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Report on Final Lance

Canadian Forces College (May 23rd - June 7th, 2000)

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DRDC Valcartier

Defence R&D Canada – Valcartier
Technical Memorandum
DRDC Valcartier TM 2004-222
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Authors

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Abstract

The participation as observers in a Theatre-level joint operational planning exercise – Final Lance (which was held in CFC from 23 May to 7 Jun 2000) allowed DRDC Valcartier defence scientists to better understand the operational planning process and the actual capabilities available to military officers to accomplish this process.

The report includes a brief overview of the Canadian Forces Operational Planning Process (CFOPP) and a description of the Final Lance exercise. It then describes the authors' observations of the execution of the planning process in this exercise, and concludes with ideas for possible future collaboration with CFC Toronto.

Résumé

En participant comme observateur à l'exercice de niveau théâtre d'opération Final Lance (qui a eu lieu du 23 mai au 7 juin 2000 au Collège des Forces canadiennes à Toronto), les scientifiques de RDDC Valcartier ont amélioré leur compréhension du processus de planification opérationnel ainsi que des moyens disponibles pour faciliter l'exécution de ce processus.

Ce rapport présente, dans un premier temps, une vue d'ensemble du processus de planification opérationnel des Forces canadiennes. L'exercice Final Lance est par la suite brièvement décrit afin de pouvoir poursuivre avec un ensemble d'observations concernant l'exécution du processus de planification opérationnel réalisées dans le cadre de cet exercice. Finalement, on conclut par des idées de collaboration future possible avec le Collège des Forces à Toronto.

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Executive summary

Final Lance is an annual exercise organised by the Canadian Forces Staff College of Toronto (CFC Toronto) to train military students in the application of the Canadian Forces Operational Planning Process. In this document, we report on the exercise, the different automated tools used by CFC, and possible areas of collaboration between DRDC Valcartier and CFC. Final Lance is based on a scenario of fictitious crisis happening on a continent called Atlantis. This crisis is the result of years of tenseness that erupted into armed conflict. The UN made a formal request to the Alliance Council to solve the conflict between Orangeland/Redland and Blueland. The Alliance is an international military alliance in a parallel world composed of many European and North of American nations. This alliance has a political organisation called the Council and a military headquarter called Major Alliance Strategic Command (MASC). The exercise is mostly limited to the operational level with some tactical planning. The exercise implied the analysis of the situation, the development of Courses Of Action (COAs), the analysis and the selection of the COAs, and finally campaign planning. This document presents our observations related to some of these exercise steps, and some description of the ADAMS (Allied Deployment and Movement System) and ITEM (Integrated Theatre Engagement Model).

Guitouni, A., Bélanger, M., Berger, J., Morrissey, D. 2006. Report on Final Lance: Canadian Forces College (May 23rd – June 7th, 2000). DRDC Valcartier TM 2004-222.

Sommaire

Final Lance est un exercice annuel organisé par le Collège des Forces canadiennes de Toronto (CFC Toronto) afin d'entraîner les étudiants à appliquer les différents concepts de planification opérationnelle. Ce document consigne des observations à propos de l'exercice, les différents outils informatiques utilisés et la possibilité de collaboration entre DRDC Valcartier et le CFC Toronto. Final Lance repose sur un scénario de crise fictive qui se déroule sur un continent appelé Atlantis. Cette crise est le résultat d'années de tension qui ont résulté en un conflit armé. Les Nations Unies ont demandé au Conseil de l'Alliance d'envisager une intervention militaire afin de résoudre le conflit entre la coalition Orangeland/Redland et Blueland. L'Alliance est une alliance militaire internationale dans un «monde parallèle» regroupant plusieurs pays d'Europe et d'Amérique du Nord. Cette alliance a une organisation politique appelée le Conseil et un quartier général militaire suprême appelé Major Alliance Strategic Command (MASC). L'exercice est principalement limité au niveau opérationnel avec peu de planification tactique. L'exercice implique l'analyse de la situation, le développement de suites d'actions, l'analyse et le choix de suites d'actions et la planification de la campagne. Dans ce document, nous rapportons nos observations pour certaines de ces étapes de l'exercice. Enfin, ce document présente certains détails à propos des systèmes ADAMS (Allied Deployment and Movement System) et ITEM (Integrated Theatre Engagement Model).

Guitouni, A., Bélanger, M., Berger, J., Morrissey, D. 2006. Report on Final Lance: Canadian Forces College (May 23rd – June 7th, 2000). DRDC Valcartier TM 2004-222.

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Acknowledgements

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1. Introduction

The purpose of this technical memorandum is to report on a recent visit of DRDC Valcartier's defence scientists to the Canadian Forces College (CFC) in Toronto. The authors have recently been involved in discussions with CFC Toronto with respect to the pertinence of ongoing decision support research in the area of Course Of Action (COA) selection. As a result of these discussions, CFC Toronto's Exercise Deputy Director, LCol Grant, invited the authors to participate as observers in a Theatre-level joint operational planning exercise – Final Lance – which was held in CFC from 23 May to 7 June 2000.

