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CECA model of the JSTAFF

David J. Bryant

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Abstract

This report describes a model of decision-making and collaboration within the Joint Staff (JSTAFF). The model was developed within the Critique-Explore-Compare-Adapt (CECA) framework [1], which incorporates important aspects of human cognition. The model was created by identifying correspondences between JSTAFF elements and the CECA framework in terms of information products, groups/agencies making up the JSTAFF, and the processes for creating, maintaining, updating, and transferring information products. The JSTAFF organization proved well-suited to the CECA framework. It was possible to readily identify numerous points of contact between the two in terms of the groups and agencies making up the JSTAFF, the processes used to perform the JSTAFF's functions, and the products that served as physical instantiations of those processes. The JSTAFF diverges from the CECA framework, however, in several key ways. Most notably, there are no products that directly correspond to the conceptual and situation models, which limits communication, comparison, and collaboration within the JSTAFF. It is suggested that the JSTAFF needs formal information products that correspond to the conceptual and situation models. The conceptual model should be formalised as a support tool or system that facilitates operational planning and the graphic representation of plans. The situation model should be formalised as an integrated picture developed by the National Defence Command Centre (NDCC) and thereby serve as a comprehensive model for the operational environment.

Résumé

Le présent compte rendu porte sur un modèle de prise de décision et de collaboration au sein de l'état-major interarmées (EMI). Le modèle a été élaboré autour du cadre Critiquer, Explorer, Comparer et Adapter (CECA) [1] qui renferme des aspects importants de la cognition humaine. Il a été créé à partir des correspondances identifiées entre divers éléments de l'état-major interarmées (EMI) et le cadre CECA en matière de produits d'information, des groupes/agences qui forment l'EMI ainsi que des processus de création, de maintenance, de mise à jour et de transfert des produits d'information. L'organisation de l'EMI s'est avérée tout à fait appropriée au cadre CECA. Nombre de points de référence qui les relient ont facilement pu être identifiés, notamment les groupes et les agences qui forment l'EMI, les processus utilisés pour exécuter les fonctions de l'EMI et les produits qui ont servi d'instanciations physiques de ces processus. L'EMI diffère cependant du cadre CECA sur plusieurs points. Notamment, aucun produit ne correspond directement aux modèles conceptuel et situationnel, un aspect qui restreint la communication, la comparaison et la collaboration au sein de l'état-major interarmées (EMI). On estime que l'EMI a besoin de produits d'information qui correspondent aux modèles conceptuel et situationnel. Le modèle conceptuel doit être organisé comme un outil ou un système de soutien facilitant la planification opérationnelle et la représentation graphique de plans. Le modèle situationnel doit être organisé en un tableau intégré élaboré par le Centre de commandement de la Défense nationale (CCDN) et servir de modèle global pour l'environnement opérationnel.

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Executive summary

CECA model of the JSTAFF

David J. Bryant; DRDC Toronto TR 2006-259; Defence R&D Canada – Toronto; January 2008.

A model of decision-making and collaboration within the Joint Staff (JSTAFF) was developed within the Critique-Explore-Compare-Adapt (CECA) framework [1], which is a modern alternative to the OODA (Observe-Orient-Decide-Act) Loop. The CECA framework incorporates important aspects of human cognition within a framework compatible with decision making at the organizational level. Specifically, it describes human cognition in terms of its goal-directedness, use of mental models for reasoning, constructive perception and sense-making, and critical thinking.

A model was created that captures the organization and functional operation of the JSTAFF. The specific JSTAFF model was created by identifying correspondences between elements of the JSTAFF and the CECA framework. First, information products created, maintained, and transferred among groups within the JSTAFF were identified to document information flow. Then the groups and/or agencies (groups/agencies) within the JSTAFF responsible for information products were identified to document where, and in what form, information resides. Finally, the processes for creating, maintaining, updating, and transferring information products were identified to document the nature of information processing and transformation.

The analysis of the JSTAFF was based primarily on three sources:

1. Canadian Forces Command System (2002). *Process models for the CF strategic and operational planning process and the DCDS decision making process in support of operations*. Department of National Defence. [16]
2. Greenley, A., Baker, K., & Greenley, M. (2005). *Joint Staff: Joint Staff Business Processes.* DRDC Valcartier Contractor Report (CR 2005-041). Greenley & Associates Incorporated, Ottawa, Ontario, Canada. [17]
3. Greenley, A., Baker, K., & Cochran, L. (2005). JSTAFF Front End Analysis Data Analysis Report (FFSE Task 147). DRDC Valcartier Contractor Report (DRAFT). Greenley & Associates Incorporated, Ottawa, Ontario, Canada. [18]

To facilitate an orderly review, the detailed analysis followed a set of seven steps:

Step 1: Identify the major groups/agencies integral to the functioning of the JSTAFF;

Step 2: Identify information products described in the sources (especially the Operational View charts);

Step 3: For each information product, identify the performing group or agency;

Step 4: Identify the processes associated with each information product and categorize with respect to the CECA framework;

Step 5: Identify mission products, performers, and processes that are missing, overlapping, redundant, etc.;

Step 6: Develop observation measures and tools for validation of the products, performers, processes; i.e. assess whether the model created is an accurate description of JSTAFF functioning; and

Step 7: Develop measures of effectiveness for the products, performers, and processes.

The organization of the JSTAFF proved well-suited to the CECA framework and numerous points of contact between the two were identified in terms of the groups and agencies making up the JSTAFF, the processes used to perform the JSTAFF's functions, and the products that served as physical instantiations of those processes.

Based on a review of the sources, 20 groups/agencies were identified, which were then categorized with respect to the CECA framework. The analysis indicated that the current JSTAFF structure conforms to the three levels (conceptual, situation awareness, and sensor levels) of the CECA framework. Numerous groups/agencies perform the information gathering role in the CECA framework. The National Defence Command Centre (NDCC) appears to be the most important agency at the situation awareness level, although the COS J3 plays a significant role at that level and as an intermediary to the conceptual level. All sources of information must pass through the NDCC in order to affect situation awareness and, ultimately, the conceptual level groups/agencies. The Deputy Chief of Defence Staff (DCDS) and Chief of Defence Staff (CDS) are the conceptual level agencies that are directly part of the JSTAFF but the roles of those agencies and others is not entirely clear at the conceptual level.

Products produced by groups/agencies within the JSTAFF were linked to types of processes described in the CECA framework. The top-down processes of Query and Direct generally involve products that take the form of requests for information and taskings or orders. Bottom-up processes of Update and Fuse generally involve SA products and briefings.

The JSTAFF diverges from the CECA framework in several key ways. First, there are no JSTAFF products that directly correspond to the conceptual and situation models of the CECA framework. The absence of comprehensive models limits communication, comparison, and collaboration within the JSTAFF as knowledge is piecemeal and must be integrated by each individual. Second, information moving up the organisation to describe the situation and information moving down to propagate the operational plan and commander's intent are represented by multiple products. Third, although the JSTAFF parallels the CECA framework, some JSTAFF groups/agencies do perform functions not specified in the CECA framework. Fourth, although groups/agencies work closely within the three levels, the separation of working elements disrupts the coherence of activity. Finally, groups/agencies at the sensor level are not under the direct management of the JSTAFF which may impair the communication of information needs.

It is suggested that the JSTAFF needs formal information products that correspond to the conceptual and situation models. The conceptual model should be formalised in a support tool or

system that facilitates operational planning as well as the graphic representation of plans. The situation model should be formalised as an integrated picture developed by the NDCC and serve as a comprehensive model for the operational environment.

Sommaire

CECA model of the JSTAFF

David J. Bryant; DRDC Toronto TR 2006-259; R & D pour la défense Canada – Toronto; Janvier 2008.

Un modèle de prise de décision et de collaboration au sein de l'état-major interarmées (EMI) a été élaboré autour du cadre Critiquer, Explorer, Comparer et Adapter (CECA) [1], constituant ainsi une alternative moderne à la boucle OODA (observer, orienter, décider, agir). Le cadre CECA renferme des aspects importants de la cognition humaine à l'intérieur d'une structure compatible avec la prise de décision au niveau organisationnel. De façon particulière, il décrit la cognition humaine en termes de but à atteindre, d'utilisation de modèles mentaux pour le raisonnement, de perception constructive, de raisonnement et de pensée critique.

Un modèle illustrant l'organisation et le fonctionnement de l'état-major interarmées (EMI) a été créé. Ce modèle, propre à l'EMI, a été créé à partir de correspondances entre divers éléments de l'état-major interarmées (EMI) et le cadre CECA. Premièrement, des produits d'information créés, mis à jour et transférés entre les groupes de l'EMI ont été identifiés dans le but de documenter le cheminement de l'information. Ensuite, les groupes et/ou les agences (groupes/agences) de l'EMI, responsables des produits d'information, ont été identifiés pour documenter où, et sous quelle forme, se trouve l'information. Enfin, des processus de création, de maintenance, de mise à jour et de transfert des produits d'information ont été identifiés afin de documenter la nature du traitement et de la transformation de l'information.

L'analyse de l'EMI repose principalement sur trois sources :

1. Système de commandement des Forces canadiennes (2002). Modèles de processus pour la planification opérationnelle et stratégique des FC et processus décisionnel du SCEMD à l'appui des opérations. Ministère de la Défense nationale. [16]

2. Greenley, A., Baker, K., & Greenley, M. (2005). État-major interarmées : procédés opérationnels de l'état-major interarmées. Rapport de l'entrepreneur de RDDC Valcartier (CR 2005-041). Greenley & Associates Incorporated, Ottawa (Ont.), Canada. [17]

3. Greenley, A., Baker, K., & Cochran, L. (2005). Analyse préliminaire de l'EMI – Rapport d'analyse des données (ESFF - Tâche 147). Rapport de l'entrepreneur de RDDC Valcartier (ÉBAUCHE). Greenley & Associates Incorporated, Ottawa (Ont.), Canada. [18]

Afin que tout se fasse de manière ordonnée, une analyse détaillée en sept étapes a été réalisée :

Étape 1 : Identifier les principaux groupes/agences faisant partie intégrante du fonctionnement de l'EMI;

Étape 2 : Identifier les produits d'information décrits dans les sources (en particulier les organigrammes des vues opérationnelles);

Étape 3 : Identifier, pour chaque produit d'information, le groupe ou l'agence s'y rapportant;

Étape 4 : Identifier le processus associé à chaque produit d'information et le classer conformément au cadre CECA;

Étape 5 : Identifier les produits, les exécutants et les processus qui manquent, qui se chevauchent, qui sont redondants, etc.;

Étape 6 : Élaborer des mesures et des outils d'observation pour la validation des produits, des exécutants, des processus, c'est-à-dire évaluer si le modèle créé décrit exactement le fonctionnement de l'EMI;

Étape 7 : Élaborer des mesures d'efficacité pour les produits, les exécutants et les processus.

L'organisation de l'EMI s'est avérée tout à fait appropriée au cadre CECA. Nombre de points de référence qui les relient ont facilement pu être identifiés, notamment les groupes et les agences qui forment l'EMI, les processus utilisés pour exécuter les fonctions de l'EMI et les produits qui ont servi d'instanciations physiques de ces processus.

Comme suite à l'examen des sources, vingt groupes/agences ont été identifiés, puis classés conformément au cadre CECA. L'analyse a révélé que la structure actuelle de l'EMI est conforme aux trois niveaux du cadre CECA (conceptuel, connaissance de la situation et détection). Nombre de groupes/agences s'occupent de la collecte de renseignements à l'intérieur du cadre CECA. Le Centre de commandement de la Défense nationale (CCDN) semble être l'organisme le plus important au niveau de la connaissance de la situation, bien que le CEM J3 joue un rôle important à ce niveau et à titre d'intermédiaire par rapport au niveau conceptuel. Toutes les sources d'information doivent transiter par le CCDN pour influer sur la connaissance de la situation et, en bout de ligne, sur les groupes/agences du niveau conceptuel. Les organisations du Sous-chef d'état-major de la Défense (SCEMD) et du Chef d'état-major de la Défense (CEMD) sont les organismes du niveau conceptuel faisant directement partie de l'EMI. Les rôles de ces organisations ne sont cependant pas entièrement clairs au niveau conceptuel.

