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Refinement of decision support requirements in support of operational planning

One use of experimentation analysis

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Defence R&D Canada – Valcartier
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DRDC Valcartier TM 2010-060
November 2010

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Abstract

Refining requirements related to a computer-based decision support system always presents a challenge. Most of the time, the requirements provided are highly abstract in nature, which leaves a vast array of possible concepts that could be developed to provide real support to the end user. To facilitate the capture of detailed decision support requirements, we propose to make use of the results of experiments conducted during exercises.

This memorandum describes how an experiment conducted at Canadian Forces College (CFC) to evaluate a collaborative planning system was used to produce refined requirements for collaborative planning.

Résumé

Le raffinement de la caractérisation des besoins liés aux systèmes automatisés d'aide à la décision est un défi continuel. La plupart du temps, les besoins sont identifiés à un très haut niveau d'abstraction, faisant place à un large spectre de possibilités sur la façon dont les concepts peuvent être implantés pour fournir une aide réelle à l'usager. Pour faciliter la collecte des besoins détaillés d'aide à la décision, il est proposé d'exploiter les résultats d'expérimentations effectuées pendant les exercices.

Ce mémorandum décrit comment une expérience effectuée au collège des Forces canadiennes pour évaluer un outil collaboratif de planification a été utilisée pour raffiner la caractérisation des besoins d'aide à la planification collaborative.

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Executive summary

Refinement of decision support requirements in support of operational planning: One use of experimentation analysis

Bélanger, M., Breton, R., Jobidon, M.-E.; DRDC Valcartier TM 2010-060; Defence R&D Canada – Valcartier; November 2010.

Defence R&D Canada – Valcartier (DRDC Valcartier) has developed a computer-based system called COPlanS (Collaborative Operations Planning System) to demonstrate how new technology can improve the ability to plan an operation using the CFOPP in a net-centric environment. In May 2006, COPlanS was assessed during an exercise conducted at Canadian Forces College (CFC) at Toronto. While the purpose of the experiment was to assess the tool's effectiveness during exercises, we decided to demonstrate that the results of this experiment could also be used to refine the requirements relating to the support of collaborative planning.

The results of this experiment were accordingly analysed with the aim of identifying refined requirements. This second analysis enabled us to identify the following areas of improvement for COPlanS:

- Two concepts of tool utilization that take into account the diverse roles of the planning team need to be developed, one for use in a distributed environment and one for use in a co-located environment;
- Adaptable user interfaces need to be designed that take into account the different positions of the planning staff, the level of OPP expertise and user preferences;
- Coaching support tools for new CFOPP employees need to be integrated;
- Advanced tools that support the development of cognitive models of the situation need to be designed and integrated;
- Intelligent analysis tools need to be developed for the campaign design, mission analysis, and COA development phases;
- Tools for automatically generating briefing material need to be more easily customized to different levels of details to meet various team preferences;
- Advanced decision-support tools for supporting deductive and inductive reasoning strategies need to be designed and integrated.

Sommaire

Refinement of decision support requirements in support of operational planning: One use of experimentation analysis

Bélanger, M., Breton, R., Jobidon, M.-E.; DRDC Valcartier TM 2010-060; R et D pour la défense Canada – Valcartier; novembre 2010.

Recherche et développement pour la défense Canada – Valcartier (RDDC Valcartier) a développé un système automatisé d'information appelé COPlanS (Collaborative Operations Planning System) pour démontrer comment les nouvelles technologies pouvaient améliorer la capacité de planifier une opération en utilisant le processus de planification opérationnel (PPO) dans un environnement réseaucentrique. En mai 2006, COPlanS a été évalué lors d'un exercice du collège des Forces canadiennes à Toronto. Bien que l'expérience était destinée à déterminer le niveau d'efficience de l'outil pendant l'exercice, nous avons décidé de démontrer que les résultats obtenus lors de celle-ci pouvaient également être utilisés pour raffiner les besoins d'aide à la planification collaborative.

Les résultats de cette expérience ont été analysés de nouveau afin de raffiner l'identification des besoins. Cette seconde analyse a mené à l'identification des avenues d'amélioration suivantes pour COPlanS :

- Deux concepts d'utilisation, tenant compte des différents rôles de l'équipe de planification, doivent être développés pour l'outil. Un concept visera l'utilisation de l'outil dans un environnement distribué et un autre, son utilisation dans un environnement commun.
- Des interfaces usagers adaptatives doivent être conçues afin de prendre en compte les différentes positions de l'équipe de planification, des niveaux d'expertises du PPO et des préférences des usagers.
- Des outils d'accompagnement pour les novices du PPO devront être intégrés.
- Des outils avancés pour aider au développement des modèles mentaux de la situation devront être conçus et intégrés.
- Des outils intelligents d'analyse devront être développés pour le design de campagne, l'analyse de mission et le développement de suites d'action.
- Des outils de génération automatique de matériel de breffage devront permettre de générer des présentations avec différents niveaux de détail pour satisfaire les préférences des différentes équipes.
- Des outils d'aide à la décision avancés devront mettre en application des stratégies de raisonnement déductif ainsi que des stratégies de raisonnement inductif.

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Acknowledgements

The authors would like to thank everyone from CFC Toronto, CEFCOM, CANADACOM, CANOSCOM and DJCP who took part in this trial of COPlanS.

1. Introduction

In a Command and Control (C2) environment, successful planning activities enables decision-makers to stay one step ahead of their opponents. Successful planning may also overcome a shortage of resources and personnel. Because of the importance of activities in operational environments, military organizations devote considerable time and efforts to developing approaches that will ensure optimal execution of the planning process. The Canadian Forces Operational Planning Process (CFOPP) is the planning process used by the CF at the strategic and operational levels. CFOPP is a systematic approach to analyzing situations, bringing staff expertise to bear on the relevant factors, narrowing down possible courses of action, obtaining the commander's approval, and developing the detailed annexes necessary in producing a feasible plan.

The existing method of executing the CFOPP fails to take advantage of available technology that would permit faster decision loops and better quality decisions during the planning process. As a result, Defence R&D Canada – Valcartier (DRDC Valcartier), to show how new technology can enhance operations planning by using the CFOPP in a net-centric environment, has developed a computer-based system called COPlanS (Collaborative Operations Planning System). This system is an integrated, flexible suite comprising planning, decision-aid and workflow management tools designed to support distributed teams involved in the military OPP. It is anticipated that COPlanS capabilities will allow planners to devote their limited cognitive resources to thinking about problems and identifying options rather than performing routine tasks such as formatting documents and briefings.

Refining requirements to support the planning process always poses a challenge. Most often, requirements are provided at a very high level of abstraction, which leaves a vast array of possible concepts that could be implemented to provide real support to the end user. While the main purpose of experimentation is to determine the efficiency of the tools tested during exercises, our intent was to demonstrate that the results of experiments could also be analysed to refine the requirements and gain greater insight into the system's weaknesses. Accordingly, experiments were carried out at Canadian Forces College (CFC) in Toronto in order to evaluate COPlanS as a CFOPP collaborative planning system at the operational level and to produce refined requirements relating to the support of collaborative planning.

This report offers a brief introduction to the CFOPP (Section 2) and COPlanS (Section 3). The experimentation approach and set-up employed at CFC are described in Sections 4 and 5, while Section 6 offers an analysis of the experiment results in Section 6.

2. Operations Planning in the Canadian Forces

The CFOPP is the process used by the Canadian Forces (CF) to prepare plans and orders for military operations. The CFOPP, described in the CF Operational planning process manual [1], is designed to guide operational planning in the CF. In terms of doctrine, the manual is authoritative, but the process requires judgement in its application. Depicting the idealized process, its aim is to optimize logical, analytical aspects of decision-making in conditions of uncertainty and ambiguity while maximizing the creative thinking and associated thought processes of the commander and staff.

CFOPP comprises five primary stages (Figure 1) with specific outputs [1]:

- The *Initiation* stage results in the activation of the planning staff and guidelines issued by the commander on the kind of planning process desired;
- The *Orientation* stage results in the development of the commander's planning guidance. During this stage, the commander offers his/her staff guidance in defining the nature of the problem and confirming the results to be achieved;
- The *Course of Action (COA) Development* stage results in the production of the concept of operations (CONOPS) that sets forth the commander's line of action in accomplishing the mission. It presents the COA to be initiated. Earlier versions of the CFOPP included a decision stage that has now been integrated into this *COA development* stage;
- The *Plan Development* stage results in a set of orders based on the commander's decision to provide subordinates and supporting units with all necessary information for initiating the planning or execution of operations;
- The *Plan Review* stage results in a regular reviews of the plan to assess its viability. The time taken to review the plan depends on the evolution of the situation, the type of operation and the environment.

The first three stages of the CFOPP constitute what is called the Estimate Process. This involves the development of different COAs based on situation analysis and the selection of the most appropriate COA for subsequent planning. The purpose of the Estimate Process is to optimize logical, analytical decision-making in conditions of uncertainty and ambiguity while maximizing creative thinking and associated thought processes by the commander and staff [1]. It is important that it be tailored to specific needs of units and formations and to standing operating procedures. It is assumed that use of the Estimate Process will ensure a minimum of quality in the planning results.

The Estimate Process is carried out by a team representing various areas of expertise. Even if the different functions to be performed at the individual stages are clearly identified, no formal procedures on how to execute them have been defined [2]. The planning staff must accordingly employ intuitive strategies in executing those functions [2]. Calling upon their experience, background and ability to retrieve the relevant knowledge stored in their memory, they will use the Estimate Process as a guide in providing their commander with a recommendation on the best COA [3].

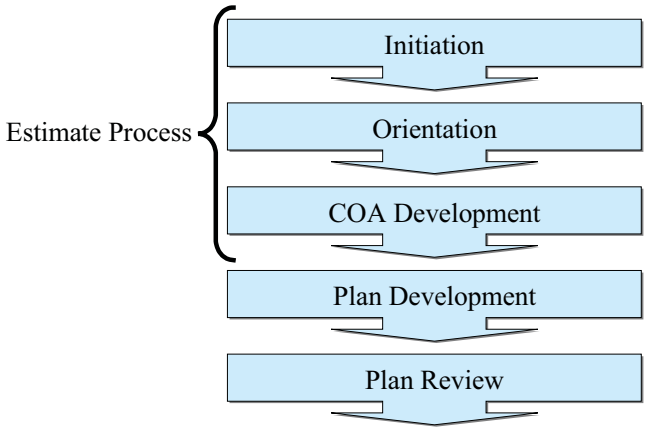

Figure 1: CFOPP

3. COPlanS

COPlanS is an integrated, flexible suite comprising planning, decision-aid and workflow management tools designed to support a distributed team involved in the CFOPP. Being both a client-server and a Web-based application, COPlanS offers functions for designing, managing and synchronising multiple concurrent battle rhythms at the strategic and operational levels, and, to a lesser extent, at the tactical level.

COPlanS offers some generic capabilities for capitalizing on net-enabling environments. These include process management, distributed collaboration, distributed document management and the automated WEB Master. The process management capability makes it possible to graphically design and implement various process templates (e.g., deliberate OPP, crisis action planning), to conduct staff checks and to manage staff, roles, activities, workflows and the approval process. It allows users to design and manage multiple concurrent distributed battle rhythms at different planning levels. The distributed collaboration tools provide a distributed collaborative workspace for sharing data and tools across workgroups/agencies, as well as a direct conduit to existing CF tools, such as Microsoft Outlook and Exchange Server. Chat is also available. The distributed document management capability allows users to automatically manage documents. It supports distributed document editing (check in/check out) and version control and is able to handle diverse formats of a document (doc, ppt, avi, etc.). The automated Web Master allows users to automatically maintain a Web consultation center for real-time information access.

COPlanS also offers various enhanced collaborative OPP capabilities that support the CF OPP in a net-enabled environment. The initiation tool allows users to:

- Create the operation;
- Describe the area of operation by locating the area of interest;
- Describe the direction provided by the higher level of command, including time constraints;
- Set the scene by assigning people to the planning team, identifying the tools to be used in planning, etc;
- Start the operations planning process.

The orientation tool allows users to jointly perform the mission analysis. The COA development tool makes it possible to sketch COAs on maps and/or Gantt charts, perform time and space synchronisation, manage resources and ORBAT and perform logistical analyses. The decision-aid tools streamline the process, improve COA evaluation and comparison and quickly produce documents in support of the commander's decisions.

The plan development and plan review tools, yet to be introduced, will furnish resources for completing, and reviewing if necessary, the various annexes needed to complete these steps.

4. Experimentation Approach

To complete this evaluation of the COPlanS as a CFOPP collaborative planning system at the operational level, the decision was made to collaborate with CFC Toronto, which is the Canadian centre of excellence for teaching the CFOPP to military officers. The curriculum of the Command and Staff Course (CSC) at CFC includes a number of different exercises. CSC's mission is to educate military officers and other national security leaders in joint, interagency, and multinational operational-level planning across the full spectrum of conflict. The 33 Program at CFC lasts 45 weeks and consists of four terms that begin in August and finish at the end of June. It comprises a variety of different activities designed to develop and ingrain through practice the ability of officers to execute the CFOPP.

