12th ICCRTS

"Adapting C2 to the 21st Century"

Team Collaboration in a Distributed Coalition Network

Network-Centric Experimentation and Application Track

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Abstract

Distributed teams representing multidisciplinary perspectives and operating in a collaborative information environment will define the future of Command and Control (C2). Multinational Experiment 4 (MNE 4) provided researchers an opportunity to evaluate how distributed teams interact in a collaborative, networked environment to conduct the Effects Based Approach to Operations (EBAO). Several factors related to team collaboration were evaluated. These included measurements of workload, perceptions of information quality, ability of subjects to develop trust in teams and the staff process, team process dynamics, training evaluations, and the assignment of roles and responsibilities within teams.

Distributed teams were able to establish trust. However, not all teams were equally effective in assigning roles and responsibilities within the team and in establishing relationships with other teams. This resulted in confusion about the overall objective. Teams also reported an unequal distribution of effort, performance, and frustration. Larger teams reported increased workload, lower performance, and higher frustration. Respondents' ratings of information quality suggest that information was complete and sufficient, but less timely, understandable, and accurate. These findings are summarized and recommendations made for organizational design, collaborative system use, and training.

Introduction

The nature of asymmetric warfare demands military collaboration with allied nations, other-government agencies and non-government humanitarian organizations. Advanced networking technologies provide the means to achieve this collaboration in a distributed manner.

The Effects Based Approach to Operations (EBAO) is fundamentally different from traditional military tactics of attrition in that it is conducted in the cognitive domain (Smith, 2002). Thus, though process, organization, and technology are required building blocks for EBAO, without systematic human cognition (implying shared knowledge, situation awareness, etc.), EBAO will not achieve the desired end-state of decision superiority.

In EBAO, operations are focused on influencing or changing system behavior or capabilities using selected instruments of power in order to achieve directed policy aims (for a more detailed description, see the MNE 4 EBO Concept of Operations, US JFCOM, 2004). A central focus of the EBAO is to achieve a greater unity of effort among the various instruments of power.

Multinational Experiment 4 (MNE 4) was conducted in February 2006 with the cooperation of many nations and the North Atlantic Treaty Organization (NATO). Participating nations contributed participants to play military and civilian staff roles in a simulated combined joint task force. Most participants were physically located in their respective nations and

connected to others via a collaborative network. [1] Each participant used the collaborative system to interact with their distributed team members. The headquarters was comprised of several teams. These included the command group, effects based planning (EBP), effects based execution (EBE), effects based assessment (EBA), Red/Green teaming, Knowledge Management (KM), Multinational Interagency Group (MNIG) and System of System Analysts (SOSA).

Team cohesion in distributed and *ad hoc* settings will be dependent upon the team's ability to form a trusting relationship (Fine & Holyfield, 1996; Mayer, Davis & Schoorman, 1985), the ability of team members to work together and to share knowledge of individual and group role sets (Warne et al., 2004). Additionally, teams will be confronted with vast amounts of information from various sources; this can overwhelm users (Edmunds & Morris, 2000). In this experiment, we examined the respondents' perspectives on their interactions within and among the staff teams.

Trust has been shown to be a critical element in the decision to share information (Warne et al, 2004) and can be defined as having an expectation of positive treatment from others when one is in a weak position (Mayer, Davis, & Schoorman,1985). As a precursor to team cohesion, trust impacts the willingness to share information (Fine & Holyfield, 1996). In the network centric environment, cooperation and collaboration are essential factors for mission readiness.

Teamwork is facilitated by a trusting environment because information exchange is enhanced (Hightower & Sayeed, 1996; Tan, Wei, Huang & Ng, 2000). Individuals must be accountable, must share information appropriately, and work toward a shared objective (Warne et al., 2004). This implies that team members must understand not only their own roles, but the general expectations of others within and outside of their immediate team. This is especially true in the EBAO because of the interactions between groups of different military forces and civilian agencies (Warne et al., 2004). These relationships lead to an increase in information exchange and a requirement for timely and accurate filtering.

Method

In this experiment, we chose to focus on the following human factors issues to examine team cohesion in EBAO. These were balanced roles and responsibilities, quality of information, trust in process, organization, and technology, workload, and teamwork. We hypothesized that if high levels of these variables could be achieved, the coalition staff would be able to approximate a cohesive staff. We defined a cohesive staff as one capable of meeting deadlines by dividing responsibilities and of handling tasks in an efficient way.