Les produits réalisés par les groupes/agences de l'EMI ont été associés aux types de procédés décrits dans le cadre CECA. Les processus descendants de demande et d'acheminement des renseignements impliquent généralement des produits prenant la forme de demande de renseignements et d'attribution de tâches ou d'ordres. Les procédés ascendants de mise à jour et de fusion des renseignements impliquent généralement des produits et des exposés liés à la connaissance de la situation.

L'EMI diffère du cadre CECA sur plusieurs points. Tout d'abord, aucun produit de l'EMI ne correspond directement aux modèles conceptuel et situationnel du cadre CECA. L'absence de modèles généraux limite la communication, la comparaison et la collaboration au sein de l'état-major interarmées (EMI) étant donné que la connaissance est morcelée et doit être intégrée par chaque personne. Deuxièmement, les renseignements qui circulent vers le haut de l'organisation pour décrire une situation et ceux qui circulent vers le bas pour propager un plan opérationnel et l'intention du commandant sont représentés par des produits multiples. Troisièmement, bien que l'EMI soit parallèle au cadre CECA, certains groupes/agences de l'EMI exécutent des tâches qui ne sont pas précisées dans le cadre CECA. Quatrièmement, bien que les groupes/agences travaillent étroitement à l'intérieur des trois niveaux, la séparation des éléments fonctionnels compromet la cohérence des activités. Enfin, les groupes/agences au niveau de la détection ne se

trouvent pas sous la gestion directe de l'EMI, ce qui peut nuire à la transmission des besoins en matière d'information.

On estime que l'EMI a besoin de produits d'information qui correspondent aux modèles conceptuel et situationnel. Le modèle conceptuel doit être organisé comme un outil ou un système de soutien facilitant la planification opérationnelle et la représentation graphique de plans. Le modèle situationnel doit être organisé en un tableau intégré élaboré par le Centre de commandement de la Défense nationale (CCDN) et servir de modèle global pour l'environnement opérationnel.

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Introduction

Background

The model presented in this report was originally conceived in the context of the Joint Command Decision Support for the 21st Century (JCDS 21) Technology Demonstration Project (TDP). The JCDS 21 TDP investigates decision support concepts and technologies that could potentially support any CF Force Employment Scenario (including Domestic Operations). It investigates individual and organisational factors in addition to technology, with respect to decision-making, and with an aim of enhancing development of relevant technologies.

The aim of JCDS 21 is to demonstrate a joint net-enabled, collaborative environment to achieve decision superiority, within a Joint, Interagency, Multinational, and Public (JIMP) framework. The JIMP framework has been identified as a critical element to consider in this project as well as its implications for the Joint Operating Concept (JOC), Public Safety and Emergency Preparedness Canada (PSEPC) and the Public Security Technical Program (PSTP). The specific objectives of JCDS are:

- Understand the implications of net-centric operations, within a JIMP framework;
- Design and demonstrate a net-centric collaborative environment that supports, a) CF business processes within a JIMP framework, b) the exploitation of information and knowledge, c) collaborative working among distributed teams, and d) strategies to achieve shared intent and decision superiority within a unified command framework;
- Develop operational and system requirements for related acquisition projects; and
- Contribute to PSTP by sharing the results of studies and experimentation and collaborating on problems of common interest, within the scope of JCDS 21 TD.

The JCDS 21 TD project will contribute to the Command, Control, Communications, Intelligence, Surveillance, and Reconnaissance (C4ISR) campaign plan by advancing key concepts of the Strategic Operating Concept (SOC).

Organisational and Individual Factors

The research described in this report supports efforts to understand the organisational and individual factors that affect performance within network-centric environments. The capstone Canadian Strategic Operating Concept (SOC) is supported by two integrating concepts: Effects-Based Approach (EBA) and Network Enabled Operations (NEOps). The EBA and NEOps concepts are in turn supported by three functional concepts of C4ISR: Conduct Operations, Sustain, and Generate. The NEOps concept is new and provides only a high level vision at this time. Both Joint and Land capability managers have embarked on a process to provide more detailed approaches to the NEOps concept by examining the NEOps concept within the JIMP environment.

The Joint Staff (JSTAFF) works in the JIMP environment with clusters of institutions [e.g., Intergovernmental Organizations (IO); Governments; and Non-governmental Organizations (NGO)], which characteristically work together on specific issues such as civil defence, disaster relief, and Search and Rescue (SAR). A key requirement for the JSTAFF is the management of information and situational awareness. Integrating knowledge through Collaborative Working (CW) across clusters of distinct governmental and non-governmental bodies requires mastering their specifics and interrelations. In this report, a model of the Joint Staff is developed to enhance organizational agility and improve decision performance of the individual, team, and organization, which are critical for achieving integrated planning and execution in a JIMP environment.

Current Work

Shared intent and shared situation awareness are critical to collaborative work. A model of decision-making and collaboration specifically suited to the JCDS 21 TDP is needed to support these critical elements. This report describes a model based on the Critique-Explore-Compare-Adapt (CECA) framework developed at DRDC Toronto [1]. The model specifies the nature of the processes and representations involved in creating and maintaining shared intent and shared situation awareness. Ultimately, the model will be empirically validated and compared to existing systems to identify incompatibilities and areas of opportunity for supporting collaborative work and enhancing decision performance. The model will serve not only as an important and useful tool for considering how decision-making factors affect individual and team performance but also as a point of reference for linking decision making to issues of visualization, knowledge management, and plan development.

The CECA framework is not a normative model but, rather, a framework in which to analyse Command and Control (C^2) systems. The objective of this report is to assess whether the JSTAFF can be described in the CECA framework and establish a model of the JSTAFF for future evaluation. Discrepancies between the structure and function of the JSTAFF and the CECA framework will be identified but these discrepancies do not imply any necessary shortcoming of the JSTAFF. By examining such discrepancies, however, it is possible to better understand how the JSTAFF functions and to determine whether the JSTAFF exhibits contrasting advantages to the CECA framework.

CECA Framework

The CECA Framework was developed by Bryant [1] as a modern alternative to the OODA (Observe-Orient-Decide-Act) Loop.[1] Although simple and intuitive, the OODA Loop obscures many underlying processes that people use to understand their environment and make decisions (e.g., [2]). The goal-directedness exhibited by human beings, for example, is an important aspect of human cognition that is not clearly laid out by the OODA Loop. A framework of command decision making should include an explicit role for plans, intentions, or goals given their criticality to decision making and problem solving (e.g., [3] [4]). Similarly, the mechanistic, information-driven view of cognition implied by the OODA Loop has been supplanted in modern cognitive sciences with the constructive or "sense-making" approach (e.g., [5] [6]), in which knowledge directs sensory systems and sets thresholds on phenomena that might attract attention.

The concept of the mental model is particularly important as a means to describe the complex and rich mental representations used in reasoning (e.g., [7] [8]). It is impossible to understand human reasoning and decision making without consideration of how knowledge is structured and organized. The defining characteristic of a mental model is that it maps elements of an external system (a problem, situation, or event) and the inter-relationships among those elements onto a conceptual structure [9] [10]. Mental models are situational representations that serve as an internal simulation of external systems. In addition, mental models are dynamic representations that continually adjust to represent the current state of the system or situation [11].

Critical thinking, broadly defined as the systematic questioning and evaluation of one's own reasoning strategies, is known to be crucial to successful problem solving (e.g., [12] [13] [14]). As a decision making strategy, critical thinking motivates one to seek evidence that potentially disconfirms one's mental model of a problem, which in turn necessitates some revision or re-thinking of the problem or one's strategy for solving it. Critical thinking promotes adaptivity and helps one detect failures in one's problem solving strategy and this improves one's ability to cope with complexity and uncertainty [15]. Insufficient critical thinking has been identified as one common maladaptive aspect of decision making (e.g., [3]).

Overview of the Framework

The Critique-Explore-Compare-Adapt (CECA) framework (see Figure 1) is a general description of C2-related decision making that is consistent with modern cognitive concepts. When an operation begins, planning activities establish the initial conceptual model (illustrated in the top-most box in Figure 1), which is a mental model of the plan. The conceptual model is parenthetically described (in Figure 1) as "how you want it to be" because it maintains the goals of the operation as well as a representation of how to achieve them. It is a representation of how the operation is intended to proceed and, thus, is closely aligned with the strategic/operational intent.

[1] See Bryant (2003) for a complete discussion of the CECA framework.

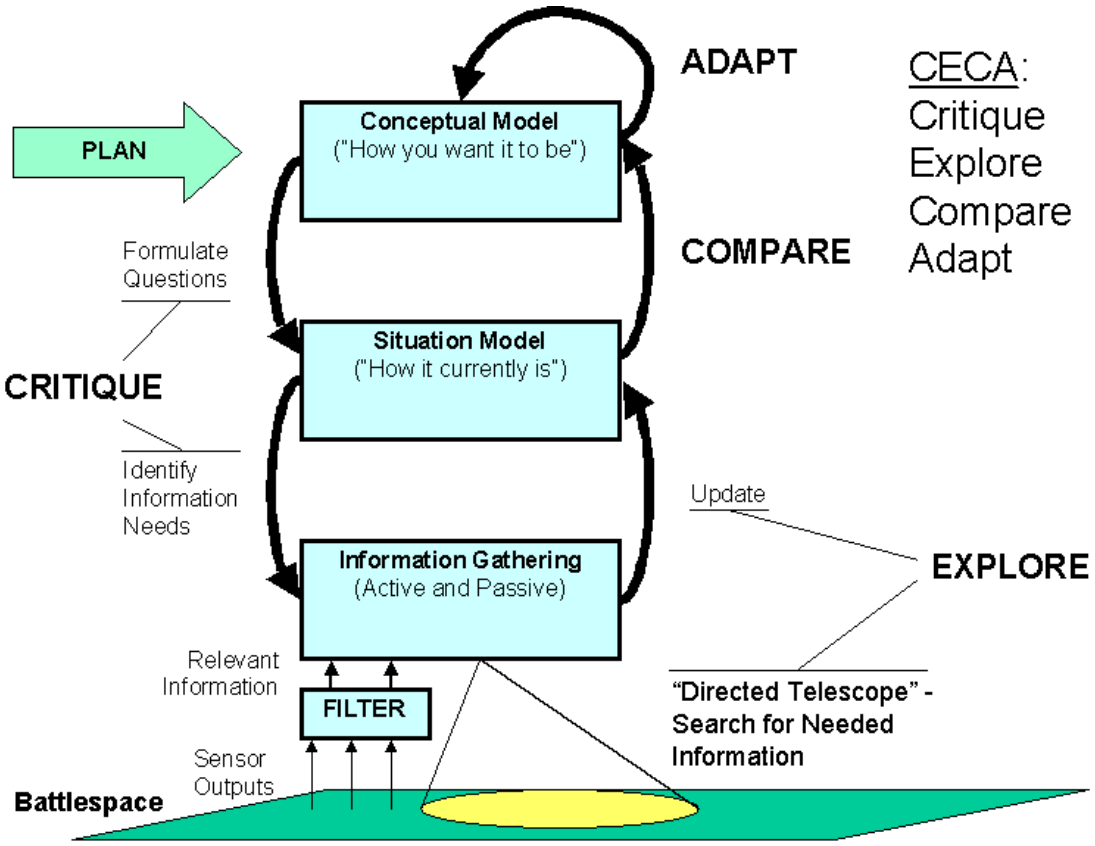

Figure 1. The Critique-Explore-Compare-Adapt (CECA) Framework.

The conceptual model describes the *states* of the battlespace one wants to achieve across a specified period of time, rather than what *actions* should be performed. Hence, the conceptual model is inherently goal-oriented. Detailed specification of desired battlespace states is crucial for a) devising appropriate actions, b) assessing the effectiveness of actions in achieving desired battlespace states, and c) assessing the relevance and effectiveness of the plan itself (and goals) in meeting higher-level operational aims. By focusing on goal states, the conceptual model is not procedural. Rather, it is a mental medium in which to consider alternative courses of actions and their consequences and to devise complex solutions to operational problems.

