monterey, CA served as participants. Most of the officers were 03 or 04; several services and nations were represented. Participants were organized into five teams of six individuals each. Participants received partial course credit for their involvement.

Apparatus

The Distributed Dynamic Decision-making (DDD) environment was used to simulate several mission scenarios for use in this study. The DDD is a distributed client/server simulator that allows extensive mission customization in order to investigate individual and team performance in an operationally rich, experimentally valid environment. In general, DDD simulations involve individual and team decision-making about complex situations based on information and resources provided by both the simulation and other team members (Serfaty & Kleinman, 1985; Kleinman & Serfaty, 1989). The simulation enables the manipulation of variables such as organizational structure and mission scenario tasking. A variety of performance measures can be recorded within the DDD (i.e., tasks processed, latencies, and accuracies) to assess performance.

Procedure

Each team was initially assigned to one of two organizational structures characterized by the types of assets within each team member's control. In the Divisional organizational structure, each team member had responsibility of functionally diverse assets in a single, defined geographic area; they were given control of all assets within that area. In contrast, participants in teams assigned to the Functional organizational structure were given control of functionally similar assets dispersed throughout the mission battle space; for example, they might be given all ISR or Strike capabilities. In this investigation, participants were assigned randomly to three Divisional teams and two Functional teams.

Participants were briefed as to the general purpose of the study before signing an informed consent form. Training began with two hours of DDD "buttonology" in which participants were taught control of the DDD user interface, the capabilities of the assets and platforms available within the DDD environment, and basic strategies for accomplishing common tasks. This was followed by a second two-hour training session in which participants completed short mission scenarios. This session exposed participants to the general mission expectations, which included following a mission task plan, reacting to unexpected time critical events, balancing defensive and offensive roles, and coordinating with other team members for task completion. The training scenarios were designed to instruct without imposing bias for any particular organizational structure. This was accomplished by creating hybrid scenarios that employed aspects of

both Divisional and Functional structures. Following the second training session, each team participated in two data-collection sessions. Each data-collection session consisted of one or more DDD simulations and one or more planning sessions. Training and data sessions varied from 2 to 3 hours, and took place over several days.

For the data-collection sessions, scenarios were developed that were either well suited to the Divisional organizational structure (divisional scenario) or to the Functional organizational structure (functional scenario; Diedrich et al. 2003). A mission was considered to be *congruent* if the team's organizational structure (Divisional or Functional) was matched with its associated scenario (i.e., a Divisional team in a divisional scenario or a Functional team in a functional scenario). In contrast, a session in which the team and scenario structures are mismatched was considered *incongruent* (Divisional with functional, Functional with divisional). Congruence was achieved by defining task requirements within a scenario that matched the asset capabilities of an organizational structure, thus reducing need for coordination between players and minimizing overhead.

Each mission scenario was presented in operational terms that were familiar to the participants. They involved a Joint Forces mission in which teams were required to use a variety of sea, land, and air assets to destroy or capture an enemy command center, two naval bases, two air bases, and a seaport. Concurrently, the teams had offensive and defensive responsibilities that were time critical and distracted them from the main mission objectives (e.g., destroy Exocet missiles and coastal defense launchers, perform search and rescue operations, engage targets of opportunity, etc.). For additional complexity, the area of operations also contained neutral parties and peripherally hostile assets which were either to be ignored or to be of low priority. Missions lasted approximately 35 minutes or until the final mission task was completed, whichever came first.

In the initial data-collection session, all teams participated in a scenario congruent with their organizational structure. Upon completion of the scenario, they were told that the enemy was introducing SCUD ballistic missiles into theater. Each team was given two additional weapon systems, anti-ballistic missiles and loiterable cruise missiles to counteract the SCUD threat. They then participated in a 45 minute facilitated planning session (PS1) to decide how to best allocate these new assets, and whether to re-allocate existing assets. Any change had to be justified by attributing it to a cause, such as improving situational awareness, reducing the need for coordination, or compensating for team player capabilities. They then ran in a second data-collection scenario with these changes. The second scenario was congruent to their initial organization, and differed from the first scenario solely by the addition of the expected SCUD missiles. The purpose of this change was to force the team to modify their structure to accommodate the additional resources, thus familiarizing them to the costs, benefits, and procedures involved with organizational change.