The NASA Task Load Index (NASA TLX) was used to measure workload because it is easy to administer, is accepted by respondents, and has high face validity (Hill, Iavecchia, Byers, Bittner, Zaklad, and Christ, 1992). On four days of each of the three weeks in the experiment, participants were asked to complete this survey at the end of the day. The survey asked respondents to rate their perceived workload experienced that day in terms of mental and

[1] Participants from the other nations who were filling staff leadership roles were co-located in the U.S. with the command staff.

physical workload, time pressure felt, satisfaction with own performance, effort, and frustration felt. Each of these questions is answered on a 10 point scale (1=low, 10=high).

Five questions were developed to measure participants' perceptions on their ability to trust in their ad hoc teams and the technology in use. These questions were 1) my team was open to ideas from all, 2) I was comfortable sharing ideas with my team, 3) team members were kept informed, 4) the collaborative technology made it possible for my ideas to be understood, and 5) the collaborative technology was an efficient way to work in a distributed environment. Each question was answered on a 7 point scale (1=low, 7=high).

Ten questions were used to measure participants' perceptions on the quality of information they received in MNE 4. These questions were all measured on a 7 point scale (1=low, 7=high). The questions asked participants to rate the quality of information they received on the basis of accuracy, appropriateness, accessibility, relevance, timeliness, completeness, sufficiency, conciseness, interpretably, and understandability.

Four questions were used to measure participants' perceptions of the team process they experienced in MNE 4. These questions were all measured on a 7 point scale (1=low, 7=high). The questions were 1) my team was effective in sharing information, 2) my team was effective in assigning roles, 3) my team was effective in assigning responsibilities, and 4) my team was effective in communicating ideas. The questions in this survey regarding roles and responsibilities do not conflict with the survey described below because HF4 asks if the team engaged in the process of assigning roles and responsibilities, not if a participant actually understood their contributions to the team.

Four questions were used to measure participants' understanding of their contributions to their primary team, or their understanding of their roles and responsibilities and those of their teammates. The questions were all measured on a 7 point scale (1=low, 7=high). These questions were 1) In my team, I was clear what was expected of me, 2) In my team, I was clear about what others were to do, 3) In MNE 4, I was clear about what other groups were to do, and 4) In MNE 4, I was clear about how all groups should work together.

131 participants participated in this experiment. Of the 124 respondents who answered the demographic survey, 68 (55%) had previous experience working in a distributed collaborative environment and 88% reported military experience. 61% reported participation in one of the spiral events (e.g. workshops or limited objective experiments) leading up to this experiment.

The primary data collection methodology was computer-based survey administration. These were analyzed with inferential statistics. The workload data were analyzed with repeated measures Multivariate Analysis of Variance (MANOVA), while the others were analyzed with analysis of variance (ANOVA). In addition, the researchers had access to real-time voice and typed conversations occurring in the small groups over the collaborative interface. This access essentially allowed the researchers to monitor several groups at one time and to record comments relating to an area of interest. Additionally, the survey questions mentioned above allowed respondents to provide explanations for any quantitative answer.

Results

Workload

Reported workload levels in the CTF EBAO headquarters showed that effort and performance were unequally distributed. A repeated measures MANOVA was used to analyze the workload survey data. These data were collected from participants at the end of four days in each of three weeks of the experiment, resulting in 12 days of data. The data for time were separated into *week* and *day*. This analysis has two within factors, *week* and *day*, and one between factor, EBAO *group*. Each participant was assigned to an EBAO group for the duration of the experiment. The N for this analysis was 92 due to missing data. Participants who did not complete the survey on each of the 12 days were deleted from the analysis. Researchers did not replace missing values in the data set. This analysis tested the main effects of *day*, *week* and *group*, three two way interactions, and one three way interaction. The MANOVA revealed several significant main effects and interactions for workload. The significant effects are:

- Group main effect: significant *Wilk's* λ F (42 ,374) = 1.67, p =.005
- Week main effect: significant *Wilk's* λ F (12,73) = 6.98, $p < .0005$
- Day main effect: significant *Wilk's* λ F (18,67) = 2.65, p = .002
- Week * group interaction: significant *Wilk's* λ F (84,455) = 1.41, p = .016
- Day * group interaction: non-significant *Wilk's* λ F (1216,450) = .98, p = .538
- Week * day interaction: significant *Wilk's* λ F (36,49) = 2.60, p = .001
- Week * day * group interaction: non-significant *Wilk's* λ F (252,350) = 1.17, p = .088

The results shown above indicate the following. The EBAO groups differed in their perceptions of experienced workload. Participants also rated their workload by week and by day differentially. The week by group interaction suggests that some groups rated their workload differently by week. The week by day interaction suggests that participants rated their workload differently by days in the week. However, the MANOVA indicates only that overall differences exist. Further univariate testing was needed to understand how the groups vary with respect to these main and interaction effects. In analyzing these results, it is only appropriate to solve for the interaction effects, since the main effects are contained in the interaction equation (Stevens, 1996).

To evaluate the week * group interaction, a univariate analysis of variance (ANOVA) was used to determine which component of workload contributed to the interaction. Results showed significant effects for the *satisfaction with own performance* (F (14,7) = 2.91, p = .001) and *frustration felt* (F (14,7) = 2.04, p = .018) dimensions of workload. To further analyze these factors, ANOVA was performed for the significant workload components as the dependent variables and *EBAO group* as the independent variable. The results are reported below.

To further assess the significant effect, post hoc tests were conducted by controlling for week and assessing group differences during that week. As shown below, ratings of satisfaction with own performance were significant for performance in weeks one, two, and three. Ratings for frustration felt were significant only in weeks one and two but not three.

- Wk1perf, significant F (7,96) = 3.72, p = .001
- Wk2perf, significant F (7,99) = 2.90, p = .008
- Wk3perf, significant F (7,96) = 2.26, p = .036
- Wk1frust, significant F (7,96) = 3.27, p = .004
- Wk2frust, significant F (7,99) = 1.89, p = .08
- Wk3frust, non-significant F (7,95) = 1.14, p = .343

Post hoc tests for the significant univariate t-tests showed the following comparisons for satisfaction with performance and frustration. These tests show how the EBO groups differed with respect to their ratings of these workload dimensions, identified by the mean rating for the group. These results are shown in table 1 and 2 below.

Table 1 Significant differences between groups on Satisfaction with Performance

Satisfaction with Performance Dimension					
Week	Group	Mean	Group	Mean	Significance
1	Command Group	7.31	EBP	5.44	p = .032
			EBE	4.38	p = .001
			EBA	5.48	p = .050
			KM	5.40	p = .034
			SOSA	5.02	p = .015
	EBE	4.38	EBP	5.44	p = .030
			MNIG	6.28	p = .006
	Red/Green Team	7.41	EBP	5.44	*p = .008*
			EBE	4.38	p = .000
			EBA	5.48	p = .017
			KM	5.4	p = .009
			SOSA	5.19	p = .003
2	Command Group	7.94	EBE	4.86	p = .001
			MNIG	5.81	p = .029
			SOSA	5.27	p = .007
	EBE	4.86	EBP	6.19	p = .008
			KM	6.32	p = .008
			Red/Green	7.20	p = .006
	SOSA	5.27	Red/Green	7.20	p = .033
3	Command Group	8.13	EBP	6.16	p =.023
			EBE	5.28	p = .002
			MNIG	6.19	p = .050
			SOSA	5.64	p = .009
	EBE	5.28	EBA	6.75	p = .020
			KM	6.57	p = .014

The pairwise comparisons shown in table 1 show that in the three weeks of the experiment, there were many significant differences among the EBAO groups with respect to their subjective ratings of 'satisfaction with own performance'. The Command Group had consistently high ratings for their own performance. We believe that this may be an artifact of the relatively unchanged roles for the Command Group in EBAO as experienced in MNE 4. For the staff participants in MNE 4, most roles required very different process tasks for the completion of the operational goals. These differences were required not only in the types of activities required but also in the use of tools and technology to complete actions and format

documents. This was not true of the command group. These leaders (Commander, Deputy Commander, and Chief of Staff) performed essentially the same roles that they would have been familiar with in their previous assignments.