One of these activities is the Friendly Lance exercise, based on the Atlantis scenario,. Executed at CFC Toronto from 29 May to 2 June 2006, it was the last evaluated exercise of the CSC program (05/06). This exercise was selected to evaluate COPlanS because of its appropriate timing for the CSC students. It was well known that major time constraints had been imposed by the schedule of this exercise (Table 1) that made it impossible to delve deeply into the CFOPP estimate process. It was accordingly recognized that the officers had insufficient time to assimilate all the information related to the scenario, complete all the analyses, develop COAs, etc.

Table 1: Exercise Schedule

DAY 1 MONDAY 29 May 06	DAY 2 TUESDAY 30 May 06	DAY 3 WEDNESDAY 31 May 06	DAY 4 THURSDAY 1 June 06	DAY 5 FRIDAY 2 June 06
0830 - 0845: *Introduction Bfg Traynor Aud* 0845 – 1000: ***CAAD Brf*** ***UN/NGO Brf*** 1030 - 1100: COMCJTF Initial Guidance JOPG 1, 2 (Tray) JOPG 3, 4 (Sim) 1100- EOD: JIPE, Mission Analysis	0830 – EOD: JIPE, Mission Analysis ***AJPSF/UN-NGO Seminars*** 0830 – 0915: Seminar 1 (JOPG 1) Seminar 2 (JOPG 2) 0915 – 1000: Seminar 1 (JOPG 2) Seminar 2 (JOPG 1) 1030 – 1115: Seminar 1 (JOPG 3) Seminar 2 (JOPG 4) 1115 – 1200: Seminar 1 (JOPG 4) Seminar 2 (JOPG 3)	**Mission Analysis Briefings** 0830 –1000: (JOPG 1,3) 1030 –1200: (JOPG 2,4) 1500 – 1600: (JOPG 5) COA Development	0830 – EOD: **COA Refinement** COA Update (Info) Briefings Manual War Gaming Visitor Arrivals AAR Surveys (Ex & COPLANS) in DND Learn Chief JOPG provide 3 Lessons Learned for	**Decision Briefings** 0800-0930: (JOPG1,3) 0930-1100: (JOPG 2,4) 1100 – Hotwash 1300 – 1430: (JOPG 5)

To meet the objective of this trial, the decision was made to conduct the experiment on two different paths. The first path involved using two groups of CSC students to evaluate COPlanS as

an OPP collaborative planning system at the operational level. The second path involved using one group of CF operators to confirm or disprove the findings.

4.1 Identification of Groups

The three groups identified for the purpose of this joint experiment were:

- The control group (JOPG3) consisted of CFC Toronto students (n = 16). They were asked to execute the task without using COPlanS;
- The second group, the COPlanS group (JOPG4), comprised CFC Toronto students (n = 17). They executed the task using COPlanS;
- The third group, henceforth referred to as the potential user group (JOPG5), consisted of military officers (n = 5), primarily from CANADACOM, CEFCOM and CANOSCOM. They also used COPlanS to execute the task.

The job of evaluating the impact of COPlanS on the execution of CFOPP fell to JOPG3 and JOPG4. The groups were similar and comparable in terms of their composition. They had been tasked to execute all phases of the CFOPP with the sole difference being that one group (JOPG3) executed the task as it is actually performed during real operations while the other (JOPG4) performed the task with the support of COPlanS. Groups consisted of personnel who knew one other and who used to work together to manually complete the CFOPP using primarily Microsoft Office tools and DND Learn. The CFC knowledge portal was also used to provide information about the exercise.

JOPG5 was composed of specialists in the field from CANADA COM (one officer), CEFCOM (two officers), CANOSCOM (one officer) and DJCP (one officer). One officer from DRDC Valcartier assumed the role of liaison officer and maintained the RFI logs. None of these people had ever worked together previously. Their work would be used to corroborate or disprove the findings of the previous comparison.

4.2 Experiment Hypotheses

The assessment of COPlanS as a potential system for supporting the CFOPP joint planning activities at the operational level was carried out through verification of various hypotheses during this experiment. The rationale supporting the hypotheses tested during the experimentation is provided below:

- Synchronisation or coordination of actions among team members is a key factor in team performance [4], [5]. Synchronising efforts when performing a collective task can be a challenge, and team performance can suffer when members have synchronisation problems. According to De Keyser and Nyssen (2001) [6], improving job control in a workspace is instrumental in managing dynamic problem situations. Thus, the collaborative workspace of COPlanS is clearly an asset.
    - **Hypothesis 1: COPlanS maintains staff synchronisation during the execution of the different CPOPP activities, thereby expediting the decision-making process**.

- In a NATO report (IST-019, TG006) [8] Breton et al. suggest that information distribution is a key aspect of team decision-making. Jobidon, Breton, and Tremblay [5] and Breton and Rousseau [4] reach the same conclusion about information-sharing. As a collaborative system, COPlanS provides an environment conducive to the sharing of information among all players on the team. COPlanS supports the information-sharing activities by distributing the information appropriately among team players.
    - **Hypothesis 2: COPlanS assures staff updating in near real-time on new information (information-sharing) and associated deductions, thereby enhancing the decision-making process.**
- In distributed environments, completing collaborative mission analyses and preparing the associated information briefs is a challenging task. Orasanu and Salas [9] suggest that sharing insights concerning the members' knowledge, skills, needs, etc, and building a shared mental model by means of sound channels of communication is essential in a team environment. Sharing insights becomes even more critical when team members are distributed in space.
    - **Hypothesis 3: COPlanS, with its collaborative environment, should help facilitate collaborative mission analysis in a structured and rational manner, thereby improving the quality of the staff assessments and information briefs.**
- As mentioned in the above hypothesis rationale, doing joint planning in a distributed environment poses particular challenges. It may prevent members from properly performing tasks such as full-scale COA development, analysis and evaluation.
    - **Hypothesis 4a: The use of COPlanS should help improve the process of completing these tasks. It should result in improvements to COA quality.**
    - **Hypothesis 4b: It should help streamline the decision-making process, leading to improvements in the quality of decision-making.**

A questionnaire was developed (see Annex A) and used as a means of assessing the previous hypotheses.

5. Experiment Set-up

During exercise Friendly Lance, JOPG4 was mainly centred in a large room with multiple terminals offering access to DND Learn and Microsoft Office suite. Although members of JOPG4 had access to some other rooms, it should be understood that personnel were not actually distributed physically when implementing the CFOPP. Consequently, since one of the strengths of COPlanS is its support of distributed collaborative planning, this trial did not allow us to assess the real effectiveness of this aspect.

In the morning of Day 1, COPlanS was available on fewer than ten computers in the main JOPG4 planning room. Four workstations were equipped with a two-screen set-up, which is the intended set-up for COPlanS. One of these COPlanS set-ups was also linked to a large screen that gave everyone a view of COPlanS information. Since JOPG4 consisted of roughly 25 people, there were not enough computers installed with COPlanS for everyone. JOPG4 members were divided into different cells according to their expertise. These cells were distributed throughout the planning room. COPlanS computers were also apportioned throughout the JOPG4 room. Most frequently, a member of each cell was designated to input the information into COPlanS. In the planning room, there were also numerous terminals equipped with Microsoft Office tools available to the officers.

At the end of the first day, the Chief of Staff (COS) JOPG4 to have access to more COPlanS workstations. By noon of Day 2, roughly 12 computers had access to COPlanS. Note that even if COPlans could have been installed on the CFC terminals, CFC staff not to allow access to COPlanS through these terminals.

It quickly became clear that even if they were computer literate (mostly with Microsoft Office tools), the people using COPlanS weren't used to working with a two-screen set-up and didn't really benefit from the system. Moreover, with the limited training they'd been given, they weren't as comfortable with COPlanS as they might have been.

For most of the session, the JOPG4 was supported by two COPlanS technical people, who answered questions and, where requested, helping with the use of the tool. And even though, by the end of the day, the technical team had received numerous comments on how easy it was to use of COPlanS and share information with other team members, there was no doubt in the minds of the technical people that only the basic functions saw any use.

5.1.1 Identification of Level of CFOPP Expertise and Knowledge

5.1.1.1 JOPG3 and JOPG4

All participants rated their level of knowledge of the CFOPP as good or higher, with over 80% of each group rating it as either good or very good. As illustrated at Figure 2, this indicates that the participants' subjective estimate of their knowledge of the OPP was equivalent for both groups.

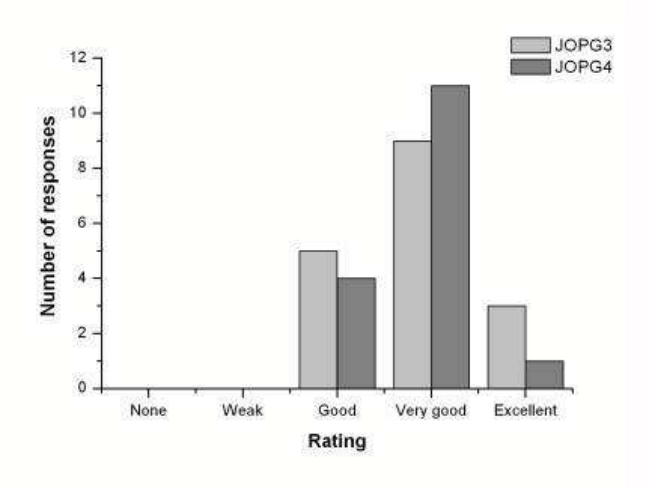

Figure 2: Subjective level of knowledge of the OPP as a function of the group.

Similarly, over 80% of participants in both groups estimated their level of experience in executing the CFOPP as either good or very good. As shown at Figure 3, although a slight difference between JOPG3 and JOPG4 was observed, with 6% of participants rating their level of experience as weak, the estimated level of experience with the CFOPP was equivalent for both groups.

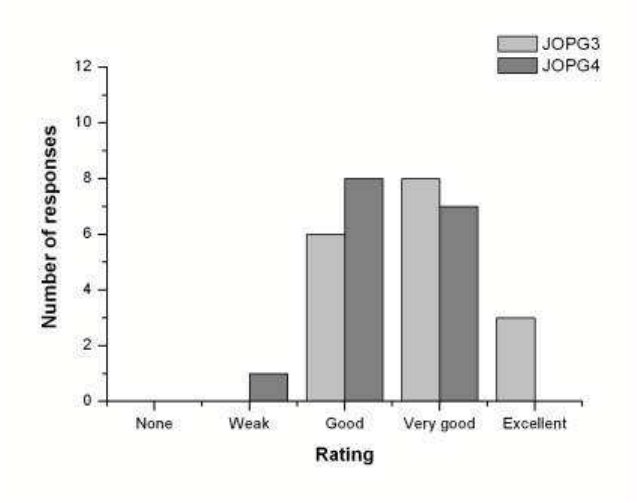

Figure 3: Subjective level of experience in executing the OPP as a function of the group .

Taken together, the results represented at Figure 2 and Figure 3 show that the two groups consisting of students (control and COPlanS) are comparable in terms of knowledge and level of expertise concerning the CFOPP process.

5.1.1.2 JOPG5

JOPG5 members estimated as relatively weak both their level of OPP knowledge (66%, see Figure 4) and their experience in carrying out the process (100%, see Figure 5).