In the third data-collection session, all teams participated in scenarios which were incongruent with their initial organization. Teams were instructed that their adversary would be changing their defenses to impede the team's mission progress. However, the team would be given the opportunity to adapt (i.e., make changes to their organizational

structure) in anticipation of the changes in mission requirements. During a second 45 minute facilitated planning session (PS2), they were able to make changes to their organizational structure by reallocating existing resources, reallocating tasks, and altering the roles of the individual team members. To encourage structural change, teams were presented with feedback on their performance in the congruent condition, in addition to a description of the performance of other teams in the incongruent condition they were about to attempt. This feedback served as an appraisal of their likely performance if they did or did not change; performance that would be low compared to their performance in the previous, congruent missions.

After completing the incongruent scenario with the changes they had indicated, they were again given feedback on their performance. They were given another opportunity to make changes to their organizational structure in a third and final 45 minute facilitated planning session (PS3), in reaction to their mission performance and the enemy's changes. Teams did not have an opportunity to participate in the incongruent mission with these final changes.

Figure 1 summarizes the optimal organization of teams for each data-collection session in this study. Each team participated in three data-collection sessions (Initial, SCUDS/PS1, and PS2), and planned for a third (PS3). For all teams, the Initial and SCUDS (PS1) sessions were congruent with their initial organizations, while the two remaining sessions (PS2, PS3) were incongruent. A team displays adaptation if they remain in their initial organization during the SCUDS/PS1 session, and reallocate assets to the alternative organization in the remaining data-collection sessions (PS2, PS3).

		Data-Collection Session			
		Initial	SCUDS/PS1	PS2	PS3
Initial Team Organization	Divisional (Teams A, C, E)	*Divisional*	*Divisional*	*Functional*	*Functional*
	Functional (Teams B, D)	*Functional*	*Functional*	*Divisional*	*Divisional*

Figure 1: Optimal team organization for each data-collection session.

Analysis Tools

The DDD is capable of capturing many aspects of mission performance, including accuracy, task completion latency, and mission success. Similarly, mission performance can also be quantified by evaluating subjective workload, communication patterns, and other factors. However, because the focus of this discussion is on structural adaptation to change, these measures will not be discussed in this paper. To assess the adaptation process, the records of changes made by each team in the course of each planning session were analyzed. From this, we calculated the percentage of assets in an optimal organization (primary measure of adaptation).

During each of the three planning sessions, teams were given the opportunity to modify their existing organizational structures. The initial organization to which a team was assigned was optimized for missions of that type. Thus, the allocation of assets in the Divisional organization was optimized for divisional missions and was ill-suited for functional missions. In contrast, the allocation of assets in the Functional organization

was optimized for functional missions. By calculating the similarity of asset allocation for each team after each planning session with the optimal Functional and Divisional organizations, the degree of overlap could be assessed. This was accomplished by determining the percentage of assets in common. Initially, each team was given 46 assets. After the inclusion of the weapon systems necessary to combat the introduction of SCUD missiles into theater the number of assets increased to 53. As teams reallocated assets during each planning session, the percentage of the 53 assets that overlapped with the optimal organizations was calculated.

Results

The allocation of assets for the teams initially assigned to the Divisional organization structure is presented in the three panels of Figure 2. Figure 3 shows similar results for teams assigned to the Functional organization structure. Note that in each figure the sum of each pair of bars will not equal 100%. Any particular asset could be described as being in line with either an optimal Functional organization, an optimal Divisional organization, or neither. In addition, there is a nominal (17%) number of assets that could be construed as being aligned with both the optimal Functional and optimal Divisional organizations. Asset allocation that is not in line with these optimal organizations was not included in this analysis.

Planning for the Introduction of SCUDs in Theater: Planning Session 1

Two of the three teams (Teams A & C) assigned the new assets in a manner that was consistent with a Divisional structure. This is illustrated by the high overlap (> 90%) in asset allocation with the optimal Divisional organization. Such an assignment of assets is adaptive because the following mission (SCUDS/PS1) was congruent with a Divisional organizational structure. The third team assigned to the Divisional structure (Team E) took a different tact. Specifically, they created a functional role for one of the team members by assigning that team member all of one weapon system. As a consequence, only 52% of their assets overlapped with the optimal Divisional structure. The actions of this latter team can be view as being maladaptive as the impending mission still matched a Divisional structure.