The conceptual model is open to revision so that the desired transition states, and perhaps even the desired end state, can be changed in response to changes in the battlespace. For this reason, the conceptual model is depicted in Figure 2 as a series of transitional states, established through planning, leading from the start-state to the desired end-state. The series of desired transition states defines the path from the initial to desired end-state.

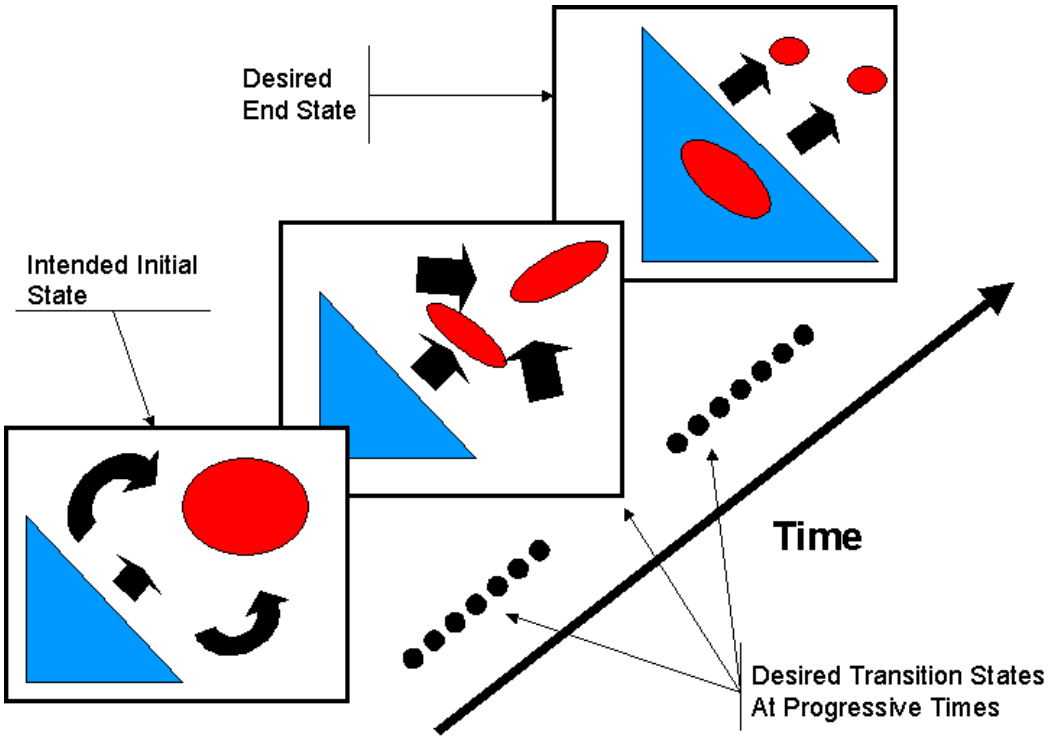

Figure 2. The Conceptual Model is a Series of Transitional States.

To know when and how to adapt one's conceptual model, one must have a *situation model* (illustrated by the middle box in Figure 1), which is a representation of the current state of the battlespace ("how it currently is") in a form that can be understood with respect to the conceptual model. In particular, the situation model must identify aspects of the current state of the battlespace that differ from the desired state of the conceptual model. An adequate understanding of the implications of the situation cannot be gained passively.

The Decision Making Process

The goal-directed nature of the conceptual model makes it imperative that information gathering be directed with respect to the conceptual model. A key to good decision making is the constant iterative evaluation of how the current situation is facilitating the achievement of goals and, more importantly, the ways in which it is thwarting the achievement of goals or putting one's own forces at risk. Thus, information needs are established in the "Critique" phase of the CECA Loop by questioning the conceptual model to identify critical aspects that, if invalidated, would render the plan for the operation untenable. From these questions, one can identify specific data types that will contribute to answering the questions.

Active and passive collection of data comprise the "Explore" phase of the CECA framework. Active collection is guided by the information needs developed in the Critique phase and thus is directed to answering questions of the conceptual model's validity. The second means of information gathering involves the continual reception and filtering of sensor data according to intelligently determined criteria. This is illustrated by the box labeled *filter* in Figure 1,

although the filter actually refers to a range of mechanisms in place to block irrelevant information. Passive collection is the process of monitoring events in the battlespace and determining whether unassessed aspects of the battlespace should receive attention. Events triggering a response in the filtering system can be actively processed and incorporated in the situation model. A filtering process is necessary to prevent the decision maker and C^2 organization from becoming overwhelmed by the volume of data that can be collected. It represents a compromise between the need to be responsive to unforeseen events that require action and the limitations on the volume of data that can be processed at any given time.

Gathered data are used to update the situation model of the battlespace, reflecting changes that have occurred in the battlespace, correction of errors in the situation model, the addition of missing elements, and the enhancement of relevant detail. All changes to the situation model must bear on the validity of the conceptual model to prevent the situation model from becoming overly complex with irrelevant information.

In the "Compare" phase, the situation model is compared to the conceptual model to determine what, if any, aspects of the conceptual model are invalid (i.e. inconsistent with the current situation). The emphasis should be on identifying ways in which the current state of the battlespace does not correspond to the state described by the conceptual model for this time period of the plan. In particular, the answers to the high-level questions used to direct information gathering must be explicitly considered to ensure that the validity of critical aspects of the conceptual model are tested.

Based on the differences between the situation and conceptual models, the conceptual model will require some degree of revision. It is then up to the decision maker to determine what to do in response to inconsistencies in the "Adapt" phase. In general, the decision maker has three options: a) ignore the inconsistencies if they are deemed of low consequence (i.e. inconsistencies with the conceptual model have little practical impact), b) alter the means by which the goals of the operation are to be achieved, or c) alter the goals themselves if the most basic assumptions of the conceptual model are invalidated.

Action and Control

In the CECA framework, the organization's deliberate action is driven by the conceptual model, which lays out the rationale for each action and coordinates all actions. Figure 3 illustrates how this works. The current state of the conceptual model (which depends on prior data gathering and adaptation) indicates what actions will advance the current state toward the next transition state and ultimately toward the desired end-state. The CECA Loop proper is shown in the figure running in parallel with the direction of action by the conceptual model. As the conceptual model drives action it also drives the data collection activities that allow the commander to assess the effects of those actions (as well as those of the other organizations, agencies, and opponents) on the state of the world.

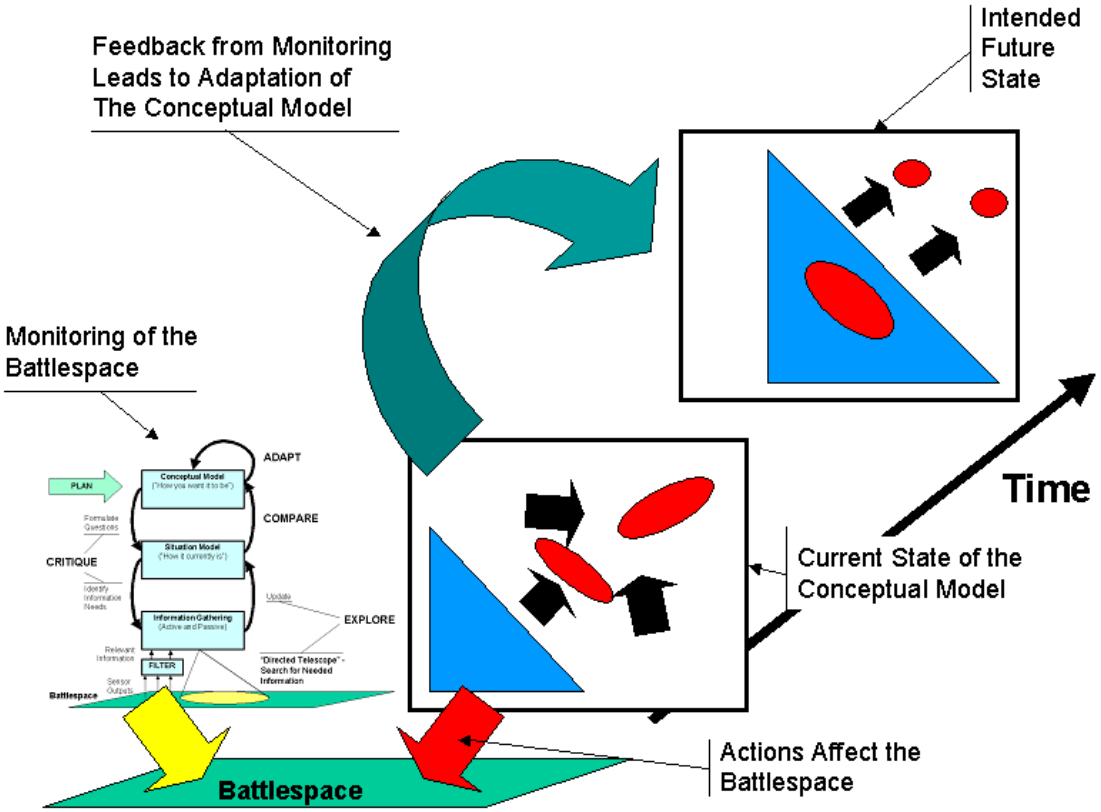

Figure 3 Control of Action in the CECA Framework.

According to this framework, action is not strictly tied to immediate observations of the environment. Rather, the conceptual model evolves in relation to *all* observed events as they affect the validity of the plan. Effective search and filtering of information is essential for this to work and depends on the sharing of the conceptual model among distributed units within the C^2 organization. Sharing such a complex model is difficult and effort needs to be devoted to creating an external conceptual model to which everyone in the C^2 organization can refer. Rather than acting as a huge document explaining every detail of the operational plan, the conceptual model is meant to create a shared mental model among all members of the C^2 organization.

Analysing C^2 Systems

The CECA framework can serve as a basis for modeling decision making in C^2 contexts. It employs principles of cognition to link individual knowledge representation to organizational procedures and structures for managing information.

The CECA framework puts the conceptual model at the centre of decision making. The conceptual model is the link between planning and action because it is a detailed representation of the objectives of the operation and the principles that guide how those goals are to be achieved, and it provides a general outline of the actions that must be taken over time. The importance of this linkage is recognized in CF doctrine and theories of human

decision making (see e.g., [2] [8] [12]). Thus, the CECA framework provides a platform for considering the effects of both technology and organizational factors, such as doctrine, procedures, and staffing, on decision making at the organizational level.

Critically, the quality of the plan/conceptual model determines the quality of the questions and hypotheses drawn by the decision maker and used to search for information. Thus, in considering how to improve and speed up the decision making process, it is critical to examine how changes to procedures or technology will affect the representation of the plan. Changes that seem to enhance procedural aspects of decision making may actually impair overall performance if they disrupt the formulation or understanding of the conceptual model.

Thus, the CECA framework describes a system in which sensory data is processed and represented, rationale decisions concerning future actions are made, and directions on actions and further perceptual activity are issued. It is not the only framework and a system that diverges in some respects may provide an effective C^2 system. It is possible, however, to examine how a C^2 system functions with respect to the CECA framework as a means of gaining insight into the functioning of that system. Specifically, aspects of a C^2 system that conform to the CECA outline can be understood in terms of the principles by which the CECA framework was developed. Aspects of a C^2 system that differ from the CECA framework present themselves as areas to be examined to determine how they function within the system and whether the divergence from the CECA framework creates any problems or inefficiencies in the system.

Modeling Approach

The CECA framework is a general framework in which to consider decision making in a C^2 context. To better understand the JSTAFF, a specific model must be created that captures the organization and functional operation of the JSTAFF. That specific model can then be compared to the general CECA framework to determine what ways in which the JSTAFF is similar and the ways in which it differs. This comparison highlights those cognitive principles implicit in the JSTAFF but also allows us to consider how different principles may guide the JSTAFF.