Also of note, the EBE group rated their performance significantly lower than other groups in all three weeks. These lower ratings are likely the result of the difficulties the EBE group experienced with the experiment scenario and the lack of information from the white-celled component commanders.

Table 2 shows subjective ratings of 'frustration felt' for EBAO groups. In week one, the EBP group felt significantly higher frustration than EBA and MNIG. This is probably due to the emphasis on planning at the beginning of the experiment. Also in week one, the MNIG reported significantly lower frustration than EBE, KM, Red/Green team, and SOSA. This could reflect the slow start for the MNIG group.[2] In week two, the Command Group reported significantly lower frustration levels than EBP, EBE, KM, MNIG, and SOSA. During week three, EBA reported significantly lower frustration than EBP. The lower frustration levels for EBA could be related to the lower group size and the more focused tasks for this group.

Table 2 Significant differences between groups on Frustration Felt

Frustration Dimension					
Week	Group	Mean	Group	Mean	Significance
1	EBP	6.72	EBA	2.35	$p = .028$
			MNIG	3.81	$p < .0005$
	MNIG	3.81	EBE	6.57	$p = .001$
			KM	5.61	$p = .027$
			Red/Green	6.79	$p = .004$
			SOSA	6.64	$p = .002$
2	Command Group	3.0	EBP	5.75	$p = .007$
			EBE	6.26	$p = .002$
			KM	5.08	$p < .047$
			MNIG	5.54	$p = .021$
			SOSA	5.89	$p = .01$
3	EBP	5.44	EBA	3.95	$p = .039$

Univariate ANOVAs were used to determine what dimension of workload contributed to the significant interaction of week * day. ANOVAs showed a significant effect for time of workload measurement on reported mental workload, $F(6, 504) = 2.82$, $p = .01$, reported physical workload, $F(6, 504) = 5.04$), $p = .0005$, reported time pressure felt, $F(6, 504) = 8.17$, $p = .0005$, and reported effort $F(6, 504) = 7.66$, $p = .0005$. Univariate tests showed that daily workload reports for the dimensions identified above were significantly different in week one and week three. Further paired t-tests showed that this difference was primarily due to significant ratings for each dimension between the first day of week one and the last day of

[2] Because the MNIG was staffed by actual interagency representatives from the participating nations, it was difficult for these individuals to devote one month to the experiment. As an accommodation, the full MNIG play was scheduled for the third and fourth weeks of the event (week one was training and week two was the first week of actual staff work). It was not until the last two weeks of the experiment that the MNIG was fully staffed and challenged with EBAO tasks.

week three. These findings are understandable. Participants were eased slowly into the experiment pace on day one and the final day of survey administration reflected the reality that most work to be completed in the experiment was done.