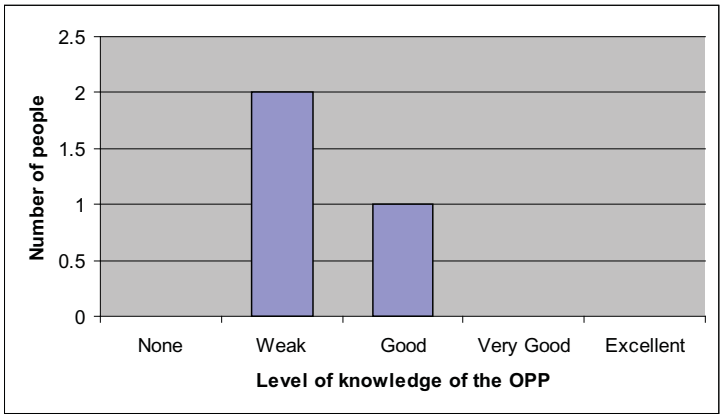

Figure 4: Subjective level of knowledge of the OPP in JOPG5

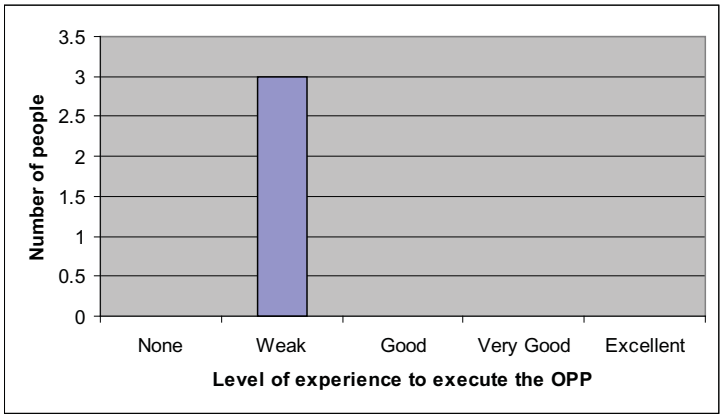

Figure 5 : Subjective level of experience in executing the OPP in JOPG5

5.1.2 Identification of Level of Knowledge of COPlanS

5.1.2.1 JOPG4 – Level of Knowledge of COPlanS

One day of training with COPlanS in Toronto had been planned for the week prior to the exercise. This training day was cancelled, however, owing to previous commitments of the participants. Instead, half the JOPG4 team was given a 45-minute demonstration of COPlanS on the Sunday evening before the exercise began. This short period of time set aside for learning COPlanS allowed the officers to navigate through the different modules of COPlanS and enter information into the tool; there was insufficient time, however, to teach them the best way to use the tool. Had that been possible, the officers would have fully understood the various modules and function, as well as the collaborative capabilities. This brief training session was deemed inadequate. Indeed, over 50% of officers felt that COPlanS training should be longer than one day (Figure 6). This is also supported by the numerous suggestions submitted by members of JOPG4 (Table 2).

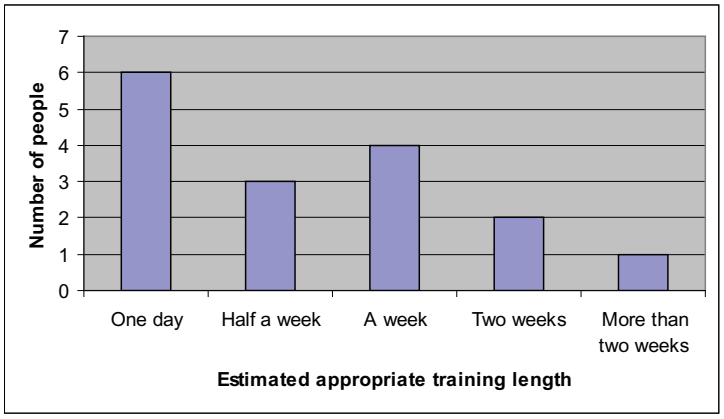

Figure 6: Estimated appropriate training length for JOPG4

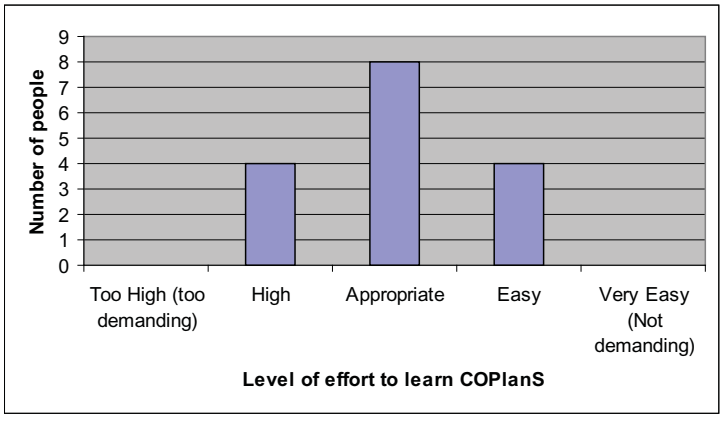

Figure 7: Estimated level of effort to learn COPlanS for JOPG4

Table 2: JOPG4's suggestions of training for COPlanS

	▸	A one-day initial training session with a follow-up session after gaining some experience with the software.
	▸	Initial briefing, hands-on exploration of the tool, exercise with SME aval.
	▸	Lecture/demo for about 1 hr/day with students using the tool via an exercise in remaining time. Initially, the students should perform every role by themselves. Students should do the last exercise collaboratively.
	▸	Exercise with coaching.
	▸	People have to have individual experience with the equipment. It's not enough to have us gather around and watch others. We then have to go through the process as a team, with each person on his/her own terminal.
	▸	Conduct a small OPP scenario to view the results and the products produced.
	▸	After a solid intro on COPlanS functionality, the user should be required to produce a min of two OPPs in ex mode, without time constraints.
	▸	Hands-on with both an experienced COPlanS technician and a planner who has used the tool during a planning event.
	▸	1 Day formal training, followed immediately by a one-week exercise to reinforce the learning and feel at home with the tool.
	▸	Make the system part of our standard baseline - aval for use all the time.
	▸	Use a simple scenario to walk through the OPP via CoplanS. This will allow for an appreciation of CoplanS input and output formats.
	▸	Combination CD/ROM and lecture.
	▸	Hands-on scenario driven
	▸	Full demonstration by experienced user; Interactive Demo; OPP Step Driven instruction, piece by piece; then try for inclusion in an Ex

Even with such brief training on COPlanS, only a minority of people from JOPG4 thought that the amount of effort needed to learn COPlanS was too great (Figure 7). These people were used to working with DND Learn, Microsoft Office Suite, Microsoft Project, and some of them were familiar with Cakewalk Home Studio.

5.1.2.2 JOPG5 – Level of Knowledge of COPlanS

As for JOPG4, the one-day training session planned for the week before the exercise was cancelled because the participants had other operational engagements. Instead, JOPG5 was given a 45-minute demonstration on the first morning of the exercise.

While some members of JOPG5 did have a good knowledge of and experience with the CFOPP, other members of the group had only limited knowledge or experience. These people were used to working with Microsoft Office Suite, Microsoft Project, and some of them were familiar with DTAV, J4i, ADAMS, Command View and Message Writer.

Each JOPG5 member had access to a computer equipped with COPlanS and a two-screen setup. The room was only large enough to accommodate the team members and a large screen on which any officer's screen could be projected, thus facilitating discussion.

The officers executed a portion of the exercise with the aim of determining whether COPlanS was capable of meeting their operational requirements. It is interesting to note that different members, probably owing to their operational requirements and expertise, identified various flaws in the scenarios (e.g., timing, locations).

Table 3: Roles of JOPG5 members

Players	**Role (during Friendly Lance)**	**Role (Normal)**
Player 1	COS, J2, J3 Air	CEFCOM: J5 Liaison
Player 2	COS Coord, RFI, "Liaison"	DRDC Valcartier
Player 3	J1, J4	CANOSCOM: J5 Plans
Player 4	J3 (main planner), J3 Maritime, J5 (partially)	CEFCOM: J5 Plans
Player 5	J3 Land, Force Protection CBRN	CANCOM: J3 Plans
Player 6	J6, J9	DJCP

As mentioned in Section 4, the data from the JOPG5 group (the potential users) did not undergo statistical analyses, since the group members used COPlanS to explore its potential and provide feedback about the tool. As mentioned previously, JOPG5 consisted of six members, most of them from the operational environment. Of those six JOPG5 members, only three completed the questionnaires. Any conclusions should therefore be treated with caution. Note that while the results of the questionnaires presented in this section represent the views of three people the additional information provided was obtained from all members.

JOPG5 members made some suggestions concerning what might be appropriate training for COPlanS (Table 4). Namely, they felt that even though the amount of effort required to learn COPlanS was appropriate (66%, see Figure 8) a week of training would be needed to learn to use the tool properly (Figure 9).

Table 4: Training method suggested for COPlanS

▸	Practice using each stage with several different scenarios
▸	Hands-on in place.
▸	Explanation of the different functions and their interrelationship, followed by hands-on scripted exercises and completed by a short CPX

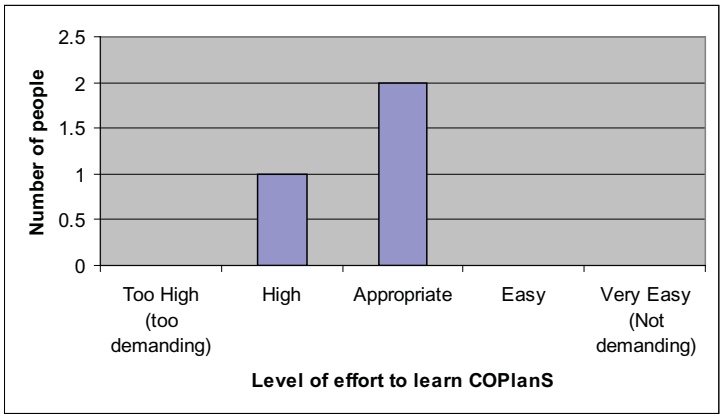

Figure 8: Estimated level of effort to learn COPlanS for JOPG5

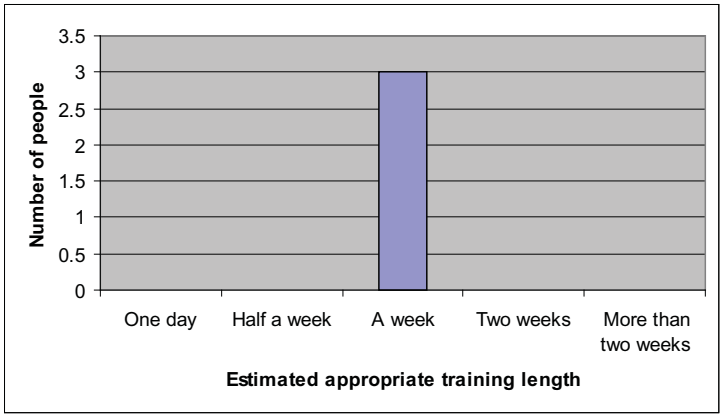

Figure 9: Estimated appropriate training length for JOPG5

6. Analysis of Experiment Results

JOPG3 and JOPG4 planned an operation using the CFOPP in a simulation mode, and we were able to compare the results posted by the two groups. It is worth noting that the findings reflect the participants' views of these aspects, and that no objective measurements were taken. Consequently, the analyses focus on the subjective evaluations of the participants rather than on any differences in performance between the two groups.

The results presented in this section represent the ratings given by team members according to 5-point scales (1 being None and 5 being Excellent) concerning different aspects of the CFOPP during exercise Friendly Lance. As noted in the previous sections, two main groups were compared, JOPG3 (control group) and JOPG4 (COPlanS group), who respectively completed the exercise both with and without COPlanS. Each group had roughly 25 members. Of these, 16 members of JOPG3 and 17 members of JOPG4 completed the questionnaire. JOPG5 had six members, and their participation was used to confirm or disprove the findings of the previous comparison.

6.1 Impact of COPlanS on the Tempo of the Decision-making Process (Hypothesis 1)

6.1.1 JOPG3 and JOPG4

Figure 10 represents the perceptions of the JOP3 and JOP4 participants concerning the tempo of the decision-making process. About 80% of participants in both groups rated the tempo as being either good or very good. Therefore, the results gleaned from the questionnaires do not suggest that the two groups differ in their views of the tempo of decision-making.

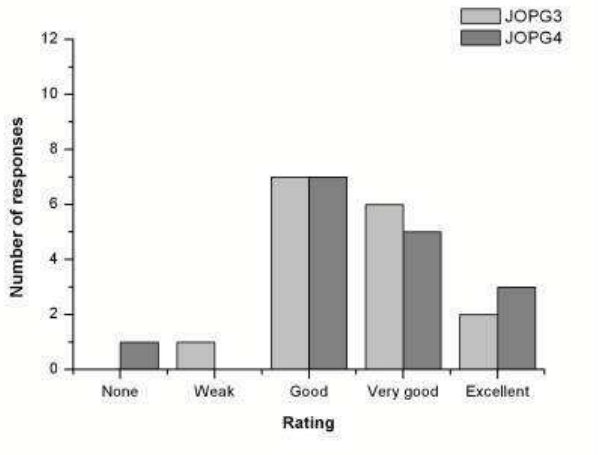

Figure 10: Estimated tempo of the decision-making process as a function of the group.

This result suggests that both groups displayed an appropriate group dynamic. At first glance, these results do not provide evidence that COPlanS improved the decision-making tempo. However, the lack of difference between the two groups is interesting given that over half the members of JOPG4 felt that COPlanS had a negative impact on tempo (Figure 11).

Obviously, the introduction of new devices that change the way a task is performed always implies a period of adaptation. During this phase, there may be a momentary decline in performance. This is confirmed in the comments made by some JOPG4 members:

- "... The interference that COPlanS created during the OPP is a function of being a new tool introduced within a staff already used to work differently and under pressure to produce high quality product in a short time. This was NOT the appropriate environment to evaluate this tool. I believe COPlanS has good potential. I am sure that if this JOPG had been required to use COPlanS at the start of this course, it would have outshined all of the other JOPGs..."
- "...Great potential, the results of this survey must not be allowed to pass judgment on this tool. Perhaps if this tool is to be used both training and proper timeline to allow the use of the tool must be put in place. Great potential..."