The specific JSTAFF model was created by identifying correspondences between elements of the JSTAFF and the CECA framework. The method for developing the model of the JSTAFF within the CECA framework can be summarized as answering the basic questions of *what, who, and how*. That is, the author consulted documents prepared as part of the front-end analysis performed by Greenley, Baker, and Cochran [18] to:

- Identify what information products are created, maintained, and transferred among groups within the JSTAFF to document information flow (What?);
- Identify which groups/agencies within the JSTAFF perform actions and are responsible for products to document where, and in what form, information resides (Who?); and
- Identify the processes for creating, maintaining, updating, and transferring information products to document the nature of information processing and transformation (How?).

Source Material

The analysis of the JSTAFF was based primarily on three sources:

1. Canadian Forces Command System (2002). Process models for the CF strategic and operational planning process and the DCDS decision making process in support of operations. Department of National Defence. [16]

2. Greenley, A., Baker, K., & Greenley, M. (2005). Joint Staff: Joint Staff Business Processes. DRDC Valcartier Contractor Report (CR 2005-041). Greenley & Associates Incorporated, Ottawa, Ontario, Canada. [17]

3. Greenley, A., Baker, K., & Cochran, L. (2005). JSTAFF Front End Analysis Data Analysis Report (FFSE Task 147). DRDC Valcartier Contractor Report (DRAFT). Greenley & Associates Incorporated, Ottawa, Ontario, Canada. [18]

The first report was sponsored by Canadian Forces Command Systems (CFCS) to document the business requirements for the OPP and the National Defence Command Centre (NDCC) Decision Making Process. Its scope included the NDCC and COS J3 business flows, workflows, and info exchanges. In all cases, business requirements were defined independent of technology. The goal of the report was to provide an understanding of business requirements at the strategic level for the two main processes that support CF operations:

Develop Situation Awareness and Manage Situation/Operation processes. A process model is developed that describes these major processes and how they fit together. The model depicts process customers and organizational boundaries. A gap analysis was also performed to assess the alignment of organization and role responsibilities. In particular, the analysis determined whether the organisation and role responsibilities work together to complete work and identify accountability, whether activities and procedures are performed in the correct manner, and whether the required technical capabilities and tools are in place for people to do jobs and complete processes effectively. The report presents a summary of capability requirements and gaps in the current NDCC and OPP processes.

The objectives of the second source were to define and characterize DND Strategic Level Command and Control processes and map the Joint Staff (JSTAFF) business process in detail. The authors developed Department of Defence Architectural Framework (DoDAF) Operational View (OV) products on the bases of CF doctrine, standard operating procedures (SOPs), and concepts of operation (CONOPS). DoDAF products articulate relationships among CF and other governmental departments (OGDs). One reason for employing DoDAF products was the flexibility with which those products can represent data, allowing for multiple "views" that can be used to document the current, or proposed future, state of a system or a capability conducive to different analysis aims.

The third source summarizes the results of the observation of JSTAFF activities in planning and decision making. Based on these observations, the authors of the report developed a high level view of the current Enterprise Architecture of the JSTAFF. The authors also employed the DoDAF to represent their data but also performed a Functional Needs Analysis (FNA) that identified areas of concentration for the subproject groups within the JCDS 21 TDP.

Analysis Steps

The analysis involved a thorough review of these sources to develop an understanding of the JSTAFF and its functions. The sources were then reviewed in detail to extract critical information concerning the "what," "who," and "how" aspects of the JSTAFF.

To facilitate an orderly review, the detailed analysis followed a set of seven steps:

Step 1: Identify the major groups/agencies making up the JSTAFF (including groups/agencies integral to the functioning of the JSTAFF);

Step 2: Identify information products described in the sources (especially the OV charts);

Step 3: For each information product, identify the performing group or agency;

Step 4: Identify the processes associated with each information product and categorize with respect to the CECA framework;

Step 5: Analyse for mission products, performers, and processes that are missing, overlap, redundant, etc.;

Step 6: Develop observation measures and tools to be used to validate the products, performers, processes; i.e. to assess whether the model created is an accurate description of JSTAFF functioning; and

Step 7: Develop measures of effectiveness for the products, performers, processes.

The DoDAF diagrams produced by Greenley, Baker, & Greenley [17] and Greenley, Baker, & Cochran [18] proved particularly helpful in identifying the groups/agencies involved and their organizational relationships, as well as documenting information flow in the JSTAFF.

To create a model of the JSTAFF, the elements identified in Steps 1-4 were correlated with the CECA framework. That is, groups/agencies were associated on the basis of their functions with the key levels of the CECA framework. Processes and information products identified in these steps were also correlated with the CECA framework to determine how the groups/agencies performed their functions and how information and knowledge were physically represented.

JSTAFF Model

The JSTAFF model presented in this section is a first attempt to describe the elements, organization, and functioning of the JSTAFF in terms of the CECA framework. That is, just as the CECA framework describes the coordination of the conceptual and situation models to produce adaptive planning and action, the JSTAFF was viewed as a system for producing intelligent behaviour at the strategic level through a feedback loop with lower formations, OGDs, and NGOs. The organization of the JSTAFF proved well-suited to the CECA framework and it was possible to identify numerous points of contact between the two in terms of the groups and agencies making up the JSTAFF, the processes used to perform the JSTAFF's functions, and the products that served as physical instantiations of those processes. These correspondences are discussed in this section, as are several differences between the current JSTAFF and the CECA framework.

Levels within the CECA Framework

The first step of the analysis was to identify the groups and agencies making up, or directly linked to, the JSTAFF. Based on a review of the sources, 20 groups/agencies were identified. These were then categorized with respect to the CECA framework. The JSTAFF fits well into the CECA framework, which, at its core comprises a feedback loop for the iterative adjustment of operational planning. Thus, just as CECA has major roles for planning, situation assessment, and information gathering, so too does the JSTAFF contain agencies or groups that perform those functions.

Table 1 JSTAFF Groups/Agencies by CECA Level.

Level	JSTAFF Group/Agency
Sensor Level	CF Int Sources (Canadian Forces Intelligence Sources) Allied Int Sources (Allied Intelligence Sources) CF Survey & Reconnaissance Elements MARPAC (Maritime Forces Pacific) MARLANT (Maritime Forces Atlantic) CADS (Canadian Air Defence Sector) 1 CAD/CANR (1 Canadian Air Division/ Canadian NORAD Region) CFNA (Canadian Forces Northern Area)
Situation Awareness Level	NDCC (National Defence Command Centre) COS J3 (Chief of Staff J3) COS J3 Intl (Chief of Staff J3 International) CFJOG (Canadian Forces Joint Operation Group) CF Contingency Operations CF Deployed Operations
Conceptual Level	(COS J3) DCDS (Deputy Chief of Defence Staff) CDS (Chief of Defence Staff) DMND (Deputy Minister of National Defence) MND (Minister of National Defence) ECSs (Environment Chiefs of Staff) (CLS, CAS, CMS) AMNDM S-CP (Associate Minister of National Defence and Minister of State (Civil Preparedness)

The structure of the CECA framework divides the decision making process into three broad levels that are critical to defining a feedback loop. These levels are indicated in Figure 4. At the "sensor" level, data is actively and passively gathered. The "situation awareness" level is concerned with the synthesis and interpretation of data to create and maintain the situation model. Finally, the "conceptual" level is the level at which the conceptual model is developed and adapted through iterative comparison to the situation model. Table 1 contains a list of JSTAFF groups and agencies categorized according to the CECA framework. Figure 4 illustrates how the groups/agencies that make up the JSTAFF fit into the CECA framework. Eight agencies are the primary input providers at the sensor level. Many more agencies are likely to serve as "sensors" on an ad hoc basis. Groups/agencies at the sensor level send information primarily to NDCC through independent channels. There is little apparent coordination among these groups/agencies, although NDCC and higher groups/agencies have some influence of sensor level groups/agencies through requests for information and Op Taskings. The JSTAFF, however, has only limited control over the actual collection of data.

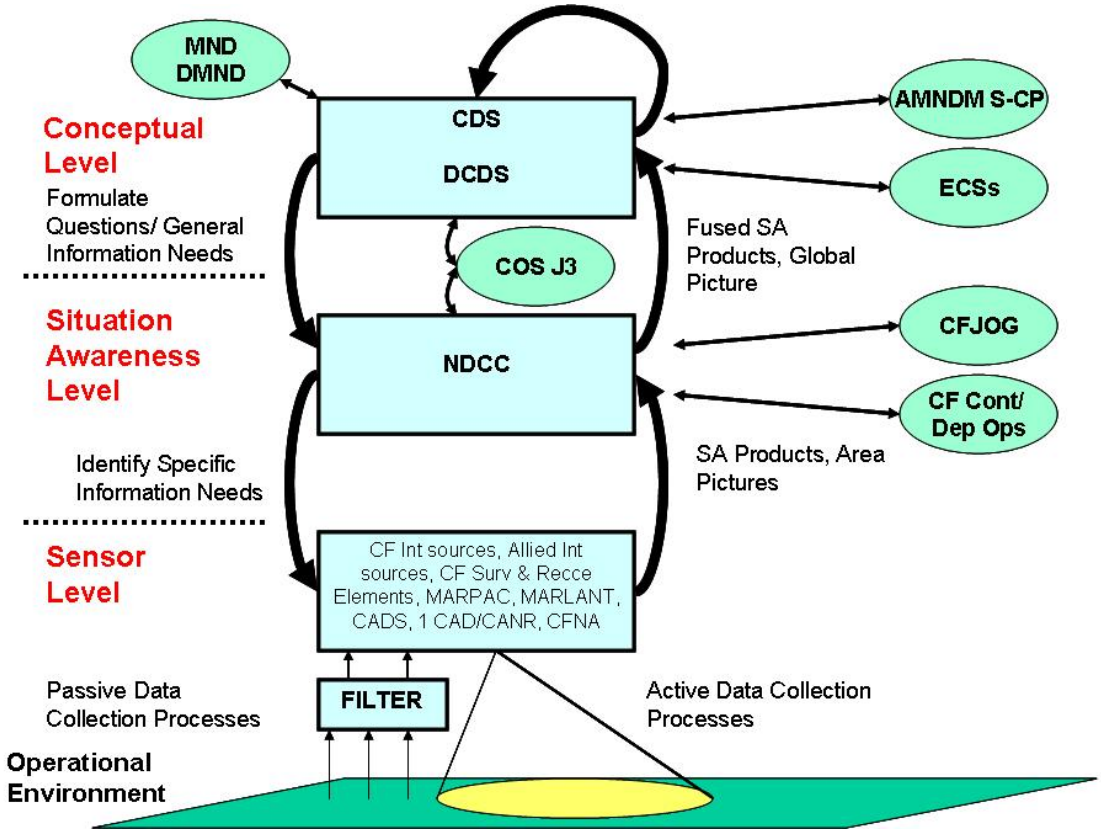

Figure 4 The JSTAFF Model.

The NDCC is the primary group responsible for situation awareness but it works with others, notably the COS J3. The COS J3, CFJOG, and CF Continental and Deployed Operations play significant roles in this process as well. Maintaining SA corresponds to building and continually updating the situation model in the CECA framework, although the NDCC does not create a product that serves the role of situation model. Instead, the NDCC collates data and pushes it, in various forms, to client groups/agencies such as DCDS. The NDCC performs regular and ad hoc briefings (JSATs and mini JSATs) that provide integrated pictures of the operational situation.

The DCDS and CDS are primary groups in charge of planning and setting strategic direction but others play important roles. The COS J3 assists at this level as a bridge to the NDCC and the MND bears the ultimate responsibility for all JSTAFF plans. The AMNDM S-CP and ECSs also play roles in these activities and, ultimately, the DMND and MND are responsible for strategic direction. Nevertheless, strategic direction and operational planning correspond to creating and adapting the conceptual model in the CECA framework, although no single, integrated product directly corresponds to the conceptual model.