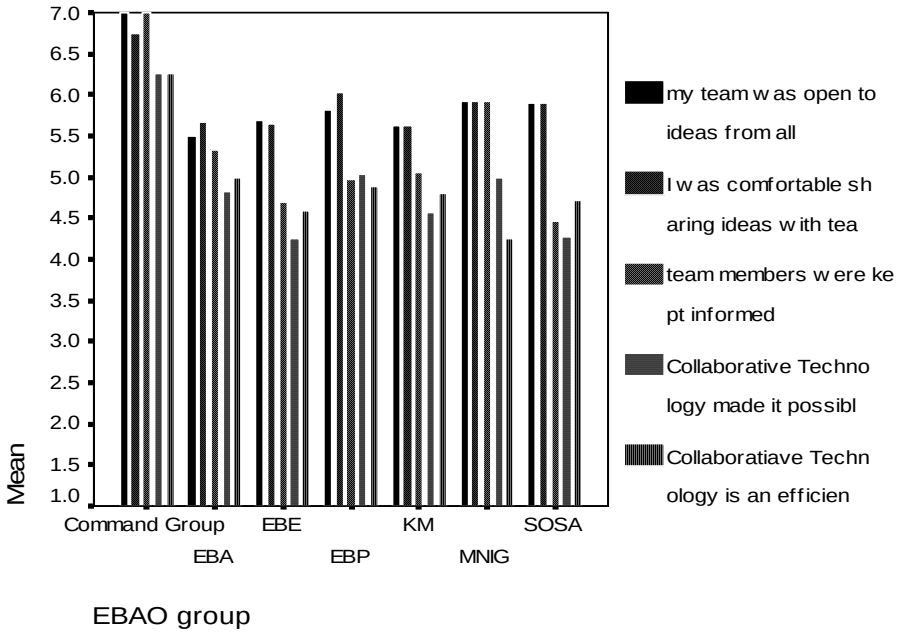
TRUST IN TEAM AND TECHNOLOGY

The distributed, ad hoc teams created for the Headquarters in MNE 4 reported high levels of trust in their primary team and in collaborative technology employed in MNE 4. The Trust in Team ANOVA revealed no significant differences between EBAO groups. As displayed in Table 3 and Figure 1 below, all groups rated their responses to the questions within close parameters. These high reported levels of trust could be an experiment artifact demonstrating the participants' willingness to help the experiment designers execute an important event. In reality, one could reasonably expect distributed teams to develop trust over a longer period of time and with less unanimity.

Table 3 CTF Trust in Teams Responses

Survey Question	N	Mean	Std. Deviation
My team was open to ideas from all	109	5.7982	1.4258
I was comfortable sharing ideas with team	109	5.8624	1.3015
Team members were kept informed	109	5.1009	1.6327
Collaborative Technology made it possible for my ideas to be understood	109	4.7615	1.4136
Collaborative Technology is an efficient way to work in distributed environment	109	4.7982	1.6146

Figure 1 CTF Trust in Teams Responses



PERCEPTION OF INFORMATION QUALITY

The Command Group consistently rated their perception of information quality received in MNE 4 higher than EBAO staff groups. The ANOVA for the perception of information quality showed significant differences for questions 1, 2, 5, 6, 7, 8, 9, and 10. Table 4 displays these differences and defines each question.

Table 4 Perceptions of information quality

Variable	Survey Question	df	Mean Square	F	Sig.
INFO1	Information was accurate	6	3.278	2.542	.025
		102	1.290		
INFO2	Information was appropriate	6	4.551	3.026	.009
		102	1.504		
INFO3	Information was accessible	6	2.743	1.393	.225
		102	1.969		
INFO4	Information was relevant	6	2.865	1.806	.105
		102	1.586		
INFO5	Information was timely	6	4.500	2.501	.027
		102	1.800		
INFO6	Information was complete	6	8.401	4.727	.000
		102	1.777		
INFO7	Information was sufficient	6	7.589	4.068	.001
		101	1.866		
INFO8	Information was concise	6	5.544	2.914	.012
		101	1.903		
INFO9	Information was interpretable	6	4.766	2.659	.020
		101	1.793		
INFO10	Information was understandable	6	3.863	2.222	.047
		101	1.739		

This finding that the Command Group rated the quality of information they received as higher than other groups is not surprising given the fact that information presented to the command group would have first been filtered by the staff. We can be interpret this to mean that the staff did a good job of filtering out information that was incomplete or insufficient prior to presenting updates to the commander.

Table 5 provides the differences in team perceptions regarding information quality. We see that the MNIG and EBE groups rated the quality of information for most categories lower than other staff groups. This is consistent with the EBE problems from gaining information of

sufficient detail from component commanders.[3] The problem of information quality with respect to the MNIG may be related to connectivity problems experienced by that group. At times during the experiment, the MNIG team had trouble using the collaboration software and could not access information that was shared with the headquarters staff.

Table 5 CTF Differences between EBAO groups in perception of information quality

Question	Group	Mean	Group	Mean	Significance
1	Command Group	6.0	EBE	4.11	.047
Accurate			MNIG	3.91	.034
2	Command Group	6.0	EBE	2.37	.012
Appropriate			MNIG	2.18	.045
			SOSA	2.27	.032
5	Command Group	6.25	EBE	3.21	.030
Timely			MNIG	2.73	.004
6	Command Group	6.25	EBA	3.64	.018
Complete			EBE	3.21	.001
			KM	3.95	.034
			MNIG	2.73	.0005
			SOSA	3.82	.036
7	Command Group	6.25	EBE	3.42	.005
Sufficient			KM	3.95	.042
			MNIG	3.0	.002
			SOSA	3.6	.023
8	Command Group	6.25	EBA	3.73	.036
Concise			EBE	3.53	.009
			KM	3.95	.045
			MNIG	3.18	.004
			SOSA	3.60	.026
9	Command Group	6.50	EBE	3.95	.013
Interpretable			MNIG	3.91	.021
			SOSA	3.90	.023
10	Command Group	6.5	EBE	4.16	.027
Understandable			MNIG	4.18	.050