Variables such as quality of the system design and the training program may mitigate the impact of the adaptation period. Once the participants have adapted, performance may attain new standards of quality. Accordingly, the results suggesting that JOPG4's use of a new system like COPlanS was not accompanied by a decline in the group dynamic relative to JOPG3 (Figure 10) can be viewed as rather positive, even if JOPG4 felt that COPlanS had some negative impact on their tempo (Figure 11).

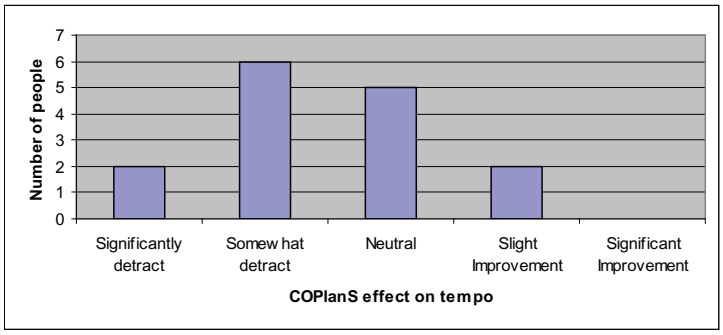

Figure 11: Estimated impact of COPlanS on tempo in JOPG4

6.1.2 JOPG 5

As noted previously, JOPG5 members felt that their OPP knowledge and experience was relatively weak (66% and 100%, respectively). Given these figures, it is not surprising that they saw the tempo of the decision-making process as slow (100%) (Figure 12). It is interesting to note, however, that the majority of members (66%, see Figure 13) thought that COPlanS had slightly improved their tempo, despite the fact that COPlanS was new to them and that the training was deemed insufficient.

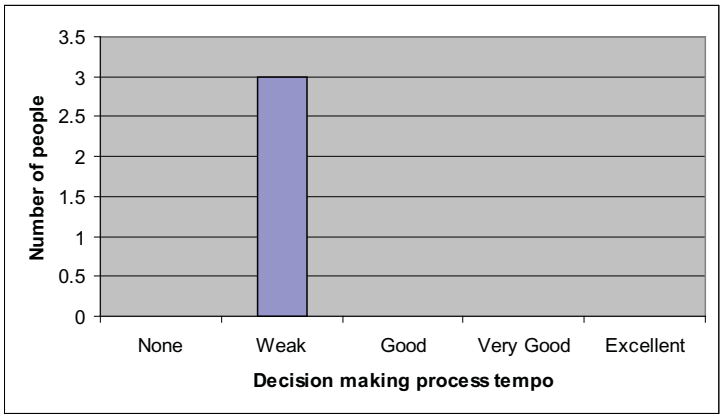

Figure 12: Estimated decision-making process tempo in JOPG5

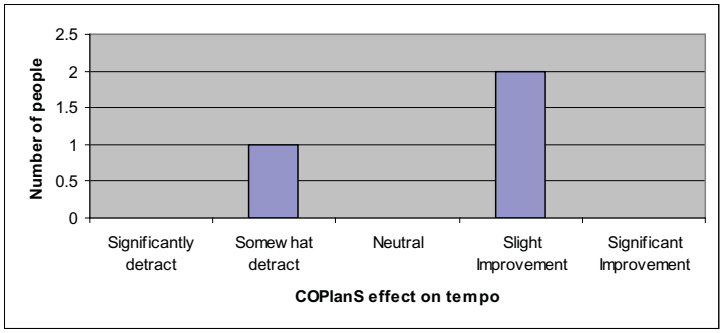

Figure 13: Estimated impact of COPlanS on tempo in JOPG5

6.1.3 Discussion

In light of these findings, we can speculate that, had appropriate training been provided, COPlanS would have led to an improvement in the tempo of decision-making. It is obvious that the experimentation approach reported here will have to be modified (e.g., in terms of time and material) for future exercises.

While better training would have been beneficial, it is unlikely that it would have solved all the problems associated with supporting a faster decision-making tempo. One of these problems concerns the absence of a concept governing utilisation of this tool.

A second problem concerns implementation of the existing interface, which apparently is not as intuitive and user friendly as one might wish. One aspect that needs consideration is that this tool has been designed to support the work of different members of a planning team. In the current version, all the available tools are visible to everyone, which some might find rather distracting. It might be worth considering the possibility of limiting displays of various tools based on their relevance to the different roles. R&D might consider having interfaces that can be adapted to the roles of individual team members.

One interesting aspect of the results is the observed difference between people conversant with the OPP and those who admit to having less experience with the process. While the team with extensive OPP knowledge and experience believed that using COPlanS adversely affected their tempo, members of JOPG5 – who felt they had limited OPP experience and knowledge – believed the opposite. This accordingly suggests that COPlanS might be of greater benefit to OPP novices. Even if not developed for this purpose, COPlanS may have played a role in coaching the planning process. Based on these assumptions, offering different types of interfaces for OPP novices and experts may be useful, or even necessary.

6.2 Impact of COPlanS on Information-sharing Activities (Hypothesis 2)

6.2.1 JOPG3 and JOPG4

The perceptions of participants on sharing information among team members are generally rather similar. This result would suggest that COPlanS has no impact on the quality of the information-sharing process. Figure 14 shows, however, that 10 participants out of 16 rated the information-sharing process with COPlanS "very good" as compared with seven people out of 17 in the JOPG3 group. While this result is not statistically significant (using an alpha of .05), it may suggest that COPlanS may in fact have a positive influence on information-sharing as perceived by the JOPG4 group. Here again, results suggesting that JOPG4's use of new systems like COPlanS was not accompanied by a fall in the quality of the sharing-information process when compared with JOPG3 can be interpreted as rather positive, despite JOPG4's contention that COPlanS had some negative impact on their tempo (Figure 15). This result is interesting given that no one had been adequately trained with COPlanS and that COPlanS had been designed to support a team distributed among different locations, not a co-located team as was the case with JOPG4.

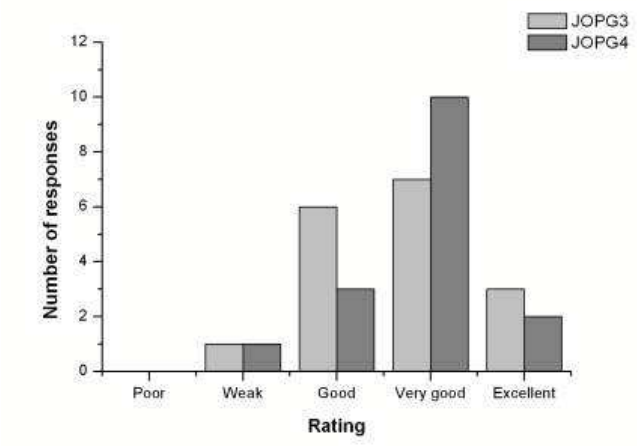

Figure 14: Perceived quality of information-sharing amongst team members as a function of the group.

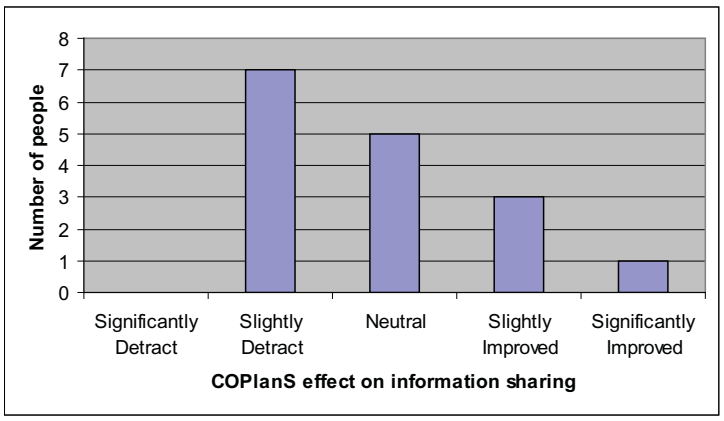

Figure 15: Estimated impact of COPlanS on information-sharing in JOPG4

6.2.2 JOPG5

JOPG5 members estimated the level of information-sharing within their group as very good (60%) (Figure 16) and were unanimous in their view that COPlanS slightly helped to improve it (Figure 17). Based on this finding, it would appear that a tool that offers access to all information input provided by team members is deemed useful in sharing information. The initiative proposed in COPlanS – installation of an editing tool accessible to everyone, complemented with a chat tool and focus group discussions – seems to have some merit.

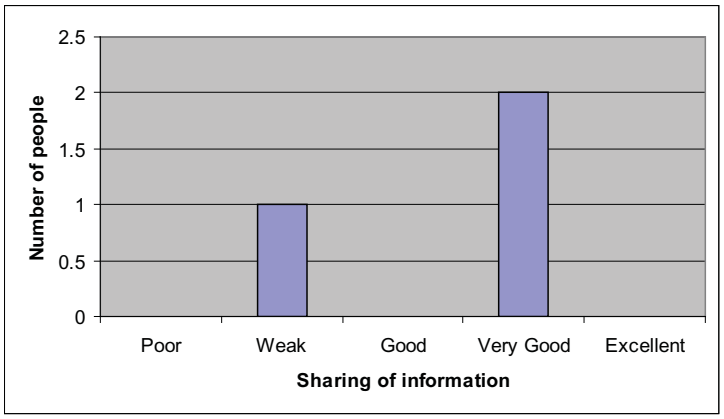

Figure 16: Perceived quality of information-sharing in JOPG5

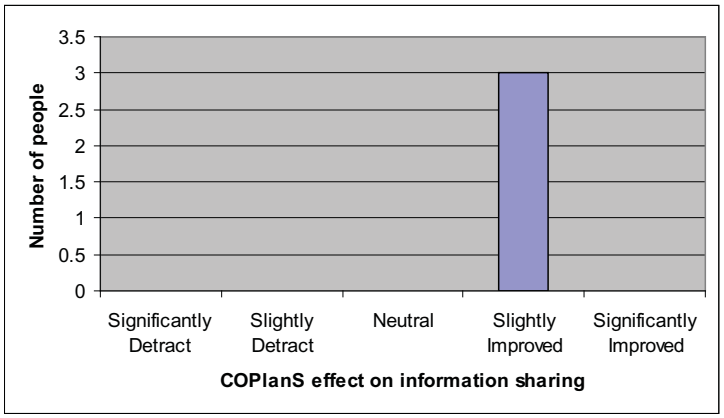

Figure 17: Perceived impact of COPlanS on information-sharing in JOPG5

6.2.3 Discussion

While COPlanS was designed to support a team of planners distributed in space and time, it was shown here that COPlanS can also be used when the team is not physically distributed, as was the case with JOPG4, whose members were all co-located. It was not clear to anyone, however, how best to use COPlanS in such situations. One member of JOPG4 pointed out:

– "...When elements of the planning staff are co-located, use of/population of basic elements of COPlanS should follow a traditional brainstorming session after which the relevant data is entered into the system. This will ensure good quality data is entered up-front and minimize refinement..."

Moreover, the information needs to be communicated to the right person, at the right time and in an appropriate format. As argued by Endsley [10], providing a human decision-maker with all the available information does not lead to a better understanding of the situation. On the contrary, it often leads to information overload, which makes the task even more difficult. Human beings have limited cognitive (e.g., attention, memory) resources. Consequently, there is a need to map information needs with the information feed.

We recommend, therefore, that a different concept of tool utilisation be developed for co-located teams, as opposed to distributed teams.

6.3 Impact of COPlanS on the Quality of the Staff Assessment (Mission Analysis) (Hypothesis 3)

6.3.1 JOPG3 and JOPG4

The results point to differences between the JOPG3 and JOPG4 conditions with respect to the subjective evaluation of staff assessment quality produced by the team. When asked to rate staff assessment quality, the responses of JOPG4 participants ranged evenly from satisfactory to

excellent. As Figure 18 demonstrates, however, 65% of the JOPG3 group rated the staff assessment quality as very good. This would seem to indicate that participants who did not use COPlanS estimated the level of quality of the mission analysis produced by their team more consistently and rated it higher than participants using COPlanS.

Although the above results (presented at Figure 18) may seem somewhat problematic when it comes to evaluating the impact of COPlanS on CFOPP mission analysis activity, it should be remembered that these results represent the participants' views and not the absolute quality of the mission analysis as such. In a paper discussing the cognitive costs of automation, Breton and Bossé [11] claimed that the use of automated support systems may ultimately impoverish the decision-maker's understanding of the situation, an essential element in activating or building an adequate mental model of the situation. They suggest that participants need to be appropriately trained in using such systems in order to overcome that problem. As noted above, it is possible that the JOPG4 group did not receive sufficient training to use COPlanS. As a result, these participants were asked to perform CFOPP activities while learning to use a new system. Such dual cognitive activities (executing the task and learning the system) may lead to a decline in task performance or, at the very least, feelings that one is performing inadequately. This hypothesis is corroborated by questionnaire showing that most JOPG4 members believed that COPlanS had increased the workload associated with mission analysis, as well as by comments such as:

– "...We had to produce a parallel product along with COPlanS to complete our tasks. This added to the workload. But, if we could just use the tool (which we did eventually) there is utility to the software..."