As mentioned, information flow within the JSTAFF comprises a feedback loop. The sensor-level agencies, although not strictly part of the JSTAFF or under its direct control, create SA products and area pictures on the basis of their information gathering activities and send these products to the NDCC, which uses them in a fusion process to build SA. The broad mandate

of the JSTAFF requires it to have access to a wide range of agencies that are capable of providing diverse data from a vast physical environment. The NDCC appears to be the most important agency at the situation awareness level, although the COS J3 plays a significant role at that level. The NDCC distributes fused SA products and a global picture to the conceptual level (DCDS & CDS), with the COS J3 acting as an intermediary that can coordinate situation assessment with planning. The DCDS and CDS are the conceptual level agencies that are directly part of the JSTAFF but the roles of those agencies and others at the conceptual level is not clear from the source documents. The DCDS/CDS also push down requests for information in the form of general questions and general information needs that direct the NDCC in updating its situation awareness.

JSTAFF Products and Processes

In the CECA framework, processes relate to the top-down direction of information gathering, the gathering of basic data/information itself, the updating and integration of data into the situation model, or the comparison of the conceptual model to the situation model. The Critique, Explore, Compare, and Adapt labels roughly correspond to these functions but the processes by which information is processed, models updated, and guidance propagated can be specified in greater detail. Figure 5 contains an illustration of the CECA framework with the specific processes indicated in red.

Specific CECA framework processes are:

- Query; > Critique
- Direct; > Critique
- Filter; > Explore
- Search; > Explore
- Update;
- Fuse;
- Compare; and
- Adapt.

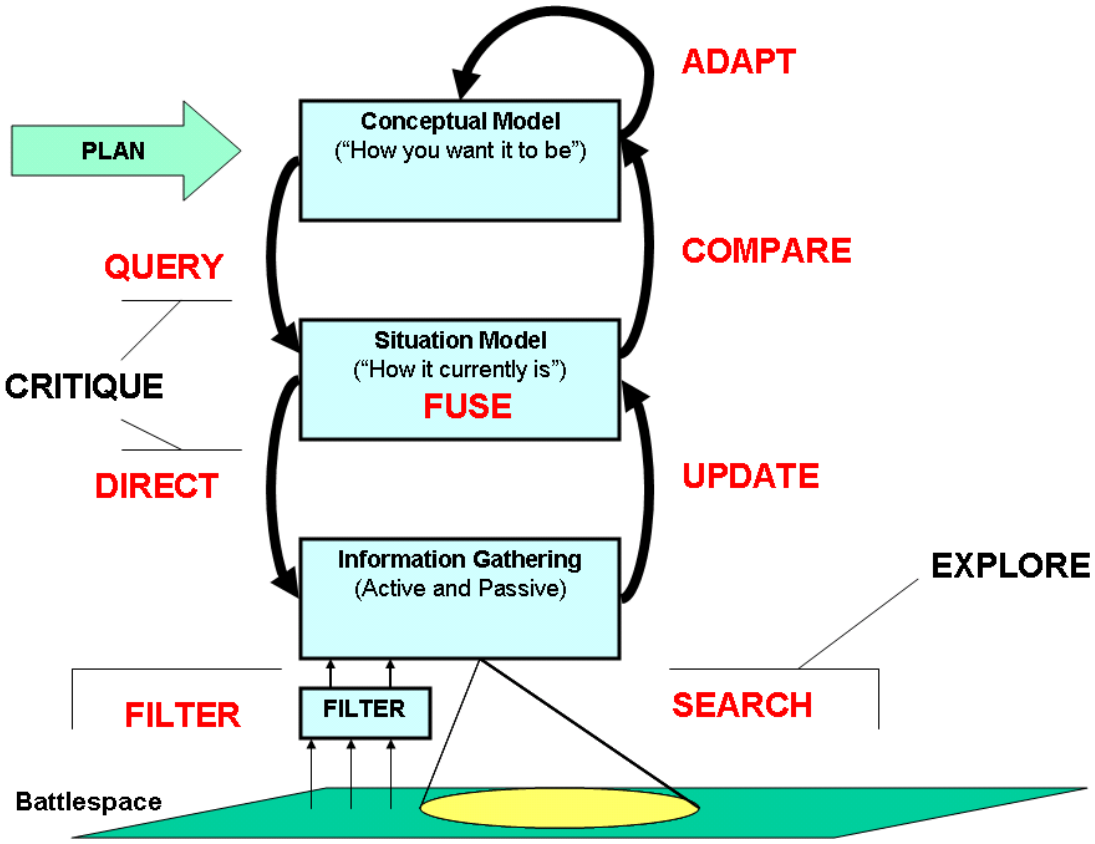

Figure 5 Categories of Processes in the CECA Framework.

The Query and Direct processes comprise Critiquing, whereas the Filter and Search processes map onto Exploration. The Update and Fuse processes describe the actions involved in building and maintaining the situation model. These processes bridge Exploration and Comparison. As illustrated in Figure 5, the processes describe either the activity "within" a box or the transfer of information from one box to another. That is, the Fuse and Adapt processes refer to actions taken to maintain the situation model or revise the conceptual model respectively. The other processes refer to either actions taken to direct how information is gathered and the situation model updated or actions that compare the situation and conceptual models.

Products produced by groups/agencies within the JSTAFF can be linked to these types of processes on the basis of the role they serve in JSTAFF functioning. JSTAFF groups/agencies produce a wide variety of information products. These products serve a variety of purposes, although most are shared among groups/agencies as a means of communicating information. These were identified from the source reports and classified with respect to the CECA framework process categories to link each product to a general purpose in the JSTAFF.

Table 2 lists the JSTAFF products and also indicates which type of JSTAFF process each is related to, as well as the source and recipient of the product

Table 2 JSTAFF Products.

JSTAFF Product	From:	To:	CECA Category
RMP	MARPAC/MARLANT	NDCC	Update
PIR	MARPAC/MARLANT	NDCC	Direct
EEI	MARPAC/MARLANT	NDCC	Direct
RFI	MARPAC/MARLANT	NDCC	Direct
Force Readiness Info	MARPAC/MARLANT	NDCC	Update
RAP	CADS	NDCC	Update
RAP	CADS	1 CAD/CANR	Update
Fused SA Products	1 CAD/CANR	NDCC	Update
PIR	1 CAD/CANR	NDCC	Direct
EEI	1 CAD/CANR	NDCC	Direct
RFI	1 CAD/CANR	NDCC	Direct
Force Readiness Info	1 CAD/CANR	NDCC	Update
Fused SA Products	1 CAD/CANR	CADS	Update
PIR	CF Int sources	NDCC	Direct
RFI	CF Int sources	NDCC	Direct
All source SA products	CF Int sources	NDCC	Update
RFI	Allied Int sources	NDCC	Direct
All source SA Products	Allied Int sources	NDCC	Update
Tasking Requests	Allied Int sources	NDCC	Direct
Collected, processed SR data	CF Surv & Recce Elements	NDCC	Update
Force Readiness Info	NDCC	CFJOG	Fusion
Requests for Info	NDCC	CFJOG	Direct
Fused SA Products	NDCC	CF Cont/Deplyd Ops	Update
RFI	NDCC	CF Cont/Deplyd Ops	Direct
Op Taskings	NDCC	CF Int Sources	Direct
All Source SA Products	NDCC	CF Int Sources	Update
RFI	NDCC	CF Int Sources	Direct
Op Taskings	NDCC	Allied Int Sources	Direct
All Source SA Products	NDCC	Allied Int Sources	Update
RFI	NDCC	Allied Int Sources	Direct
Taskings	NDCC	CF Surv & Recce Elements	Direct

Table 2 JSTAFF Products.

JSTAFF Product	From:	To:	CECA Category
Fused SA Products	NDCC	COS J3	Fusion
SA Briefing	NDCC	COS J3	Fusion
Fused SA Products	NDCC	MARPAC, MARLANT	Direct
Fused SA Products	NDCC	CADS, 1 CAD/CANR, CFNA	Direct
RFI	NDCC	CADS, 1 CAD/CANR, CFNA	Direct
EEI	NDCC	CADS, 1 CAD/CANR, CFNA	Direct
PIR	NDCC	CADS, 1 CAD/CANR, CFNA	Direct
Daily Global Situation Brief	NDCC & each JSTAFF element	Senior JSTAFF & all other JSTAFF element	Compare
Daily JSAT Meeting	Relevant JSTAFF element	Other JSTAFF elements & relevant OGDs	Fusion
Mission-specific Mini JSAT	Relevant JSTAFF element	Other JSTAFF elements & relevant OGDs	Fusion
SA Products	NDCC	Higher groups	Fusion / Compare
Daily Briefing Packages	NDCC	Senior JSTAFF	Fusion
Strategic Regional Assessment	NDCC	Senior JSTAFF	Fusion / Compare
JSTAFF Status updates	JSTAFF	COS J3	Compare
COS J3 Status Updates	COS J3	JSTAFF	Query
Awareness of potential or impending tasks	NDCC	COS J3	Fusion
Taskings & meeting schedules	COS J3	Lower groups	Direct
OPP Deliverables	??	Cos J3	Plan/Re-plan
OPP Deliverables	??	Chair (OPI)	Plan/Re-plan
JSTAFF/Chair (OPI) Status & Tasking Update	JSTAFF & Chair (OPI)	JSTAFF & Chair (OPI)	Query
CDS/DCDS Tasks	CDS / DCDS	COS J3	Direct
Op Taskings	COS J3	CF Surv & Recce Elements	Direct
CCIR	COS J3	CF Surv & Recce	Direct

Table 2 JSTAFF Products.

JSTAFF Product	From:	To:	CECA Category
		Elements	
Op Taskings	COS J3	CF Int Sources	Direct
CCIR	COS J3	CF Int Sources	Direct
Op Taskings	COS J3	Allied Int Sources	Direct
Op Logs	COS J3	NDCC	Query
Op Orders	COS J3	NDCC	Query
SA Products	COS J3	NDCC	Query
CCIR	COS J3	NDCC	Query / Direct
CCIR	COS J3	CF Cont/Deplyd Ops	Direct
Strategic Plans	COS J3	CF Cont/Deplyd Ops	Direct
Orders	COS J3	CF Cont/Deplyd Ops	Direct
Fused SA Products	COS J3	DCDS	Compare
EEI	COS J3	COS J3 Int	Fusion
Coord & Taskings	COS J3	CFJOG	Direct
Op Taskings	DCDS	COS J3	Query
CCIR	DCDS	COS J3	Query
Op Taskings	DCDS	CF Cont/Deplyd Ops	Direct
Military Strategic Direction	CDS	DCDS	Plan/Re-plan
Op Taskings	CDS	DCDS	Plan/Re-plan
CCIR	CDS	DCDS	Query
Military Strategic Direction	CDS	ECSs (CLS, CAS, CMS)	Direct
Strategic Guidance	ECSs (CLS, CAS, CMS)	CF Cont/Deplyd Ops	Direct
Force Readiness	ECSs (CLS, CAS, CMS)	NDCC	Update
RFI	ECSs (CLS, CAS, CMS)	NDCC	Direct

?? indicates that the source of products is unknown or inconsistent.

Table 3 presents a summary of JSTAFF processes categorized by CECA process. Top-down processes of Query and Direct generally involve products that take the form of requests for information and taskings or orders. Bottom-up processes of Update and Fuse generally involve products that take the form of SA products and briefings. The SA products are not defined in the sources consulted and they are likely to be diverse. Similarly, a wide range of topics is likely discussed at briefings. It is quite likely that data come in many disparate forms (e.g., text, graphics, video) and can cover virtually any topic as the JSTAFF themselves must be prepared to respond to any incident that poses a threat to national security.

Table 3 JSTAFF Product Summary.