TEAM PROCESS

The Command Group, MNIG, and EBA groups reported high levels of behavior geared toward assigning roles and responsibilities. The SOSA, EBP, KM, and EBE groups had lower ratings for this measure. The results for the team process survey suggested that significant differences existed only for question 3 (my team was effective in assigning responsibilities). These results are shown in table 6. Though the other questions originally suggested significant differences, the strength of the significance level was insufficient for follow-on comparisons. Figure 2 provides an illustration of group differences. Though all groups rated their team fairly high on these questions, several groups do have lower scores. The EBE and EBP groups were the largest groups and possibly struggled with team process due to that fact. The SOSA was a smaller group, but because of the nature of their work product, tended to work in isolation rather

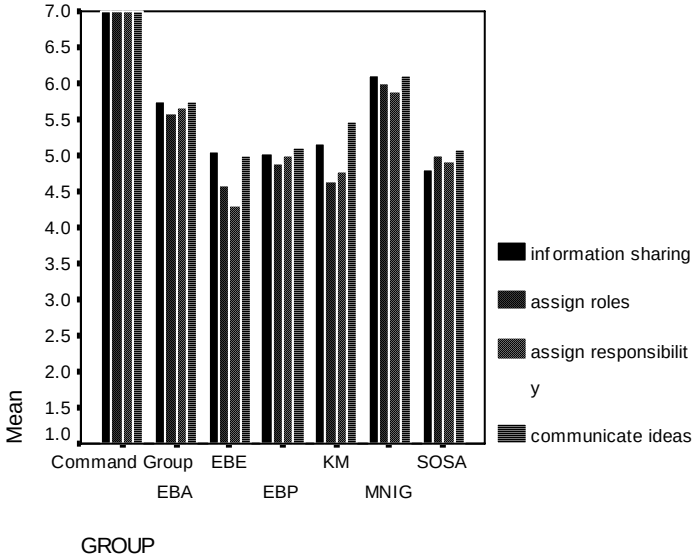
[3] Throughout the experiment, the EBE group noted that they did not have the correct level of detail from the component commanders (played by confederates) to do a good job of operational level execution. This was an experiment design problem that was difficult to adjust once the experiment began.

than together, possibly arguing for a reduced need for group process. [4] The KM group also tended to work in semi-isolation, fixing technical and computer problems as staff asked for help.

Table 6 Team Process results

Variable	df	F	Sig.
My team was effective in sharing information	6	2.477	.028
	98		
My team was effective in assigning roles	6	2.688	.019
	98		
My team was effective in assigning responsibilities	6	3.208	.006
	98		
	104		
My team was effective in communicating ideas	6	2.347	.037
	98		

Figure 2 Chart of team responses to team process survey



The significant difference between EBAO groups for question 3 occurred between the Command Group and EBE. The mean for the former was 7.0 compared to the EBE mean of 4.32. This difference between groups was significant at p=.013. This suggests that the EBE group, to a lesser extent than other EBAO groups in MNE 4, did not effectively assign responsibilities to their team members. This could be a result of the leader of the EBE group arriving at the experiment several days late due to uncontrollable problems. However, this points out an important reality for large staffs; that ad hoc leaders must be able and willing to take over for absent leaders.

[4] The SOSA group was comprised of PMESII analysts. When a staff member needed political advice, they would contact the political analyst, who would respond.