Even on the issue of workload, more people (43.5%) believed that COPlanS had had a positive effect on staff assessment than the contrary (25%) (Figure 19). Similarly, more people felt that COPlanS had had a positive impact on collaborative mission analysis (31%) than the contrary (19%) (Figure 20).

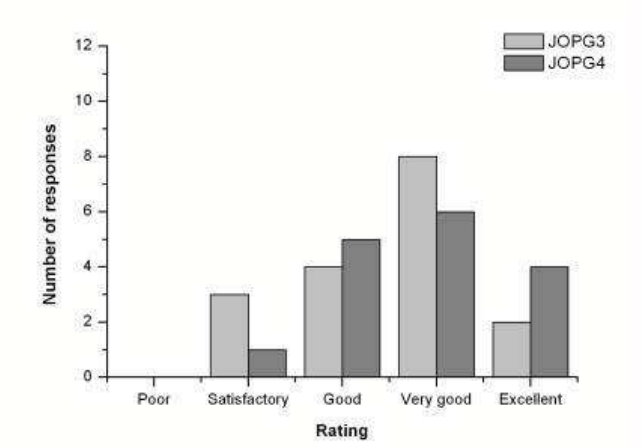

Figure 18: Perceived quality of JOPG staff assessment (mission analysis) as a function of the group.

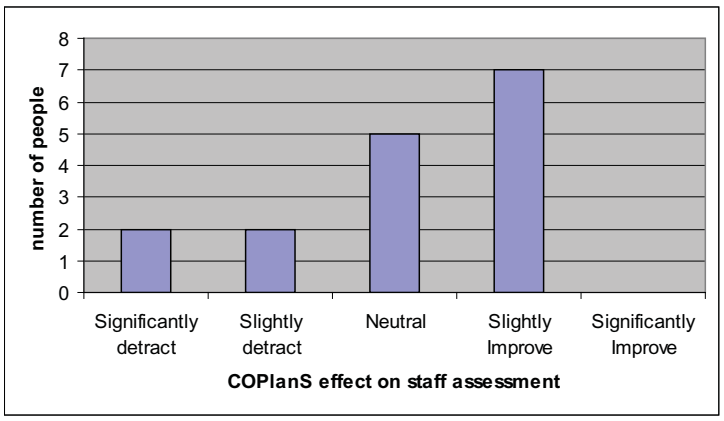

Figure 19: Perceived impact of COPlanS on staff assessment in JOPG4

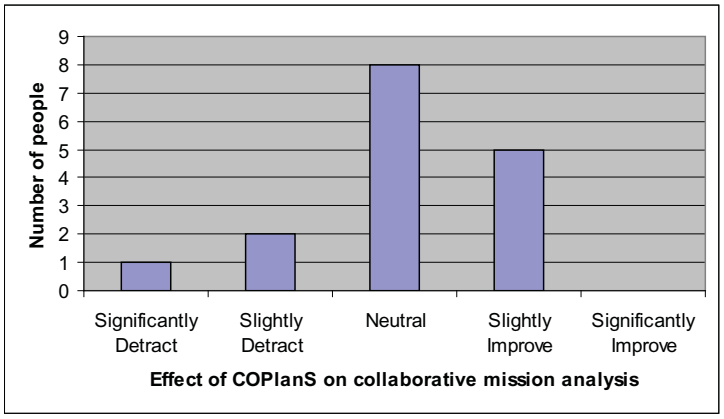

Figure 20: Perceived impact of COPlanS on collaborative mission analysis in JOPG4

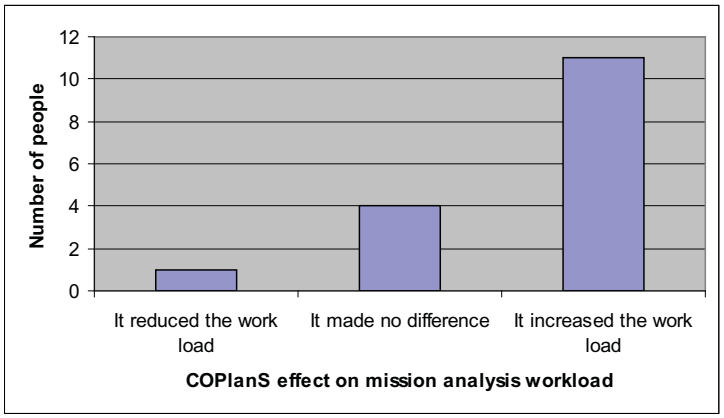

Figure 21: Perceived impact of COPlanS on mission analysis workload in JOPG4

When using COPlanS to generate the information brief, JOPG4 members were concerned with the briefing produced. Being somewhat unfamiliar with the tool, they produced a brief containing all the information in the tool for the orientation stage, rather than selecting the different aspects that they wanted included in the brief. In many cases, they later discovered that the information contained in the brief was inappropriate and that the COPlanS slides were not as attractive as the ones they might have prepared themselves. This may partly explain why most members found the information in the mission analysis brief incomplete and/or inaccurate (Figure 20). In fact, JOPG4 members instead tended to use the brief produced by COPlanS as a tool the team could use to review what should or should not be included in the mission analysis brief. They would subsequently add slides to help the commander understand the situation. There's no doubt that the automation of briefs, if it is to be useful, needs to be customizable at every level of detail so as to accommodate team preferences.

It is interesting to note some of the comments made by CFC Defence Staff involved in the exercise to the effect that the briefing produced by JOPG4 was extremely comprehensive and covered all aspects that needed to be considered for the exercise.

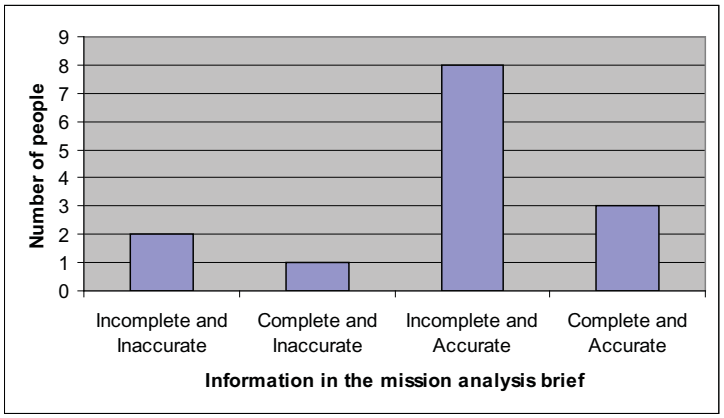

Figure 22: Evaluation of the information provided in the COPlanS mission analysis brief (JOPG4)

After the brief was presented, the JOPG4 team decided not to use COPlanS in developing the COA, excepting one officer who was required complete COA development using the tool. Based on the results of the survey on the problems encountered with COPlanS during the exercise, we do not believe that this decision was a result of system instability. Indeed, only 6% of members referred to frequent problems with the application (Figure 23), while 6% of members experienced significant problems with the application (Figure 24).

One reason for this decision might have been that members of JOPG4, being evaluated on the briefings presented to the commander, felt that the briefing automatically generated by COPlanS strayed too far from their expectations. This is corroborated by the user comments. For instance:

– "...COPlanS is a very good but need to be reviewed to provide the appropriate products at the end with an appropriate level of authority to amend entries..."

In fact, members of JOPG4 believed that the work required to adapt the brief to their preferences involved a duplication of effort, since they decided to complete the process with and without COPlanS.

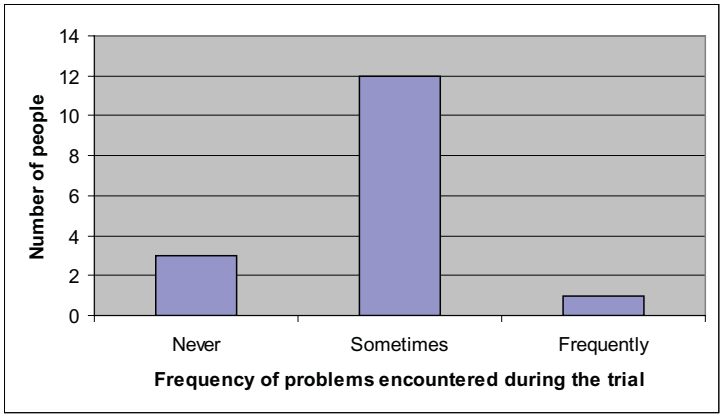

Figure 23: Estimated frequency of problems encountered by JOPG4 during the trial

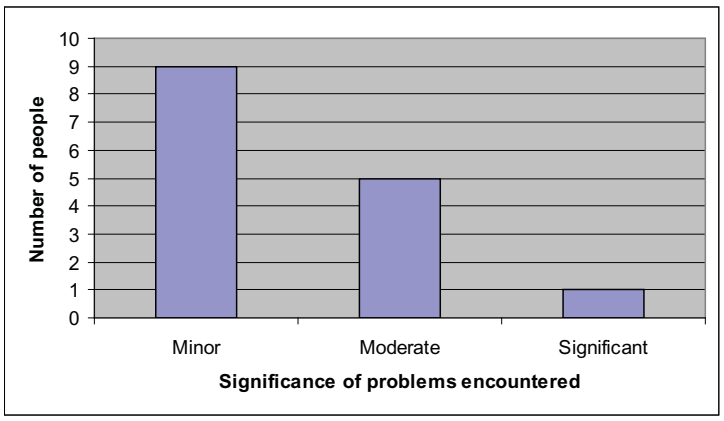

Figure 24: Estimated significance of problems encountered by JOPG4 during the trial

6.3.2 JOPG5

Since JOPG5 lacked sufficient people to complete the entire CFOPP, there was no reason to consider their self-assessments of the various process outputs. Since they had used the tool to assess its utility in carrying out the process, however, their evaluations of the impact of COPlanS on any of the CFOPP stages/outputs are extremely informative concerning the utility of the implemented concepts.

Sixty-six percent of JOPG5 members felt that COPlanS has the potential to slightly improve the staff assessment (Figure 25). In addition, 66% of JOPG5 felt that using COPlanS led to a slight improvement in the mission analysis (Figure 26). It may be presumed, therefore, that it would be advantageous to introduce a tool that different people working in parallel could use to complete a structured assessment of the mission. Considering that the people who completed the questionnaire had a limited knowledge of the CFOPP, this aspect may be deemed more important than having an extensive knowledge and experience of the CFOPP.

It is noteworthy that JOPG5 members quickly identified various problems with the exercise scenario. For example, they saw discrepancies between the information provided on the map and the textual information and between the infrastructure map and the rail restoration map. These different aspects became topics of discussion and resulted in requests for information (RFIs) being sent for the purpose of clarification.