CECA Process Category	Associated JSTAFF Products
Query	COS J3 Status Updates JSTAFF/Chair (OPI) Status & Tasking Update Op Logs Op Orders SA Products CCIR Op Taskings
Direct	PIR EEI RFI Tasking Requests Op Taskings Taskings & meeting schedules CCIR Strategic Plans Orders Coord & Taskings Military Strategic Direction Strategic Guidance
Filter*	N/A
Search*	N/A
Update	All source SA products RMP Force Readiness Info RAP Fused SA Products Collected, processed SR data
Fuse	Force Readiness Info Fused SA Products SA Briefing Fused SA Products Daily JSAT Meeting Mission-specific Mini JSAT Daily Briefing Packages Strategic Regional Assessment
Compare	Daily Global Situation Brief Strategic Regional Assessment JSTAFF Status updates Fused SA Products
Adapt	OPP Deliverables Military Strategic Direction Op Taskings

* The processes of Search and Filter were assumed to lie outside the primary interest of the JSTAFF

Although the Compare and Adapt processes employ products such as briefings, assessments, taskings, and strategic direction summaries, these processes should comprise the creative and problem solving activities of the JSTAFF. As such, the kinds of products indicated, aside from the Strategic Regional Assessment and OPP Deliverables, do not seem to be fully representative of creative processes.

The source materials consulted do not provide sufficient detail to fully specify the content of each product. An important step in developing the JSTAFF model will be identifying the purpose, content, and format of all communications so that they can be more precisely linked to CECA processes.

Communication Channels

Based on the listing of products in Table 2, it is possible to depict the lines of communication among the relevant entities of the JSTAFF. In doing so, the bottom-up and top-down flows of information can be more clearly identified. Figure 6 presents an illustration of the JSTAFF with the groups/agencies arranged by their level in the CECA framework. The top level, consisting of the DMND, MND DCDS, CDS, AMNDM S-CP, and ECSs, corresponds to the conceptual level. These groups/agencies conduct planning and set strategic direction. In terms of the CECA framework, their role is to build and adapt the conceptual model for the operation. The middle level, consisting of the COS J3, NDCC, CFJOG, CF Cont, and CF Deployed, correspond to the situation awareness level. These groups/agencies are responsible for creating the best situational awareness possible given the information available. In terms of the CECA framework, they take in information and maintain situation awareness for the entire JSTAFF. The COS J3 is shown at a slightly higher level to indicate its special role as a bridge between the situation awareness and conceptual levels. The COS J3 contributes to development of both a conceptual model for the operation and situation awareness.

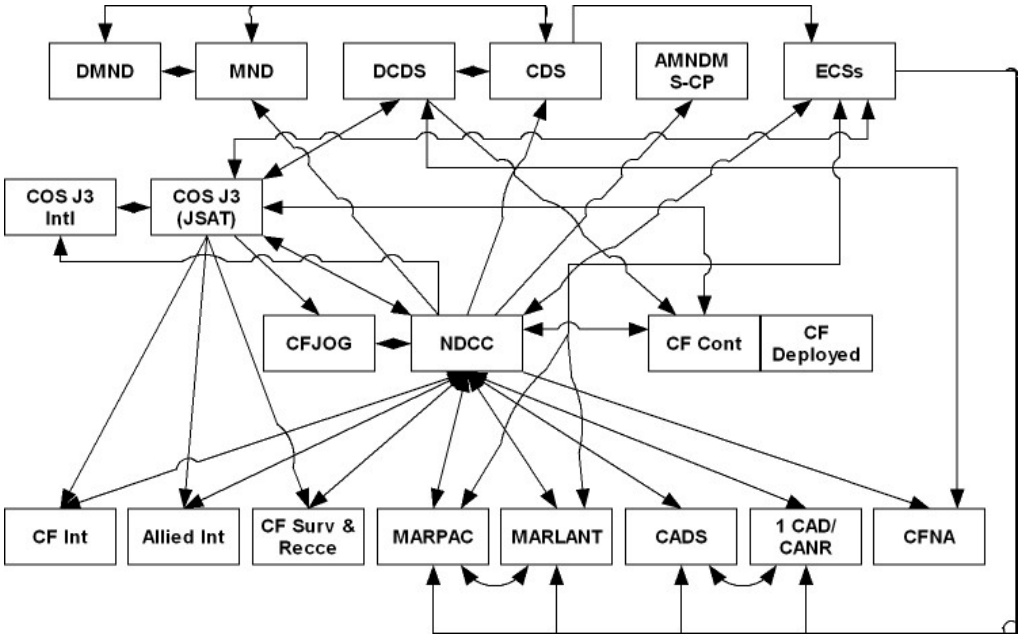

Figure 6 Communication Links in the JSTAFF Model.

The bottom level, consisting of CF Int, Allied Int, CF Survey and Reconnaissance, MARPAC, MARLANT, CADS, 1 CAD/CANR, and CFNA, correspond to the sensor level of the CECA framework. They provide information to the situation awareness level, although there are some direct links to the conceptual level. The CFNA, for example, has a direct link to the DCDS and MARPAC, MARLANT, CADS, and 1 CAD/CANR all link directly to ECSs.

Inspection of Figure 6 indicates that the NDCC plays the most significant role in maintaining situation awareness, although the COS J3 is also important. Information from virtually all sources must pass through the NDCC in order to affect situation awareness and, ultimately, the conceptual level groups/agencies. An exception is the CFNA, which communicates directly with the DCDS. The COS J3 is closely linked to the NDCC but receives information directly from CF Int, Allied Int, and CF Survey and Reconnaissance. The COS J3 also serves as the link between the NDCC and DCDS, thereby coordinating communication of situation awareness up to the conceptual level and propagation of higher intent down to the situation awareness level. The NDCC does communicate directly to the CDS and MND but it is unclear the extent to which these communications represent integral parts of the collaborative decision making process among groups/agencies at the conceptual level.

Although the NDCC is a central point in the communication of data and formulation of SA, it does not produce a single, integrated product that represents that SA. In the CECA framework, SA is captured by a situation model but this situation model is not intended to be a simple piece of terminology for individual SA. Rather, it is intended to be a sharable representation of the operational environment. Thus, a major potential deficiency of the NDCC is that it does not produce a sharable situation model, leaving its "clients," those

higher groups/agencies reliant on NDCC for SA and those lower groups/agencies in need of direction concerning information needs and strategic direction, to form individual SA that may or may not correspond to that of others in the JSTAFF. A single situation model does not guarantee that everyone shares the same understanding of the situation – indeed, it is impossible for every individual to share exactly the same mental model – but it helps everyone frame the situation according to the same parameters and provides a tool for achieving consensus and resolving differences in understanding.

It is unclear how the groups/agencies at the conceptual level collaborate in planning and exercising C^2 for an exercise. The DCDS appears to be the primary client for situation awareness and may produce the conceptual model used by all conceptual level groups/agencies. The NDCC, however, does send SA products to all conceptual level groups/agencies, meaning that they may form somewhat different understandings of the operational situation, depending on which SA products are transmitted and how those products are interpreted.

An issue not fully addressed in the source materials is the extent to which JSTAFF products facilitate teamwork within groups/agencies. The large number of different information products suggests that there exists the potential for inefficiencies and confusion in building common SA among the groups/agencies making up the JSTAFF.

Divergences from the CECA Framework

Although the organization of the JSTAFF parallels that of the CECA framework in several key ways, there are some discrepancies. These discrepancies reflect differences from the CECA framework in the sense that a) the information processing in the JSTAFF is not in line with the cognitive principles at the heart of the CECA framework, or b) the JSTAFF structure does not facilitate individual information processing or mental representation. These discrepancies could present barriers to effective performance by impairing the maintenance of SA, the propagation of shared intent, and the comparison of the situation and conceptual models.

Central and Comprehensive Models

A key feature of the CECA framework is the continual coordination of the conceptual and situation models. Effective control and adaptation to unforeseen events depends on this coordination, which in turn depends on having complete and accurate conceptual and situation models. In the existing JSTAFF organization, however, there are no products that directly correspond to the conceptual and situation models. Rather than having single comprehensive representations of the plan/commander's intent and the operational situation, the JSTAFF relies on multiple, fragmentary products to describe these. This discrepancy suggests that individuals working in various JSTAFF groups/agencies may have difficulty building and maintaining good SA or identifying critical information needs. The absence of comprehensive models limits communication, comparison, and collaboration within the JSTAFF as knowledge is piecemeal and must be integrated by each individual.

The situation model of the JSTAFF is represented by various products that include fused SA products, SA briefings, and JSAT meetings. The goal of the situation model is to facilitate common understanding of the situation in a timely fashion. Multiple products undermine the development of common understanding and reduce its timeliness by requiring individuals to seek and integrate information. A significant challenge in developing SA becomes the collating of data from separate sources to determine which bits are redundant. A single, comprehensive product – an external model of the situation – could serve as a cognitive tool to help individuals apprehend the situation rapidly. Although work would have to be done to build and maintain such an external model, subsequent users of the model would not have to perform extensive integration of source data. C4ISR software such as CommandView could evolve to support comprehensive situation modeling.

The conceptual model of the JSTAFF is represented by various products that include OPP products, JSTAFF status updates, COS J3 status updates, Op Orders, and Op Taskings. As with the situation model, there is no single cohesive external product to represent the conceptual model. The CECA framework argues for a single, unified representation of operational plans and commander's intent that are available to all groups/agencies. Also in contrast to the CECA framework, which represents the conceptual and situation models in a common, goal-oriented format, the JSTAFF conceptual model is represented in a different way than the situation model. Whereas the products that represent the situation model (SA products, etc.) focus on the state of the operational environment, the products that serve to

represent the JSTAFF conceptual model tend to focus on actions (especially orders). Given that the comparison of the situation and conceptual models is the basis for adaptation, the mismatch in how the two are represented by the JSTAFF could have serious implications for planning and decision making performance. Projected goal states should be the focus of representation in the conceptual model because it is those states that are the objective of an operation. Actions serve as means to bring about goal states. Thus, in comparing the conceptual and situation model, one wants to know to what extent the current situation differs from the state that has been projected in the conceptual model. Where differences in states occur, decision makers can determine what actions are appropriate to move the environmental situation in line with the objective. The JSTAFF conceptual model could be made more useful by representing it in terms of goal steps leading to the ultimate desired state at the end of the operation.

Given the current state of C4ISR support tools, the comparison of the conceptual model (i.e. plans, strategic direction) to the situation model is not being supported to the same extent as SA alone. Although efforts are underway to develop tools to aid in sharing information, synchronization of data fusion, and online communications, there does not seem to be a concerted effort to develop tools that support the side-by-side comparison of a conceptual model of the operation to a situation model of the operational environment. Such a comparison tool would be a tremendous benefit to the capability of the JSTAFF to rapidly adapt in the face of evolving events.

Multiple Overlapping Information Products

As noted above, information moving up the organisation to describe the situation and information moving down to propagate the operational plan and commander's intent are represented by multiple products. In part, this is a result of the need to continually update the groups/agencies in the organisation concerning the evolving situation and changes in the plan. The proliferation of information products, however, also results from differences in ways of capturing and formatting information employed by the various groups/agencies making up, and working with, the JSTAFF. Reports from these groups/agencies tend to reflect the perspectives of those groups/agencies. Moreover, information referring to different aspects of the situation or operational plan tends to get split up into multiple products, each of which focuses on a single aspect of the whole. In other words, there is little emphasis on integration in the transmission of information, which is nonetheless a key requirement for SA.

The transmission of information through multiple, separate products poses problems at the organisational and individual levels. At the organisational level, information flow is complicated by the requirement to manage multiple, redundant products, which also hamper collaboration as there is no single common reference for the whole operation. More importantly, the diversity of groups/agencies at the sensor level make it more difficult and time-consuming to exercise top-down guidance of information gathering. The JSTAFF must send requests for information and guidance to each sensor-level group/agency and ensure that all groups/agencies are "on the same page" with respect to the JSTAFF's information needs. First, the formation and maintenance of SA is impaired. At the individual level, the presence of multiple SA products makes it harder for people to develop a coherent mental representation of the situation. With many information products being transmitted among

groups/agencies, a fair degree of effort is required of each individual to create his/her own SA and mental representation of the operational plan.