The two teams assigned to the Functional structure (Teams B & D) allocated the new weapon systems to combat the SCUD threat in a manner consistent with a Functional organization. As shown in Figure 3, at least 94% of assets overlapped with an optimal Functional structure. In both cases, all of the assets of one weapon system were assigned to one team member and all the assets of the other weapon system were assigned to a second player. Such assignments were adaptive as the subsequent mission (SCUDS/PS1) was still aligned with the Functional organizational structure. In addition, both teams made another similar adjustment in that they reassigned the search and rescue assets from the initial team member to another team member. This change was consistent with the Functional organization, and we surmise that it was done to off-load a team member that was perceived to be overloaded.

Note that a majority of the adaptive changes made during the first planning session were forced. Teams were required to allocate the assets of two new weapon systems to counter-act the appearance of SCUD launchers and missiles in theater. A few teams took

the opportunity to realign asset allocation to balance the workload better or compensate for a weak team member. In contrast, what is reported next is the planning and asset reallocation to adapt to a mission that was incongruent with the team's initial organizational structure based on between–player coordination requirements for task processing.

Planning for Incongruence: Planning Session 2 and 3

Prior to planning session 2, each team received a detailed briefing indicating that the enemy had made substantial changes. The mission described to the Divisional teams was now congruent with a Functional organizational structure and the mission described to the Functional teams was now congruent with a Divisional organizational structure. In effect, the mission described was incongruent with the team's initial organization, and would require significant asset reallocation to the alternative organization to retain congruence.

Two of the teams initially assigned to the Divisional structure (Teams A & E; Figure 2) made significant changes away from an incongruent Divisional structure and toward a congruent Functional structure. Team A made adaptive changes in anticipation of the incongruent mission scenario, while the previous changes of Team E now proved adaptive. Both teams created an ISR coordinator by assigning the UAV assets to the charge of one team member. Moreover, Team A went further and allocated most of the fixed winged assets to one team member to create a *de facto* strike commander. Neither team, however, became decidedly Functional, with at most 38% of assets inline with the optimal Functional structure. Their new structure can be best described as hybrid: somewhere between a Divisional and Functional structure. In planning session 3, which followed the teams' experience with the incongruent mission both teams made only small adjustment to the allocation of assets. Interestingly, in both case there was about a 6% shift in assets toward the (now) non-optimal Divisional structure.

The third Divisional team (Team C) remained decidedly Divisional in structure as 81% of their assets were still assigned to this structure after planning session 2. Experience with the incongruent mission had only a small impact. The team's allocation to the Functional structure increase by a little more than 10%, but three quarters of the assets were still allocated inline with a Divisional structure. This team did not adapt, remaining strongly Divisional in the face of an incongruent Functional mission.

Both teams initially assigned to the Functional organizational structure (Teams B & D) made little or no changes to their structure as a result of planning session 2 (Figure 3). Although the teams received a briefing prior to planning session 2 that the enemy had made several adjustments to its defensive and offensive posture that created a misfit between their current structure and the mission, these two teams decided to stay with their Functional structure.

After participating in the incongruent mission one of the Functional teams (Team B) was willing to institute significant changes in the direction of a Divisional structure creating a hybrid structure – an adaptive move. The other Functional team (Team D) was still

reluctant to make changes and ended up making one or two alterations in asset allocation that were non-adaptive (not in the direction of a Divisional structure).