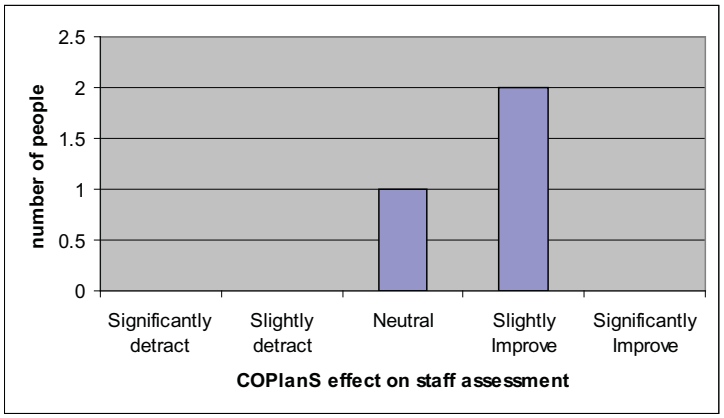

Figure 25: Estimated impact of COPlanS on staff assessment in JOPG5

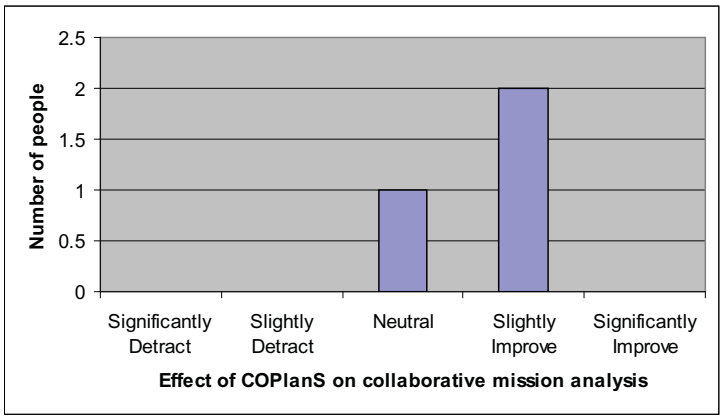

Figure 26: Estimated impact of COPlanS on collaborative mission analysis in JOPG5

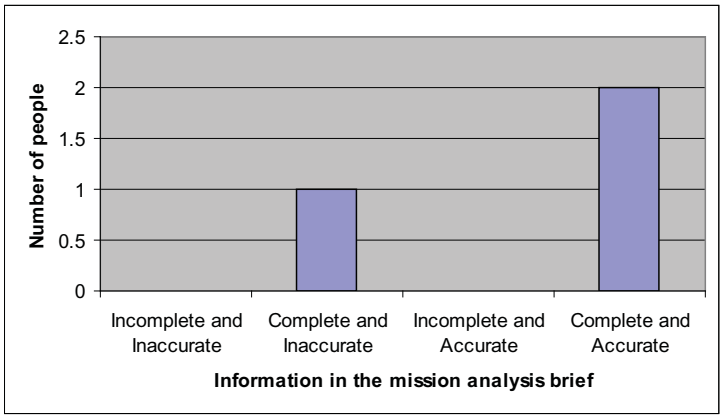

Figure 27: Evaluation of the information in the COPlanS mission analysis brief (JOPG5)

6.3.3 Discussion

The results may suggest that the authoring approach used in COPlanS for mission analysis falls short of what is really required. More advanced tools may be needed to support a campaign design approach integrated into the CFOPP process. In fact, we recommend that an investigation be carried out into the development and integration of intelligent decision support tools better able to support mission analysis, as well as the development of mental models of the situation. For example, a better drawing tool for Campaign Design might support the development of mental models, while intelligent decision support could automatically provide lists of possible critical capabilities (CC), critical requirements (CR), and critical vulnerabilities (CV) for each identified centre of gravity.

It is worth noting that novice OPP users found that COPlanS did improve the mission analysis process. This may be in keeping with a previous assumption that the design of the COPlanS interface was more appropriate for OPP novices than OPP experts.

Finally, it is worth repeating that an automatic briefing production tool must be customizable to different levels of detail based on team preferences.

6.4 Impact of COPlanS on the Quality of COAs Produced by the Team (Hypothesis 4a)

6.4.1 JOPG3 and JOPG4

It is important at this point to remember that only one officer used COPlanS to complete the remainder of the CFOPP. Even though this officer was able to hear the conversations of other JOPG4 members concerning the development of COAs, he was alone in completing all the cognitive tasks associated the individual stages of COA development. Moreover, he was required to produce the decision brief within the same time constraints as the rest of the JOPG4 team. So, with the exception of one officer, the results of JOPG4 questionnaires show the COA development stage being completed without COPlanS.

The ratings of the quality of COAs produced by the team point to a small difference between the two groups in their evaluation of the quality of COA comparison done by the team. Indeed, while 70% of the JOPG3 group rated the COA comparison as either very good or excellent, about 70% of the JOPG4 group rated it as either good or very good (see Figure 28).

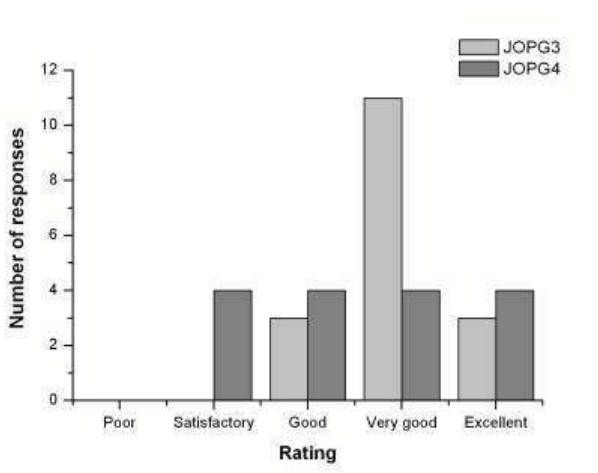

Figure 28: Perceived quality of the COAs produced by the team as a function of the group.

While still not significant, the results showed at Figure 29 suggest that the views of participants concerning the quality of the COA comparison done by the team varied more widely in JOPG4 than in JOPG3. It should be remembered that, with the exception of one officer, JOPG4 made no use of COPlanS during this stage. One can speculate on whether the variations among team members may have been partly owing to the fact that they moved from doing the CFOPP with a planning tool to completing it without that tool. Nonetheless, their failure to use COPlanS during this stage of the OPP is reflected in the questionnaire results relating to the impact of COPlanS on COA quality, COA comparison, and production of the decision brief. In fact, Figure 30, Figure 31 and Figure 32 show that roughly 75% of JOPG4 members were neutral with respect to the impact of COPlanS on these aspects.

Members of JOPG4 did attend the briefing presented by the officer working with COPlanS. Based on what they were told, there was no consensus on the perception of the quality of COPlanS decision brief (Figure 33).

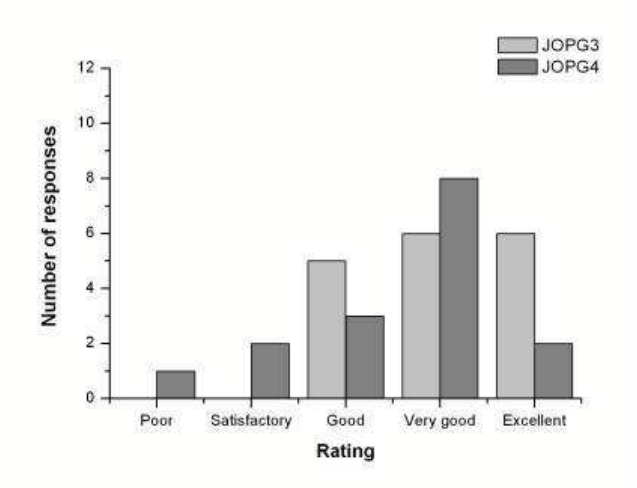

Figure 29: Perceived quality of the COA comparison done by the team as a function of the group.

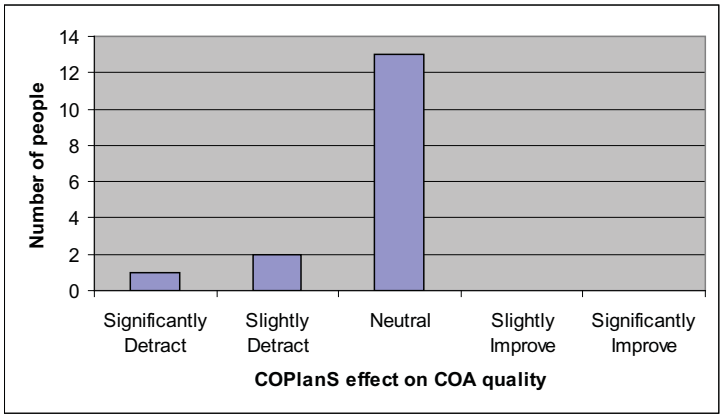

Figure 30: Perceived impact of COPLanS on COA quality in JOPG4

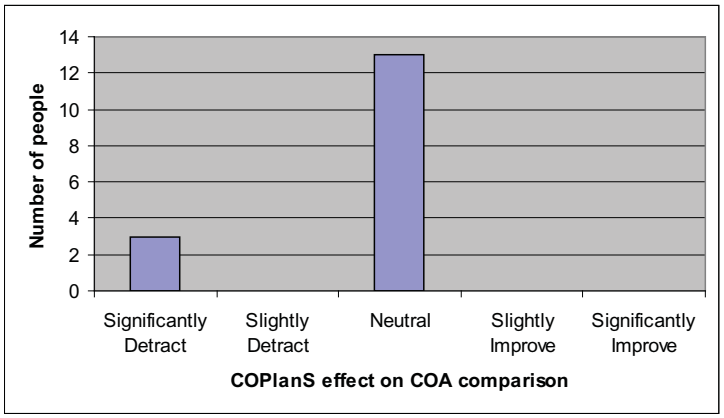

Figure 31: Perceived impact of COPlanS on COA comparison in JOPG4

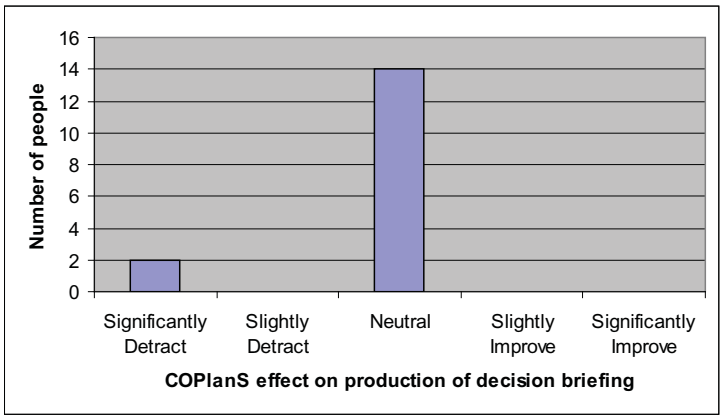

Figure 32: Perceived impact of COPlanS on production of decision briefing in JOPG4

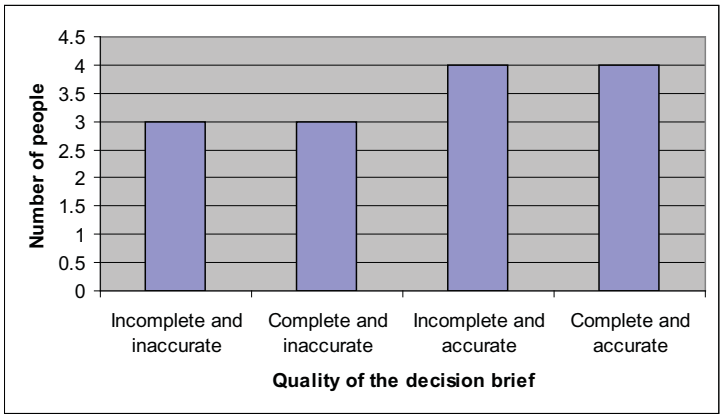

Figure 33: Perceived quality of the COPlanS decision brief in JOPG4

6.4.2 JOPG 5

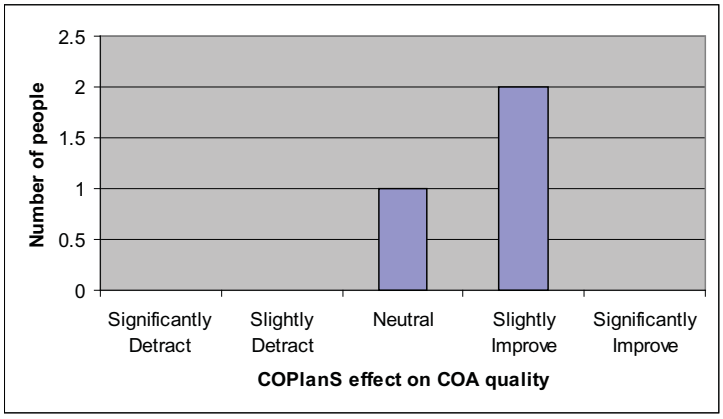

Figure 34: Perceive impact of COPLanS on COA quality in JOPG5

Sixty-six percent of JOPG5 members felt that COPlanS has the potential to slightly improve the quality of the COA and the decision brief (Figure 34 and Figure 35). Accordingly, its capacity to produce an automated briefing can be considered a key functionality. However, implementation of this functionality in COPlanS needs to be reviewed. In fact, despite the fact that 66% of JOPG5 members indicated that the information in the mission analysis brief was comprehensive and accurate (Figure 27), they did note that the briefing generated by COPlanS was too large and included a great deal of information that was not entirely relevant. This is confirmed by the following comment:

– "The system provides a lot of information; however, it produces too much information instead of key information. This results in too much time being consumed in vetting the presentations to pear them down to the information required to brief the Commander."

Furthermore, a lot of the information presented in COPlanS needed to be reformatted so as to improve the visual aspect of the slides.

Although not tested, the possibility of briefing directly from the tool was discussed. As this was viewed as a potential requirement, briefing directly from the tool would permit delving into any aspect of the briefing and getting answers to specific questions. One of the VIPs observing the exercise remarked that there will always be a need for briefing products that can be distributed to anyone absent from the briefing. This again highlights the need for a tool capable of automatically generating the brief, even if the decision is made to brief directly from the tool.

Since the members of JOPG5 did not have time to complete the COA development stage because of visitors, they were not able to populate the information into COPlanS. This might explain why no one characterized the produced decision brief as comprehensive and accurate (Figure 36).