It is important that sensor-level groups/agencies be free to transmit information freely in order to alert the JSTAFF to important events. The coordination of that information, however, should be treated carefully. The NDCC is the primary nexus for sensor-level information but is concerned with integrating information to build SA rather than giving guidance to sensor-level groups/agencies or filtering data. Just as the COS J3 plays a facilitating role in coordinating interaction of the NDCC with the conceptual level groups/agencies (DCDS, etc.), there seems to be a role for some entity to serve as a bridge between the NDCC and sensor-level groups/agencies. This entity would be responsible for integrating all requests for information coming down from the conceptual level and issuing concise and timely direction and guidance to sensor-level groups/agencies. It would also act as a filter to screen information coming up from the sensor level to eliminate irrelevant and redundant inputs.

Multiple Groups/agencies Make Up Functional Levels

Although the JSTAFF parallels the CECA framework, the groups/agencies that make up JSTAFF are not specifically aligned to the CECA framework. Table 4 shows the groups/agencies that make up each level. At the conceptual level, the MND and DMND make up one of the primary groups and the CDS and DCDS the other. The AMNDM S-CP and ECSs also contribute to this level but are not central. The SA level is, perhaps, the most integrated. The NDCC serves as the sole primary agency at this level, although CFJOG and CF Cont and CF Deployed headquarters also contribute. Eight or more agencies serve as primary contributors to the sensor level.

Table 4 Groups and Agencies Within the CECA Framework.

CECA Level	Primary		Adjunct
Conceptual Level	MND DMND	CDS DCDS	AMNDM S-CP ECSs
SA Level	NDCC		CFJOG CF Cont/Deployed
Sensor Level	CF Int Sources CF Surv & Recce MARPAC MARLANT	Allied Int Sources CADS 1 CAD/CANR CFNA	

Although groups/agencies work closely within the three levels, the separation of working elements nevertheless disrupts the coherence of activity. This must be especially true at the sensor level where the numerous groups/agencies likely have little insight into what the others are doing. The groups/agencies making up the sensor level are not strictly part of the JSTAFF but coordinating their activities, or at least their inputs to the JSTAFF, will be a significant

challenge. Where multiple groups/agencies work together at the same level, they must attempt to integrate their activities.

Although the separation of groups/agencies within the JSTAFF stands in contrast to the CECA framework, it is a necessary structure given the broad mandate and global area of interest of the JSTAFF. Unlike an individual attempting to assess the situation, the JSTAFF must make use of numerous distinct entities to gather data. It is more reasonable to expect a single entity will be responsible for assembling data to create a situation model and, indeed, the NDCC primarily serves that role. Division at the strategic level is necessitated by the distinction between the command structure of the DND and that of the civilian government.

Indirect Control of Sensors

Given that the groups/agencies at the sensor level are not under the direct management of the JSTAFF, communicating information needs is of paramount importance. Adaptation in the face of an evolving operation/event requires the JSTAFF to critique its operational plan and identify critical elements that could invalidate it. By identifying these elements, the JSTAFF can direct its sensors to rapidly gather data pertinent to the critical elements, allowing rapid evaluation and adaptation, if necessary.

The lack of direct control reduces the JSTAFF's ability to get required information quickly. Working with multiple independent groups/agencies also makes it more difficult to effectively communicate those information needs. Even if they can be communicated to one group/agency, another may not be able to understand them and further effort would have to be devoted to reformulating the information needs in a way that is understood. These problems could be mitigated, at least partially, by an effort to develop inter-agency standards for communications, computer compatibility, and data handling procedures.

Discussion

The JSTAFF functions in a way that is consistent with the CECA framework. Specifically, the JSTAFF, as a whole, functions to create a strategic direction (conceptual model) that directs the search for information. The information updates a situation model that can be compared to the conceptual model, which can then be adapted as needed. Various groups within the JSTAFF or agencies that interact closely with the JSTAFF perform these functions. Some, at the sensor level, provide information input, whereas others (primarily the NDCC) at the situation modeling level fuse and interpret information to create a unified understanding of the situation. Still other groups at the conceptual level plan and update the strategic direction. These groups/agencies communicate in various ways, including the exchange of formal products.

The main points of difference between the JSTAFF and the CECA framework are the apparent absence of coherent, physical situation and conceptual models and the diffuseness of information gathering and communication within the organisation. According to the CECA framework, developing a conceptual model allows the organisation to represent its plan in a single, shareable format that concentrates on laying out the objectives of the organisation. Given the current JSTAFF structure and planning processes, there is no direct analogue to the CECA-defined conceptual model. It is unclear to what extent groups/agencies at the conceptual level interact and plan in a collaborative fashion but it is clear that there is no central and widely available product that represents the plan. The NDCC serves as a focal point for developing situation awareness but, again, there seems to be no central product that fills the role of the situation model. Thus, the JSTAFF relies on shared mental representations to achieve shared intent and shared awareness. The weakness of this is that mental representations cannot be directly compared and their degree of correspondence cannot be quantified.

The lack of physical situation and conceptual products is both symptomatic of, and causally related to, the diffuse nature of communication in the JSTAFF. As mentioned, there is some organisation of functions that allow the groups/agencies making up the JSTAFF to take on specialized roles. In particular, the NDCC and COS J3 are central players in building situation awareness. It is clear, however, that numerous communication channels exist among groups/agencies within and between levels in the organisation. Highly interconnected communication channels have become popular in C^2 thinking under the general rubric of network-enabled operations. The power of networks comes from their capability to re-organize cells and their functions to produce adaptive behaviour. In the JSTAFF, however, groups/agencies are not multi-functional cells. Rather, they retain fairly restrictive mandates and have limited freedom of action. Moreover, there exists a strong chain of authority from the MND. Providing groups/agencies with highly interconnected channels along which information can flow does not produce an adaptive network without corresponding channels along which authority and responsibility can flow.

The JSTAFF differs from the CECA framework primarily in its multiple communication paths and multiple products at the conceptual and situational levels. With many lines of communication bringing in sensory data, there is a real potential for confusion, mis-representation of data, and loss of information. Similarly, multiple paths exist for

communicating strategic plans and information needs down, which could lead to inconsistent accuracy and efficiency in guiding SA development. The CECA framework, however, describes, in a sense, an ideal C^2 system. Given that the JSTAFF comprises numerous groups/agencies, some of which are outside the government, it may not be possible to completely integrate communication channels. The JSTAFFwould likely have more success in developing single products that correspond to the conceptual and situation models and sharing them among groups/agencies. Increasingly powerful and sophisticated computer networks allow for shareable knowledge bases in which plans, situation representations, orders, etc. can be accessed.

Although discrepancies between the JSTAFF and CECA framework do not necessarily indicate problems in the JSTAFF, the efficiency of communication and information representation do seem to be areas that could be improved. Whereas the overall structure of the JSTAFF assigns fairly clear roles to groups/agencies at the sensory, SA, and strategic planning levels, these groups/agencies do not seem to be optimally interconnected to smoothly take in data, transform it into SA, and use that SA to guide planning.

Situation and Conceptual Models

Adaptive planning and execution are accomplished in the CECA framework by the comparison of a unique and comprehensive situation model with a unique and predictive conceptual model. Thus, the conceptual model establishes testable assumptions and expectations that guide data acquisition and the situation model establishes the most complete and accurate representation of the operational environment possible. Given these two models, it is possible to identify where discrepancies exist between assumptions and expectations and the state of the real world, assess the impact of those discrepancies, and determine appropriate changes to the conceptual model. The effectiveness of the feedback loop depends on the completeness and accuracy of these models and the efficiency of the feedback loop on the coherence of the models.

Completeness and accuracy of the situation model is promoted by extensive and deep critiquing of the conceptual model. “Critiquing” covers a wide range of comparative and analytic processes (see [19]). In this context, the term is taken to refer to any and all processes that question the assumptions and logic of the conceptual model to develop information needs, especially information needs pertaining to testing the necessary conditions for the validity of the conceptual model (see [1]).

The efficiency of the feedback loop depends on the ease with which all aspects of the situation and conceptual models can be compared. This in turn depends on how centralised are the models within the organisation. When information and knowledge are fragmented across individuals and groups, it is difficult to adequately compare the situation to the conceptual model. Moreover, it is difficult to monitor the comparison process to assess how well and how completely it has been performed. Having a single or unique situation model that includes all available information allows for a single, controllable comparison to the conceptual model.

The JSTAFF model developed here lacks sufficient detail to fully characterise the nature of situation and conceptual models created by the JSTAFF or the processes by which they are updated and compared. It seems clear that the JSTAFF does not maintain single, unique, and coherent models as actual products. Rather, groups and agencies communicate information and conduct briefings and meetings to ensure the wide distribution of information. This distribution, along with explicit forums for interaction among groups/agencies, is intended to promote shared understanding. What remains unclear is how well the objective of shared understanding is met in the face of fragmentary information sharing.

Several questions should be answered to represent how the JSTAFF represents the situation and coordinates their plans with operational events. These questions include:

- Is there a single, shared situation model within the JSTAFF?
- In what form is the situation model represented?
- Who maintains the situation model?
- What processes are used to create and update the situation model?
- What mechanisms are in place to ensure shared understanding?

The same questions can be posed with respect to the conceptual model, along with the question of how the conceptual and situation models are compared as part of monitoring the success of operational plans.

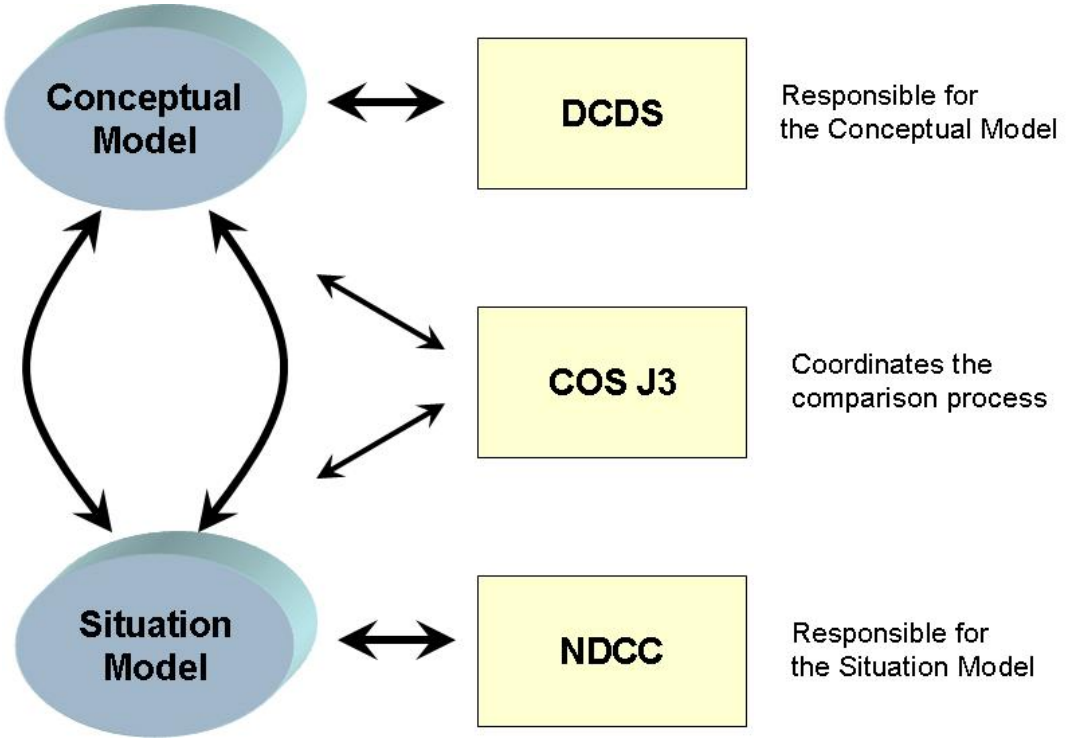

Figure 7 Proposed Use of Single, Centralised Conceptual and Situation Models.

The CECA framework can provide a guide to the organisation of the JSTAFF, which could potentially enhance its effectiveness by adopting formal information products that correspond to the conceptual and situation models. These products would serve as both working tools for conceptual and situation awareness levels of the JSTAFF and as media in which to compare the evolving operational environment (situation model) to operational plans (conceptual model). This is illustrated in Figure 7, which depicts the DCDS as responsible for maintaining the conceptual model and the NDCC for the situation model.