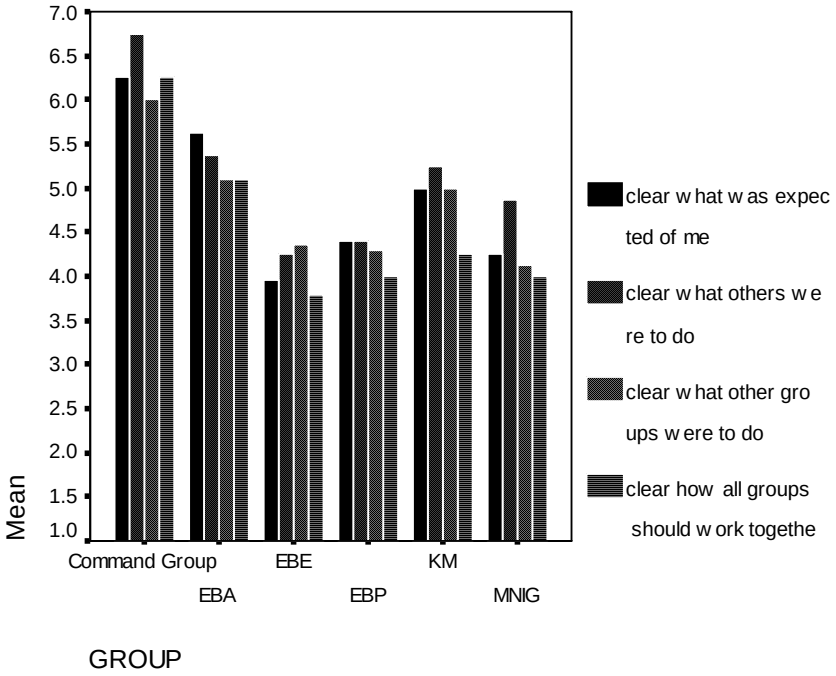
ROLES AND RESPONSIBILITIES

The groups differed significantly on questions 1 (It was clear what was expected of me) and 4 (It was clear what other groups were to do) (see Table 7). Figure 3 illustrates that the EBE and EBP groups had lower overall scores, while EBE, EBP, KM, and MNIG demonstrated difficulty knowing what other groups were to accomplish. This is likely related to an understanding of the Concept of Operations for MNE 4 and pre-experiment training, but would certainly be an area of concern for an actual staff.

Table 7 Between groups differences

		Sum of Squares	df	Mean Square	F	Sig.
clear what was expected of me	Between Groups	33.572	5	6.714	1.972	.093
	Within Groups	251.978	74	3.405		
	Total	285.550	79			
clear what others were to do	Between Groups	29.548	5	5.910	2.445	.042
	Within Groups	178.840	74	2.417		
	Total	208.387	79			
clear what other groups were to do	Between Groups	16.686	5	3.337	1.494	.202
	Within Groups	165.264	74	2.233		
	Total	181.950	79			
clear how all groups should work together	Between Groups	30.383	5	6.077	2.372	.047
	Within Groups	189.567	74	2.562		
	Total	219.950	79			

Figure 3 CTF results roles and responsibilities



Conclusions

Workload

Workload measures are a valuable tool for the measurement of organizational health and should be used with other relevant measures. The NASA TLX is a widely used tool to measure six components of workload, it is easily administered survey, takes very little time and effort to complete, and has excellent validity. This survey should be included in future experiments especially because the MNE 4 data would provide a baseline.

The Command Group consistently rated their satisfaction with their own performance higher than the staff groups. This is likely due to the fact that the command tasks in the MNE 4 execution of EBAO did not change from traditional military standards. This could not be said of the staff groups that were required to perform very different tasks, using new and unfamiliar technology, and executing military operations with a new language and with nonmilitary participants acting as team members. The question of how the Command Group tasks, activities, and interactions should change to support EBAO should be explored in detail in support of MNE 5. Special consideration should be given to the commander's interactions with local persons of interest and the EBAO interagency group. In these types of communications, important information is exchanged that the commander must perceive, understand, and report to the staff. This process is one of many ways that holistic and dynamic understanding is maintained.

It is important to note that frustration between groups was significant in the first and second week of the experiment. In week one, EBP had a higher frustration level than EBA or MNIG. The MNIG group also reported lower frustration than EBE, KM, Red/Green Team, and SOSA. These ratings are supported by observations that showed the EBE and EBP groups working diligently to understand their respective roles in the experiment. The lower frustration levels for MNIG in week one are likely related to the slow formation of this group and their belated understanding of the larger experimentation issues. The MNIG frustration levels rose in the second and third weeks. In the second week, the Command Group reported lower frustration than all other staff groups. This is most likely related to the conclusion drawn above, that the command group's tasks were not different from previous training and experience.