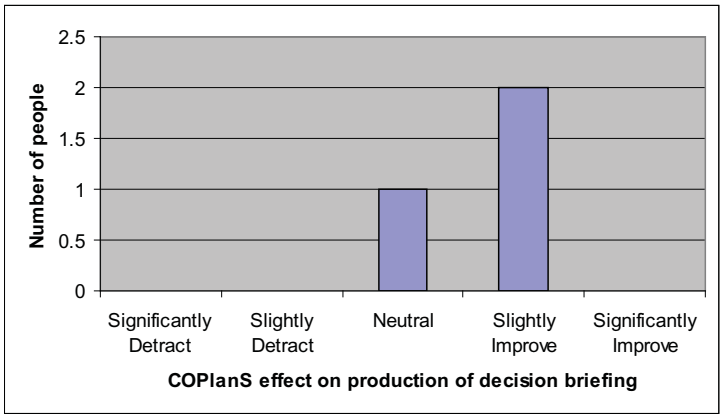

Figure 35: Perceived impact of COPlanS on production of decision briefing in JOPG5

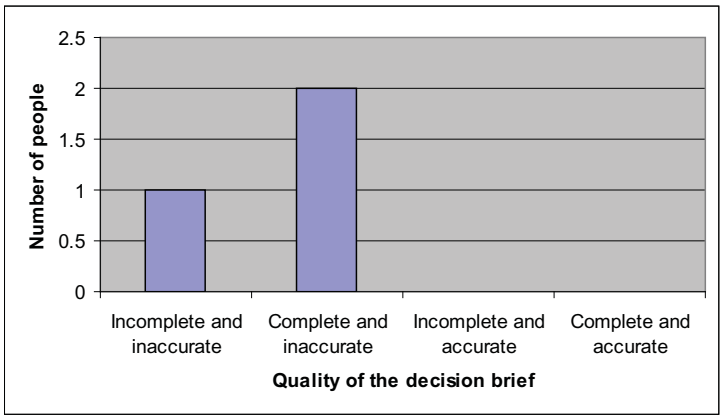

Figure 36: Perceived quality of the COPlanS decision brief in JOPG5

6.4.3 Discussion

The results obtained may suggest that the authoring approach used in COPlanS for COA development falls short of what is actually required. More advanced tools may be needed to support the creation of COA from a graphics (sketching tool) and a conceptual perspective. In fact, we recommend that an investigation be carried out into the development and integration of intelligent decision support tools better able to support the COA development process.

This recommendation is supported by the following comment:

- "...COPlanS was good for data dumping from the J-2 perspective, however, COA development for asymmetric ops was difficult..."

The comments relating to the automated production of the mission analysis brief apply as well to the decision brief.

6.5 Impact of COPlanS on the Quality of the Team Decision-making Process (Hypothesis 4b)

6.5.1 JOPG3 and JOPG4

Figure 37 presents the perceived quality of the team decision-making process for JOPG3 and JOPG4. As can be seen, the evaluation of the decision-making process appears to be quite similar for the two groups.

Since they did not use COPlanS throughout the estimate process, it is interesting to note that although JOPG4 members are rather neutral with respect to the sort of impact COPlanS may have on the COA decision-making process and the overall decision-making process (Figure 38 and Figure 39) 43% of JOPG4 members think that COPlanS would have a positive effect on the operational planning process, while 25% think that the impact would be negative (Figure 40).

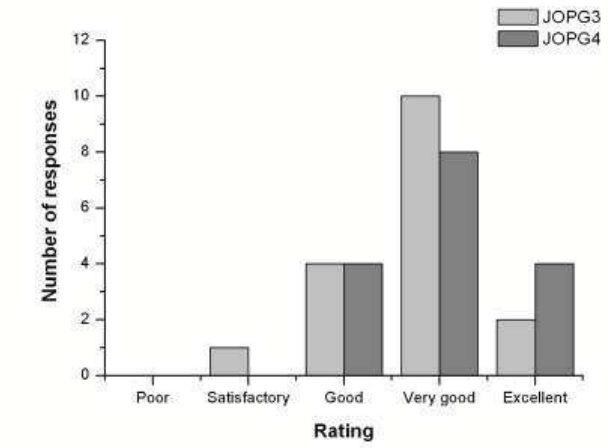

Figure 37: Perceived quality of the decision-making process of the team as a function of the group

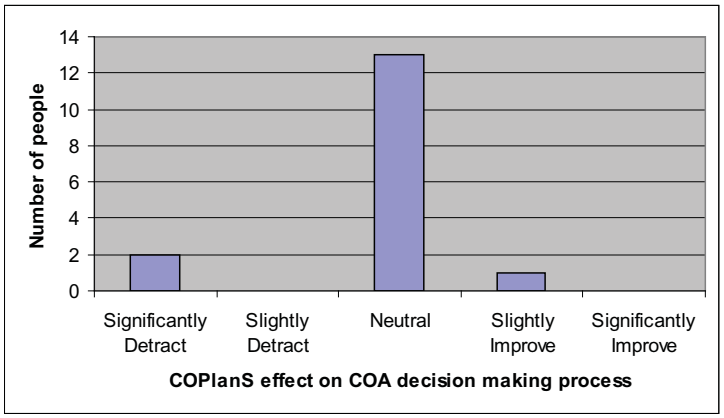

Figure 38: Perceived impact of COPlanS on COA decision-making process in JOPG4

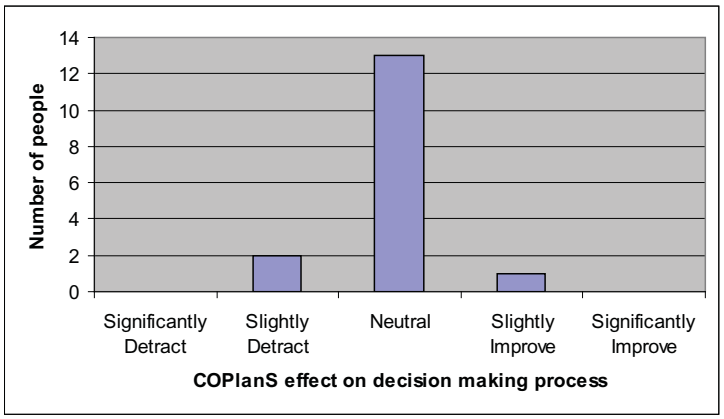

Figure 39: Perceived impact of COPlanS on decision-making process in JOPG4

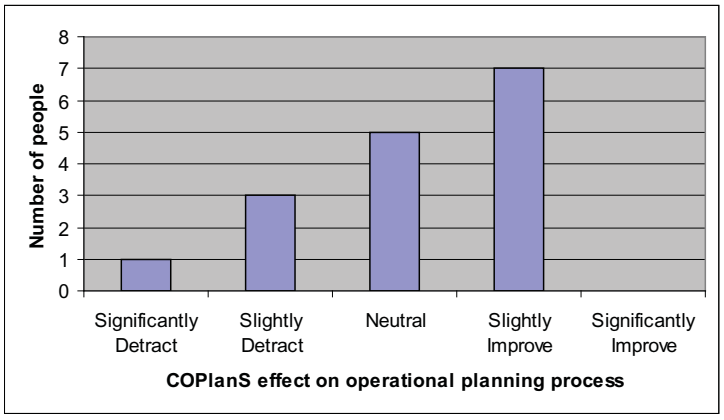

Figure 40: Perceived impact of COPlanS on operational planning process in JOPG4

6.5.2 JOPG5

In JOPG5, the perceived impact of COPlanS on COA comparison and on the COA decision-making process was rather neutral (66%) (Figure 41 and Figure 42). This result may be partly attributable to the lack of time JOPG5 had to cover this aspect.

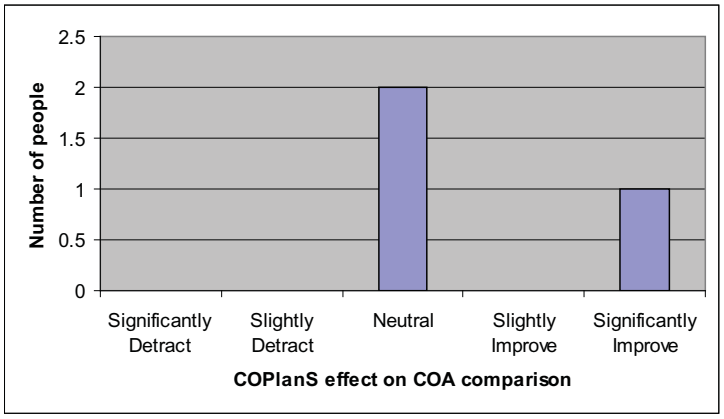

Figure 41: Perceived impact of COPlanS on COA comparison in JOPG5

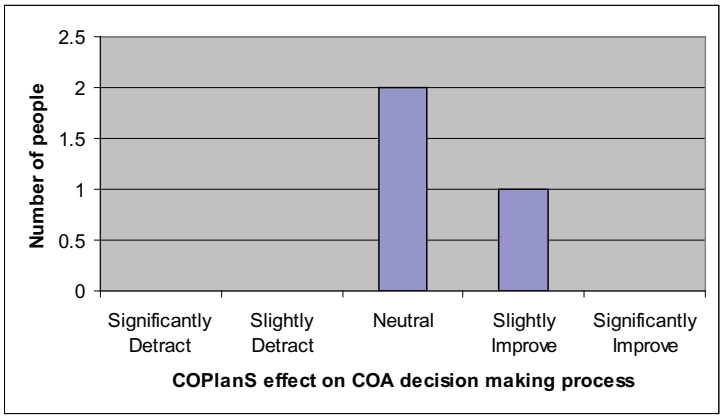

Figure 42: Perceived impact of COPlanS on COA decision-making process in JOPG5

Unfortunately, no conclusions can be drawn when it comes to the impact that using COPlanS had on workload. Indeed, the only two people who answered this question were divided on the issue (Figure 43). Although not referred to in the questionnaires or comments, training with the tool (or lack thereof) may play a role in the participants' perception on whether COPlanS increased or reduced workload. This issue needs further analysis.

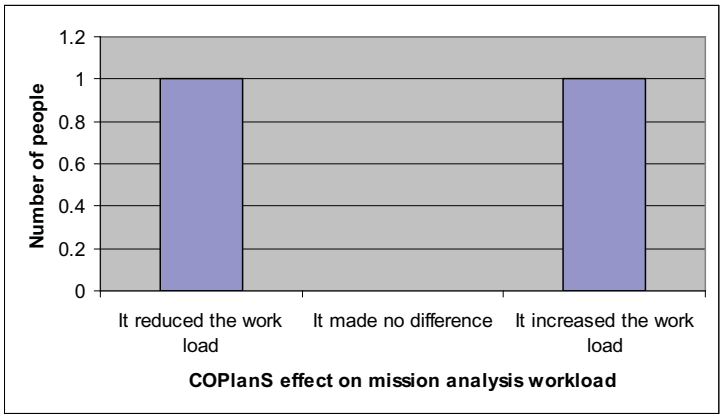

Figure 43: Perceived impact of COPlanS on mission analysis workload in JOPG5

From a more holistic perspective, 66% of JOPG5 members considered that the use of COPlanS slightly improved the decision-making process (Figure 44) and everyone felt that it improved the operational planning process (Figure 45). It would appear, therefore, that the use of a collaborative planning tool in conducting the CFOPP is desirable.

It should be noted that, while the tool was tested from an operational perspective, different ways to use the tool (and the related usability issues) were identified. This confirmed the need for a good CONOPS governing the use of such collaborative operational planning tools.