If the CECA framework is adopted, a conceptual model should be formalised in a support tool or system that facilitates operational planning as well as the graphic representation of plans. Thus, it serves two purposes: aiding the conceptual level groups/agencies in planning and communicating direction to lower formations. The situation model should formalise the integrated picture developed by the NDCC and serve as a comprehensive model for the operational environment. Thus, the situation model is the reference for all elements of JSTAFF.

Conceptual and situation model products can facilitate the comparison process to the extent that the models are represented in the same format. That is, the conceptual model should be goal-oriented and describe projected states of the environment to be achieved. These projected states can be compared to the state of the actual operational environment represented in the situation model at any point in time. This allows discrepancies between the current situation and desired state of the operational environment to become readily apparent and help planners in adapting to the situation.

C4ISR Applications

Effective C^2 demands a knowledge management tool that allows the comparison of comprehensive situation and conceptual models. Such a tool should provide a number of benefits:

- Common representations across distributed elements: A single, central knowledge management tool allows the organisation to create representations of the operational plan (conceptual model) and of the situation (situation model), which supports common understanding among distributed teams and individuals;
- Integrated models: A single, central knowledge management tool can support data fusion and information integration functions that assist teams and individuals in mental representation of knowledge and reduce the cognitive effort needed;
- Comparison of situation and conceptual models: A single, central knowledge management tool facilitates the representation of the operational plan and situation in compatible formats so they facilitate point-by-point comparison; and
- Communication across a distributed organisation: A single, central knowledge management tool provides a focus for all communication that all teams and individuals can refer to, as well as integrated models that preserve the operational history.

Current C4ISR applications could meet the need for knowledge management. CommandView, for example, is a software application developed by Thales Raytheon

Systems that acts as a “knowledge portal” for distributed C4ISR organisations. It is intended to serve as a tool to aid operators in information integration, situation assessment, and communication. The effectiveness of any C4ISR application will depend on its fit to the operational environment.

References

[1] Bryant, D.J. (2003). *Critique, Explore, Compare, and Adapt (CECA): A new model for command decision-making*. DRDC Toronto (TR 2003-105). Toronto, Ontario: Defence R&D Canada – Toronto, Department of National Defence.

[2] Cook, T. M., Leedom, D. K., Grynovicki, J. O., & Golden, M. G. (2000). *Cognitive representativeness of battlespace complexity: Six fundamental variables of combat* (Final Report ARL-TN-155). Aberdeen Proving Ground, MD: Army Research Laboratory, Human Research and Engineering Directorate.

[3] Jansson, A. (1999). Goal achievement and mental models in everday decision making. In P. Juslin & H. Montgomery (Eds.), *Judgment and decision making: Neo-Brunswikian and process-tracing approaches* (pp. 23-43). Mahwah, NJ: Lawrence Erlbaum Associates.

[4] Newell, A., & Simon, H. A. (1972). *Human problem solving*. Englewood Cliffs, NJ: Prentice-Hall.

[5] Peschl, M. F. (1992). The art of constructing knowledge in natural and artificial cognitive systems from the perspective of computational neuro-epistemology. *Cognitive Systems, 3*, 219-240.

[6] Rock., I. (1993). *The logic of perception*. Cambridge, MA: The MIT Press.

[7] Johnson-Laird, P. N. (1983). *Mental models*. Cambridge, MA: Harvard University Press.

[8] Fiore, S. M., Salas, E., & Cannon-Bowers, J. A. (2001). *Group dynamics and shared mental model development*. In M. London (Ed.), How people evaluate others in organizations. Applied in psychology (pp. 309-331). Mahwah, NJ: Lawrence Erlbaum Associates.

[9] Moray, N. (1999). *Mental models in theory and practice*. In D. Gopher & A. Koriat (Eds.), Attention and performance XVII: Cognitive regulation of performance: Interaction of theory and application (pp. 223-258). Cambridge, MA: The MIT Press.

[10] Rouse, W. B., Cannon-Bowers, J. A., & Salas, E. (1992). The role of mental models in team performance in complex systems. *IEEE Transactions on Systems, Man and Cybernetics, 22*(6), 1296-1308.

[11] Hatano, G., & Inagaki, K. (2000). *Knowledge acquisition and use in higher-order cognition*. In K. Pawlik & M. R. Rosenzweig (Eds.), International handbook of psychology (pp. 167-190). London, England: Sage Publications.

[12] Cohen, M. S., Freeman, J. T., & Thompson, B. (1998). *Critical thinking skills in tactical decision making: A model and a training strategy*. In J. A. Cannon-Bowers & E. Salas (Eds.), Making decisions under stress: Implications for individual and team training (pp. 155-189). Washington, DC: American Psychological Association.

[13] Emilio, G. (2000). *Promoting critical thinking in professional military education* (Research Report AU/ACSC/058/2000-04). Maxwell AFB, AL: Air Command and Staff College.

[14] Riedel, S. (2001). *Training critical thinking skills for battle command: ARI workshop proceedings* (Final Report). Alexandra, VA: Army Research Institute for the Behavioral and Social Sciences.

[15] Cunningham, K. (2000). *Bounded rationality and complex process coupling: Challenges for intelligence support to information warfare* (Strategic Research Report). Carlisle Barracks, PA: Army War College.

[16] Canadian Forces Command System (2002). Process models for the CF strategic and operational planning process and the DCDS decision making process in support of operations. Department of National Defence.

[17] Greenley, A., Baker, K., & Greenley, M. (2005). *Joint Staff: Joint Staff Business Processes.* DRDC Valcartier Contractor Report (CR 2005-041). Greenley & Associates Incorporated, Ottawa, Ontario, Canada.

[18] Greenley, A., Baker, K., & Cochran, L. (2005). JSTAFF Front End Analysis Data Analysis Report (FFSE Task 147). DRDC Valcartier Contractor Report (DRAFT). Greenley & Associates Incorporated, Ottawa, Ontario, Canada.

[19] Irandoust, H. (2006). *Critiquing systems for decision support*. DRDC Valcartier (TR 2003-321). Valcartier, Quebec: Defence R&D Canada – Valcartier, Department of National Defence.

List of symbols/abbreviations/acronyms/initialisms

1 CAD/CANR	1 Canadian Air Division/Canadian NORAD (North American Aerospace Defence Command) Region
AMNDM S-CP	Associate Minister of National Defence and Minister of State (Civil Preparedness)
C^2	Command and Control
C4ISR	Command, Control, Communications, Coordination, Intelligence, Surveillance, and Reconnaisance
CADS	Canadian Air Defence Sector
CAS	Chief of Air Staff
CCIR	Commander's Critical Information Requirements
CDS	Chief of Defence Staff
CECA	Critique-Explore-Compare-Adapt
CF	Canadian Forces
CF JOG	Canadian Forces Joint Operation Group
CFCS	Canadian Forces Command Systems
CFNA	Canadian Forces Northern Area
CLS	Chief Land Staff
CMS	Civil-Military Support
COA	Course of Action
CONOPS	Concept of Operations
Cont	Continental
COS	Chief of Staff
COS J3	Chief of Staff J3
CW	Collaborative Working
DCDS	Deputy Chief of Defence Staff
Dep	Deployed
DGOR	Director General Operational Research
DJFC	Director Joint Force Capability
DMND	Deputy Minister of National Defence
DND	Department of National Defence
DoDAF	Department of Defence Architectural Framework
DRDC	Defence Research & Development Canada
DSM	Decision Support Matrix
DST	Decision Support Template
DST	Decision Support Template
EBA	Effects-based Approach
ECOA	Enemy Course of Action
ECSs	Environment Chiefs of Staff
EEI	Essential Elements of Information
FCOA	Friend Course of Action
FFIR	Friendly Force Information Requirements
FNA	Functional Needs Analysis
G3	General Staff 3

GSB	Global Situation Brief
IM	Information Management
Int	Intelligence
Intl	International
IO	Intergovernmental Organizations
IR	Information Requirement
J2 IM	J2 Information Management
JCDS 21	Joint Command and Decision Support 21
JIIFC	Joint Intelligence Information Fusion Capability
JIMP	Joint, Interagency, Multinational and Public
JSAT	Joint Staff Action Team
JSTAFF	Joint Staff
LF	Land Force
MARLANT	Maritime Forces Atlantic
MARPAC	Maritime Forces Pacific
MDMP	Military Decision Making Process
MND	Minister of National Defence
NDCC	National Defence Command Centre
NEOps	Network Enabled Operations
NGO	Non-governmental Organizations
OODA	Orient-Observe-Decide-Act
Op O	Operations Order
Op Tasking	Operational Tasking
OPI	Office of Primary Interest
OPP	Operational Planning Process
OPP	Operations Planning Process
OV	Operational View
PIR	Priority Intelligence Requirement
PSEPC	Public Safety and Emergency Preparedness Canada
PSTP	Public Security Technical Program
RAP	Recognised Air Picture
Recce	Reconnaissance
RFI	Request for Information
RMP	Recognised Maritime Picture
SA	Situation Awareness
SAR	Search and Rescue
SITREP	Situation Report
SOC	Strategic Operating Concept
SRA	Strategic Regional Assessment
TD	Technology Demonstration
TF	Task Force
Wng O	Warning Order

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This report describes a model of decision-making and collaboration within the Joint Staff (JSTAFF). The model was developed within the Critique-Explore-Compare-Adapt (CECA) framework [1], which incorporates important aspects of human cognition. The model was created by identifying correspondences between JSTAFF elements and the CECA framework in terms of information products, groups/agencies making up the JSTAFF, and the processes for creating, maintaining, updating, and transferring information products. The JSTAFF organization proved well-suited to the CECA framework. It was possible to readily identify numerous points of contact between the two in terms of the groups and agencies making up the JSTAFF, the processes used to perform the JSTAFF's functions, and the products that served as physical instantiations of those processes. The JSTAFF diverges from the CECA framework, however, in several key ways. Most notably, there are no products that directly correspond to the conceptual and situation models, which limits communication, comparison, and collaboration within the JSTAFF. It is suggested that the JSTAFF needs formal information products that correspond to the conceptual and situation models. The conceptual model should be formalised as a support tool or system that facilitates operational planning and the graphic representation of plans. The situation model should be formalised as an integrated picture developed by the National Defence Command Centre (NDCC) and thereby serve as a comprehensive model for the operational environment.

Le présent compte **rendu porte** sur un modèle de prise de décision et de collaboration au sein de l'état-major interarmées (EMI). Le modèle a été élaboré autour du cadre Critiquer, Explorer, Comparer et Adapter (CECA) [1] qui renferme des aspects importants de la cognition humaine. Il a été créé à partir des correspondances identifiées entre divers éléments de l'état-major interarmées (EMI) et le cadre CECA en matière de produits d'information, des groupes/agences qui forment l'EMI ainsi que des processus de création, de maintenance, de mise à jour et de transfert des produits d'information. L'organisation de l'EMI s'est avérée tout à fait appropriée au cadre CECA. Nombre de points de référence qui les relient ont facilement pu être identifiés, notamment les groupes et les agences qui forment l'EMI, les processus utilisés pour exécuter les fonctions de l'EMI et les produits qui ont servi d'instanciations physiques de ces processus. L'EMI diffère cependant du cadre CECA sur plusieurs points. Notamment, aucun produit ne correspond directement aux modèles conceptuel et situationnel, un aspect qui restreint la communication, la comparaison et la collaboration au sein de l'état-major interarmées (EMI). On estime que l'EMI a besoin de produits d'information qui correspondent aux modèles conceptuel et situationnel. Le modèle conceptuel doit être organisé comme un outil ou un système de soutien facilitant la planification opérationnelle et la représentation graphique de plans. Le modèle situationnel doit être organisé en un tableau intégré élaboré par le Centre de commandement de la Défense nationale (CCDN) et servir de modèle global pour l'environnement opérationnel.

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CECA; Joint Staff; organisational model

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