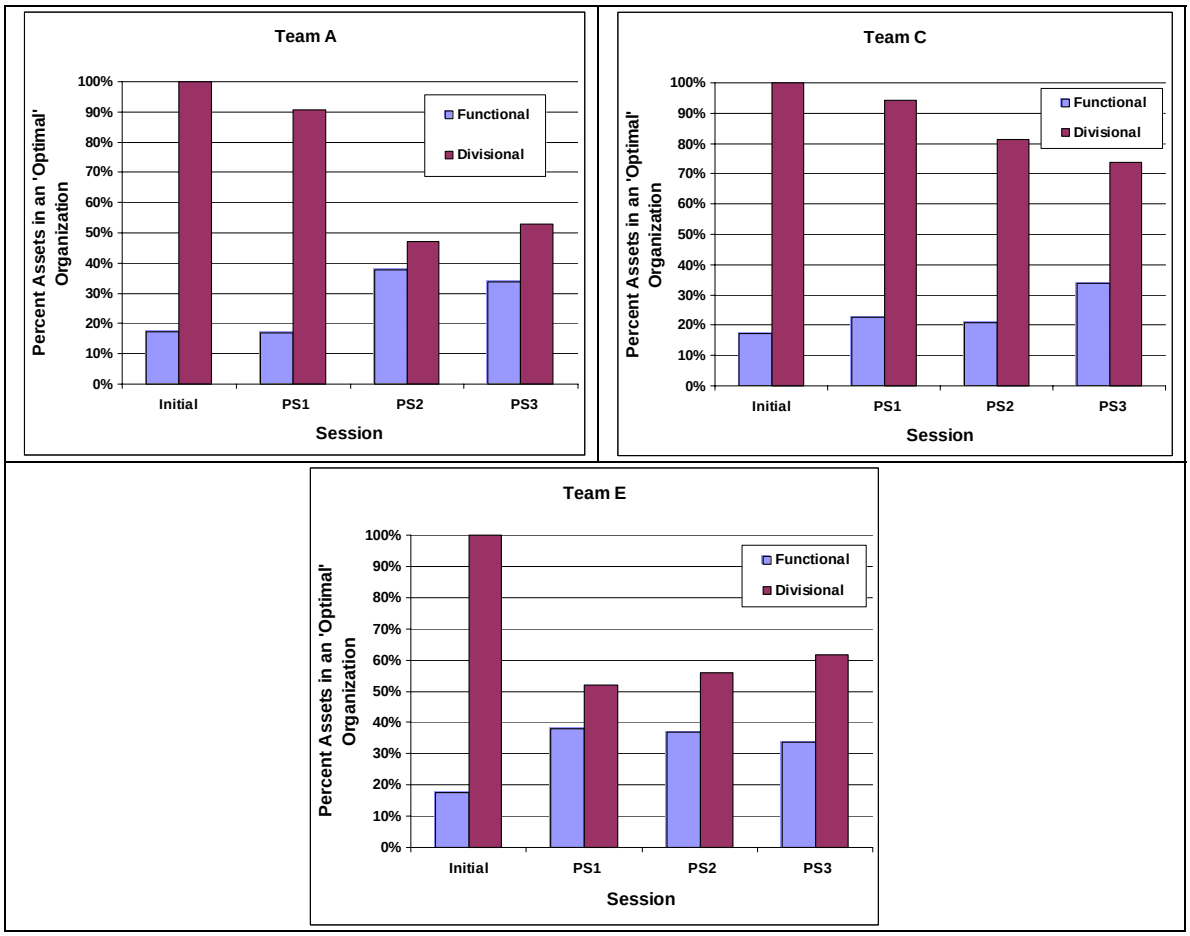

Figure 2. Percentage of assets in an "optimal" organization as a result of each planning session for teams initially assigned to a Divisional organizational structure

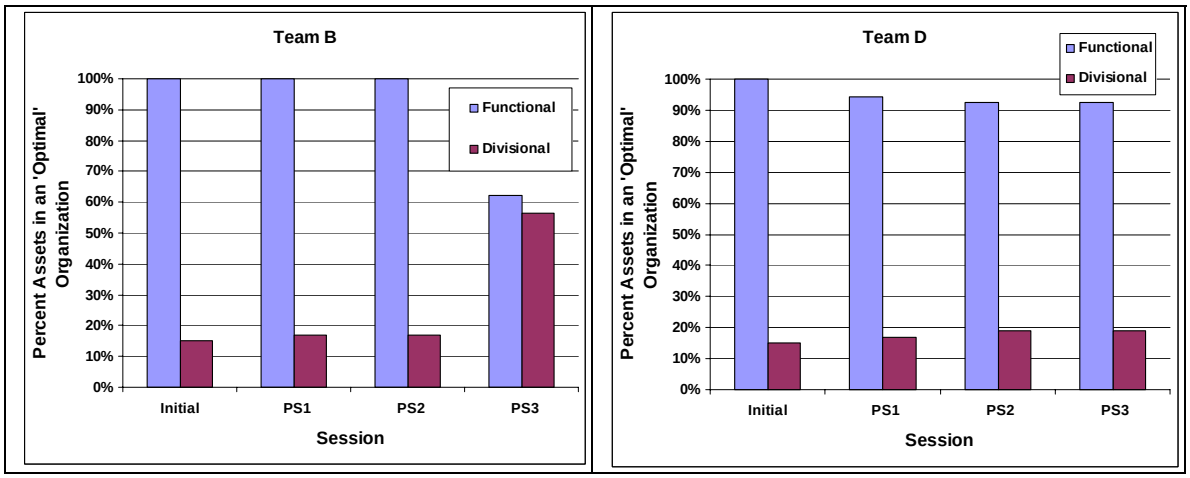

Figure 3. Percentage of assets in an "optimal" organization as a result of each planning session for teams initially assigned to a Functional organizational structure

Discussion

The major goal for this experimental effort was achieved. Teams made structural changes under appropriate conditions, although the changes made were modest in most cases. A majority of the teams made adaptive changes to their asset allocation, either in anticipation or in response to incongruent enemy tactics. Preliminary indications suggest that teams initially assigned to a Divisional organizational structure were more likely to make adaptive changes to their structure.