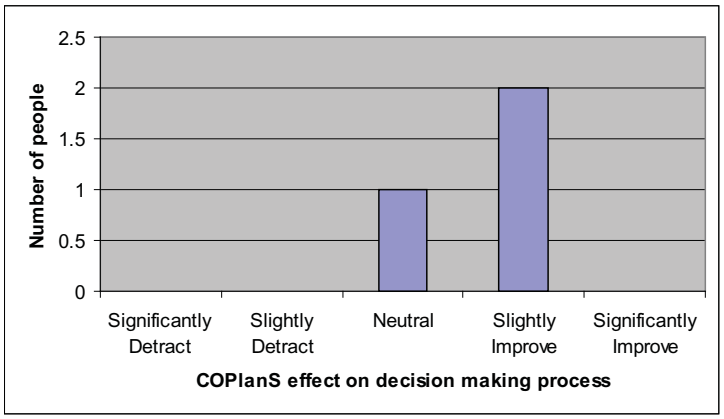

Figure 44: Perceived impact of COPlanS on decision-making process in JOPG5

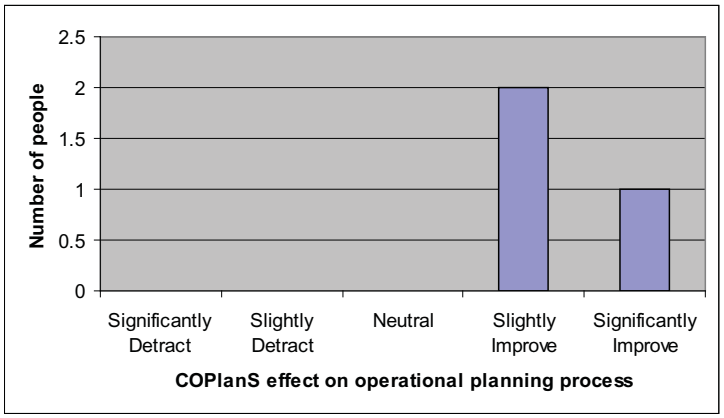

Figure 45: Perceived impact of COPlanS on operational planning process in JOPG5

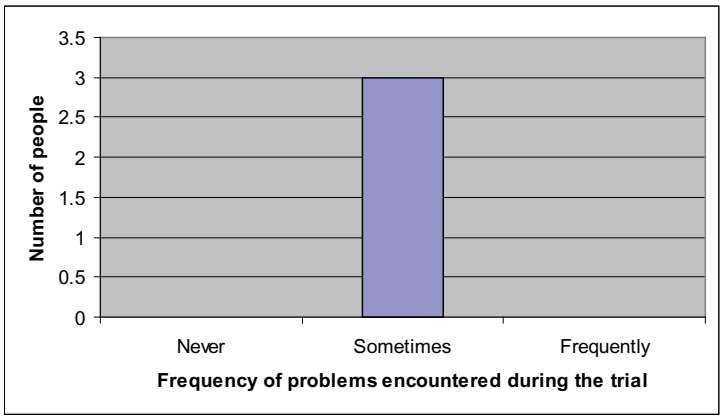

Figure 46: Perceived frequency of problems encountered by JOPG5 during the trial

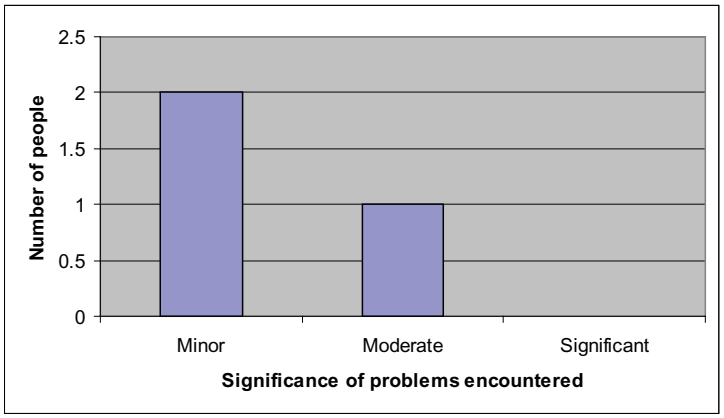

Figure 47: Perceived significance of problems encountered by JOPG5 during the trial

6.5.3 Discussion

The results obtained suggest that a collaborative planning tool can be useful in enhancing the CFOPP. However, the experiment's results neither support nor deny the need for COPlanS in improving the quality of the team decision-making process.

However, the decision-making task raises an issue in itself. While systems employ deductive reasoning strategies, humans often resort to inductive reasoning. The distinction is important and often explains the problems associated with system/humans interaction. On the one hand, systems use "if-then" rules and are able to process enormous amounts of data. On the other hand, however, they cannot go beyond the data. Conversely, while humans find it difficult to deal with large pools of data, they are able to go beyond the data through inductive reasoning. They can be creative in the way they interpret things. The huge amount of information processing associated with the CFOPP requires deductive reasoning; however, the human capacity for inductive reasoning is still critical. As a result, there is a need to support both types of reasoning.

7. Discussion and conclusion

Four key factors had a major impact on the results of this trial. The first two were the shortage of training on the use of COPlanS and the lack of appropriate CONOPS for the various kinds of expertise contributing to the planning process. Since participants had insufficient knowledge of the functions offered by the tool and were not proficient in using it, it was very difficult to obtain a precise evaluation of the tool's effectiveness.

A third factor was the shortage of COPlanS terminals available to participants. People without access to COPlanS had to ask someone else to input their information or request access to their terminal. It is very likely their restricted access to COPlanS adversely affected their perception of the value of the tool and its products. And lastly, a fourth issue that may have affected the results concerns the fact that COPlanS, although designed to support the execution of the CFOPP by a distributed team, was used in a co-located setting for this exercise. Unfortunately, this aspect was not specifically assessed in the trial.

On a more general note, it should be understood that even if the current implementation of the decision-support concepts in COPlanS were to be qualified as deficient this assessment concerns the specific implementation of the concept and not the concept itself. As often acknowledged in system design, there are many ways to implement a concept, and it is important to find a good method in order to build an effective system.

While the experiment did not lead to any statistically significant conclusions (mainly because of the small sample size and limited data), the experiment results did allow for the identification of areas of improvement for COPlanS. These are:

- Two concepts of tool utilization need to be developed that take into account the different roles of a planning team: One for the use in a distributed environment and the other for use in a co-located environment;
- Adaptable user interfaces need to be designed that take into account the different positions of the planning staff, level of OPP expertise and users' preferences;
- Coaching support tools for CFOPP novices need to be integrated;
- Advanced tools that support the development of mental models of the situation need to be designed and integrated;
- Intelligent analysis tools need to be developed for the campaign design, mission analysis, and COA development phases;
- The automatic briefing production tool needs to be more customizable to different levels of details in order to satisfy various team preferences;
- Advanced decision-support tools that support both deductive and inductive reasoning strategies need to be designed and integrated.

Finally, it is important to understand that, even though the experiment was not designed to gather information about requirement refinements, further analysis of the experiment results led to identification of 7 areas of improvement for COPlanS. Consequently, the method of leveraging

existing experiment results in order to identify refined requirements can be considered a successful approach to requirement gathering.

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Annex A Questionnaire

The following questions are used to determine whether the questionnaire results depend on the user's knowledge of OPP or computer literacy:

- (All) How would you rate your knowledge of the OPP? (Evaluation Scale)
    1) None
    2) Weak
    3) Good
    4) Very Good
    5) Excellent
- (All) How would you rate your level of experience in executing the OPP? (Evaluation Scale)
    1) None
    2) Weak
    3) Good
    4) Very Good
    5) Excellent
- (All) Name the computer-based systems other than Microsoft Office that you use on a regular basis (Descriptive)

The following questions were prepared for the three groups (Potential User Group, COPlanS Group, Control Group) in order to confirm the experiment hypothesis set forth at the start of the document:

A.1 Tempo and Synchronisation:

- (All) How would you rate the tempo of your group's decision-making? (Evaluation Scale)
    1) None
    2) Weak
    3) Good
    4) Very Good
    5) Excellent
- (For COPlanS users) To what degree did COPlanS affect the tempo of the decision-making process? (Evaluation Scale)
    1) Significantly detract
    2) Somewhat detract
    3) Neutral
    4) Slight Improvement
    5) Significant Improvement

A.2 Information-sharing:

- (All) How would you rate the sharing of information among your team members? (Evaluation Scale)

    1) Poor
    2) Weak
    3) Good
    4) Very Good
    5) Excellent

- (For COPlanS users) To what extent did COPlanS improve information-sharing among your team members? (Evaluation Scale)

    1) Significantly Detract
    2) Slightly Detract
    3) Neutral
    4) Slightly Improved
    5) Significantly Improved

A.3 Staff Assessment:

- (All) How would you rate the quality of the JOPG staff assessment (mission analysis)? (Evaluation Scale)

    1) Poor
    2) Satisfactory
    3) Good
    4) Very Good
    5) Excellent

- (For COPlanS users) To what extent did COPlanS improve the quality of the JOPG staff assessment (mission analysis)? (Evaluation Scale)

    1) Significantly detract
    2) Slightly detract
    3) Neutral
    4) Slightly Improve
    5) Significantly Improve

- (For COPlanS users) Was the data on the mission analysis brief collected with COPlanS comprehensive and accurate?

    1) Incomplete and Inaccurate
    2) Complete and Inaccurate
    3) Incomplete and Accurate
    4) Complete and Accurate

- (For COPlanS users) Did COPlanS effectively support the collaborative mission analysis activity? (Evaluation Scale)

    1) Significantly Detract
    2) Slightly Detract

3) Neutral
4) Slightly Improve
5) Significantly Improve

- (For COPlanS users) To what extent did the use of COPlanS affect the mission analysis task workload? (Evaluation Scale)

1) It reduced the work load
2) It made no difference
3) It increased the work load

A.4 COA/Decision:

- (All) How would you rate the quality of the COAs produced by your team? (Evaluation Scale)

1) Poor
2) Satisfactory
3) Good
4) Very Good
5) Excellent

- (For COPlanS users) To what extent did COPlanS improve the quality of the COAs produced by your team?

1) Significantly Detract
2) Slightly Detract
3) Neutral
4) Slightly Improve
5) Significantly Improve

- (All) How would you rate the quality of the COA comparison completed by your team? (Evaluation Scale)

1) Poor
2) Satisfactory
3) Good
4) Very Good
5) Excellent

- (For COPlanS users) To what degree did COPlanS support the COA comparison? (Evaluation Scale)

1) Significantly Detract
2) Slightly Detract
3) Neutral
4) Slightly Improve
5) Significantly Improve

- (For COPlanS users) To what extent did COPlanS help structure the process for deciding on a COA? (Evaluation Scale)

1) Significantly Detract

2) Slightly Detract
3) Neutral
4) Slightly Improve
5) Significantly Improve

- (For COPlanS users) To what extent did COPlanS support the production of the decision briefing? (Evaluation Scale)

1) Significantly Detract
2) Slightly Detract
3) Neutral
4) Slightly Improve
5) Significantly Improve

- (For COPlanS users) Was the decision brief created in COPlanS complete and accurate?

1) Incomplete and inaccurate
2) Complete and inaccurate
3) Incomplete and accurate
4) Complete and accurate

A.5 General:

- (All) How would you rate the quality of your group's decision-making process? (Evaluation Scale)

1) Poor
2) Satisfactory
3) Good
4) Very Good
5) Excellent

- (For COPlanS users) To what extent did COPlanS improve the quality of the decision-making process? (Evaluation Scale)

1) Significantly Detract
2) Slightly Detract
3) Neutral
4) Slightly Improve
5) Significantly Improve

- (For COPlanS users) To what extent did COPlanS support the operations planning process? (Evaluation Scale)

1) Significantly Detract
2) Slightly Detract
3) Neutral
4) Slightly Improve
5) Significantly Improve

- (For COPlanS users) How would you rate the effort required in learning to use COPlanS? (Evaluation Scale)

1) Too High (too demanding)
2) High
3) Appropriate
4) Easy
5) Very Easy (Not demanding)

- (For COPlanS users) What would be the most appropriate training length needed to be able to use COPlanS? (Evaluation Scale)

1) One day
2) Half a week
3) A week
4) Two weeks
5) More than two weeks

- (For COPlanS users) What training method would you recommend for COPlanS? (Descriptive)
- (For COPlanS users) How often did you experience problems with COPlanS? (Evaluation Scale)

Never
Sometimes
Frequently

- (For COPlanS users) How significant were the problems you encountered with COPlanS? (Evaluation Scale)

1) Minor
2) Moderate
3) Significant

- (All) Comments: (Descriptive)

List of symbols/abbreviations/acronyms/initialisms

C2	Command and Control
CC	Critical Capabilities
CF	Canadian Forces
CFC	Canadian Forces College
CFOPP	Canadian Forces Operational Planning Process
COA	Course of Action
CONOPS	Concept of Operations
COPlanS	Collaborative Operations Planning System
COS	Chief of Staff
CR	Critical Requirements
CSC	Command and Staff Course
CV	Critical Vulnerabilities
DND	Department of National Defence
DRDC	Defence R&D Canada
OPI	Office of Primary Interest
R&D	Research & Development
RDDC	Recherche et développement pour la défense Canada
RFI	Request for Information

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Refining requirements related to a computer-based decision support system always presents a challenge. Most of the time, the requirements provided are highly abstract in nature, which leaves a vast array of possible concepts that could be developed to provide real support to the end user. To facilitate the capture of detailed decision support requirements, we propose to make use of the results of experiments conducted during exercises.

This memorandum describes how an experiment conducted at Canadian Forces College (CFC) to evaluate a collaborative planning system was used to produce refined requirements for collaborative planning.

Le raffinement de la caractérisation des besoins liés aux systèmes automatisés d'aide à la décision est un défi continuel. La plupart du temps, les besoins sont identifiés à un très haut niveau d'abstraction, faisant place à un large spectre de possibilités sur la façon dont les concepts peuvent être implantés pour fournir une aide réelle à l'usager. Pour faciliter la collecte des besoins détaillés d'aide à la décision, il est proposé d'exploiter les résultats d'expérimentations effectuées pendant les exercices.

Ce mémorandum décrit comment une expérience effectuée au collège des Forces canadiennes pour évaluer un outil collaboratif de planification a été utilisée pour raffiner la caractérisation des besoins d'aide à la planification collaborative.

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