Trust in Team and Technology

The highest response scores from the EBAO participants in this survey were for the questions "My team was open to ideas from all" and "I was comfortable sharing ideas with my team." These mean results were 5.79 and 5.86, respectively. These questions were measured on a 7 point scale, suggesting that these scores are high. Lower scores were reported for the questions that asked if the collaborative technology was sufficient to have ideas understood and was an efficient way to work in a distributed environment. These mean scores were 4.76 and 4.79, respectively. These ratings suggest that the collaborative technology, though occasional problems were experienced with the network connection, was accepted by participants and should be pursued as a future work technique.

Information Quality

Information quality remains a difficult problem for an operational headquarters conducting EBAO. This is in part an information technology issue and also a human perception issue. Advanced technologies are needed to distribute information appropriately. This is the problem of getting the *right* information to the *right* people at the *right* time in the *right* format. The fact that the Command Group consistently rated their perception of information quality they received higher than EBAO staff groups likely represents the information fusion capability performed by the staff prior to sharing information with their leaders. And finally, respondents reported that information was complete and sufficient, but less timely, understandable, and accurate. The routing of information through a labyrinth of software programs and teams was the likely cause of this delay and confusion.

Team Process

The EBAO groups identified by the survey as having the most clearly defined roles and responsibilities included the Command Group, MNIG, and EBA. We have previously made the point that the functions in the Command Group were essentially unchanged in MNE 4 from traditional military experience. This would explain this group's understanding of their roles and responsibilities. The MNIG, though a new concept for the military, represented a homogenous group of interagency experts who understood the problems of humanitarian operations extremely well. This group, while not familiar with the military staff and structure, did exhibit a solid understanding of their purpose in MNE 4. The EBA group represented a small group that was led by an extremely competent individual with vast experience in MNE 4 and previous experiments in this series. This leader took time in pre-event exercises to detail the roles and responsibilities of the EBA. This work was evident in the survey responses reported here.

Roles and Responsibilities

The larger teams (EBE and EBP) reported that they understood their roles to a lesser extent than the remaining staff groups. This is problematic because these are the primary staff work groups in an operational headquarters. This finding argues for increased training on roles and responsibilities. It was also troublesome that many groups demonstrated a weakness in understanding what other groups were to accomplish.

Overall conclusions

The surveys used in this experiment were helpful in understanding the uneven process of teamwork and trust in the conduct of this distributed collaborative event. It is noteworthy that the teams, each of which was comprised of members from the participating nations, reported that team members established a trusting relationship. This was likely facilitated by the fact that two-thirds of the participants had met at some point in the year prior to the experiment in the conduct of a spiral event. Though the teams were able to establish trust, they were not all equally effective in assigning roles and responsibilities within the team and in establishing relationships with other teams. This resulted in confusion about the overall objective. Teams also reported an unequal distribution of effort, performance, and frustration. Larger teams reported increased

workload, lower performance, and higher frustration. Respondents' ratings of information quality suggest that information was complete and sufficient, but less timely, understandable, and accurate.

The frustration element appeared to be generated by two primary factors that were not shared equally among the teams. The interagency group (MNIG) expressed significant frustration at their lack of understanding and familiarity with the military staff process. They considered it rigid and complex. Military groups, on the other hand, expressed frustration at the software tools that had been designed to support planning, execution, and assessment activities.

These findings suggest that smaller teams were able to establish the prerequisite characteristics needed for performing in a capable manner. System designers should consider maximum group sizes in staffing military headquarters. This is especially important when the primary communication device is a collaborative software system and the team members will never meet in a face to face medium. In this environment, training is an essential and critical skill that is often unappreciated by designers and users. Many of the skills used in MNE 4 were quickly lost if not used routinely. The training staff should continue to work hand in hand with concept developers to sequentially build a training program. This would allow for a 'just in time' approach to training that could be instituted at each stage of the experimentation planning process, or a staff building process. Training for EBAO in a collaborative environment is substantial. Not only are there explicit learning objectives, but implicit objectives as well. The implicit objectives speak to the technological and social developments that argue for EBAO. Without this background and understanding, an experiment participant, or staff member, cannot effectively implement EBAO tasks.

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