The observation of the planning sessions provided many insights. The two Functional teams in planning session 2 proved somewhat representative of most teams at this point: teams recognized that there was a mismatch between their organizational structure and the mission, but resisted making any changes. An often heard argument against making any changes was the cost of changing. Team members felt they were just getting to understand their roles and certainly did not want to encounter change. This can be thought of as a primary aspect of inertia to change organizational structure (Hollenbeck et al, 1999). However, it should also be pointed out that at this point in the protocol teams had not experienced the pain of performing in a misfit situation – that is, they had not actually played the scenario in the model-based misfit condition of Diedrich et al. (2003).

In addition to adapting to changes in the mission, teams adapted to balance workload and compensate for a weak team member. In some instances a team's attempts to balance workload worsened coordination requirements because they split assets that were usually employed together over several team members.

Despite our attempts to legitimize structural changes and provide feedback to help the teams gain insight into when structural change may be called for, the teams voiced reluctance to institute structural change. They were concerned about the cost of change. Teams frequently considered and discussed several structural changes only to abandon them because they were worried about learning how to employ unfamiliar assets or how to undertake new mission tasks with little practice. If we are to continue to press the virtues of structural change we will need to address this concern directly either through model driven aids showing the cost-benefit to change or enhanced training.

In addition, the organizational structures employed in the simulation were simplified representations of real world C^2 organizational structures. Yet, even at this simple level the officers in the study had difficulty understanding the dynamics of the organizational structures used. Moreover, they had even more difficulty visualizing what effects a particular structural change would have. In the language of cognitive models, the officers did not have an adequate model of an organization in their heads and they could not run this model to visualize the effect of various changes. Consequently, the adaptation process may be facilitated if intermediate organizations that are pre-existing and derived by higher authority to fit the mission are provided. In other words, the process could be facilitated if the players had a "library" of organizations to choose from that could be matched to mission demands based on modeling and previously experience given mission types. The important aspects of these intermediate organizations could be specifically pointed out in relation to the mission in detail. Perhaps, dynamic models could be

provided for these organizational structures to allow the decision makers to conduct "what if" scenarios. Alternatively, aspects of the intermediate organizations could be demonstrated by subject matter experts via video to give the decision makers insights into the different organizations and what they offer.

Finally, the feedback we provided the officers to inform them that incongruence exists between the current structure and the mission was not well understood and not detailed enough to help them identify effective structural changes. Critically, this was related to the observation that teams were often unaware as to how poorly they had performed a mission. During training the orientation was to stay on mission and ultimately take the final objective, the enemy's sea port before the scenario ended. This led participants to believe that if they took the seaport or had gotten reasonably close to doing so they had performed well, but there was much more to high mission performance than just taking the seaport: e.g., the level or accuracy with which each mission task was done, how well teams protected their assets and protected areas from enemy attack, how well teams prosecuted unexpected tasks that occurred throughout the scenario, and how well teams discriminated between enemy and neutral platforms. Unfortunately, teams seemed to be relatively unaware as to how well they did on these latter issues. These data suggest that feedback must be enhanced and made specific to various aspects of the mission. In general, we must address this by providing more detailed feedback and by providing training on how to use this more detailed feedback to assess team mission performance.

In total, this exploratory study advanced our knowledge a great deal concerning how teams approach making organizational changes. Based on these data, we must now profit from our findings and develop more and/or better training and aids to assist this process if we wish to see it carried out effectively. For instance, individuals and team can receive training on understanding the complexities of organizational structures, training to better diagnosis team performance, and aids that provide detailed feedback on team performance and the fit between structure and mission. Ultimately, these are valuable for they reflect a starting point for training, decision aids, and other adaptation processes. Indeed, these data are compelling because they demonstrate that the teams would indeed adapt. However, the extent of these adaptations was modest and not necessarily in a positive direction with respect to mission effectiveness. Hence, our ongoing work will address how to shape and encourage the necessary adaptations.

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