The objectives of participating in this exercise were as follows:

- provide DRDC Valcartier's scientists with a better understanding of the problems involved in collaborative planning – specifically in the context of coalition operations;
- permit DRDC Valcartier's scientists to better understand the capabilities and limitations of CFC Toronto's in-house computer support tools;
- explore areas where DRDC Valcartier's R&D efforts could prove beneficial in the kinds of operations conducted at CFC Toronto, and to leverage from ongoing Technology Demonstration Projects, such as the Common Operational Picture 21 (COP 21) Technology Demonstration Program (TDP); and
- provide CFC Toronto staff with a better understanding of the types of decision support research currently being conducted at DRDC Valcartier.

The memorandum includes a brief overview of the Canadian Forces Operational Planning Process (CFOPP) and a description of the Final Lance exercise. It then describes the authors' observations of the exercise, and concludes with ideas for possible future collaboration.

2. Canadian Forces Operational Planning Process (CFOPP)

Prior to the presentation of Final Lance, we felt that it would first be appropriate to provide an overview of the CFOPP. Given that the planning process is critical to the success of any mission, the students at CFC are taught CFOPP, which is comprised of six main steps [Fig. 1]. The *Initiation* step can either commence with the receipt of a mission statement or simply in anticipation of a new mission. According the Joint Operations Planning Process (JOPP) manual [0], "during this step, the task is assigned or assumed, major combat and logistic resources and strategic transportation assets are identified for planning purposes, the intelligence process initiated, and the groundwork is laid for planning to begin." As soon as the new mission is received, the staffs prepare for the mission analysis by gathering all relevant information (e.g. maps of the area of operations, own and higher headquarters' standing operating procedures (SOPs), appropriate documents, estimates), and issue warning orders to supporting and subordinate units.

Figure 1. Canadian Forces Operational Planning Process [2]

In the *Orientation* step, the Commander begins the analysis and definition of the mission, prepares the planning guidance and describes the proposed end state of the operation. The Staff Organisation and Operations Document [3] states that the orientation step includes the analysis of higher headquarters' orders; initial intelligence; assessment of specified, implied and essential tasks; review of the available assets; estimation of the constraints; identification of the critical facts and assumptions; risk assessment; Commander's critical information requirements; initial

reconnaissance; mission analysis briefing; development of initial Commander's intent; and issue of the Commander's guidance.

The *Course Of Action (COA) Development* step involves the entire staff. The Commander's guidance and intent helps the staff to focus on the development of comprehensive and flexible plans within the time available. These COAs "should answer the fundamental questions of when, who, what, where, why and how" [2,3]. Each COA should be suitable, feasible, acceptable, exclusive and complete. A good COA positions the force for the future operations and provides flexibility to meet unforeseen events during its execution [3]. The "who" in a COA does not specify individual units, but rather uses generic assets and capabilities. During the COA development step, staffs analyse the relative combat power of friendly and enemy forces, and generate comprehensive COAs.

The *Decision* step is based on the analysis and comparison of the proposed COAs, and the primary approach used in this analysis is war-gaming. The central framework used by the staff in the war-gaming is a discussion of the actions, reactions and counter-reactions [3,4]. It relies heavily on a doctrinal foundation, critical judgement, and experience [2,3]. During a war-gaming session, the staff takes a COA and determines its strengths and weaknesses by pitting it against potential enemy COAs. As a result of this analysis, the Commander and his staff may make changes to an existing COA or develop an entirely new one. Prior to the war-gaming session, the Commander will identify a list of evaluation criteria. These criteria represent the factors to measure the relative effectiveness and efficiency of each COA.

The COA comparison highlights the respective advantages and disadvantages of each COA. The most commonly used technique was the decision matrix, which used pre-defined evaluation criteria to assess the evaluation of each COA. Each staff officer was free to use his own matrix – with the commander's criteria – for comparison in his own field of expertise [3]. Typically, these matrices did not provide a decision solution and, in practice, it was the Chief of Staff (COS) determined each criterion's relative importance. An ad hoc aggregation process lead to one or more recommendations and the COS then decided which one he would recommend to the Commander during the Commander's Decision Brief.

COA approval consists of a choice of the best COA according to the Commander's beliefs and estimates. If the Commander were to reject all of the proposed COAs, then the staff would be required to start the process over again. Once a COA was chosen, the Commander still had the opportunity to refine his intent, guidance and priorities for execution planning. By deciding on a COA, the Commander assesses what residual risk is acceptable, and based on his decision, and final guidance, the staff then refines the COA, completes the planning process and issues orders. The aim of the plan development step was to provide a set of orders based on the Commander's decision. Orders provide all of the necessary information to subordinate and supporting units to initiate planning or execution of operations. In the final step, the Commander conducts a final review of the plan, and grants approval for orders to be disseminated.

3. Exercise Final Lance (May 23rd – June 7th, 2000)

Exercise Final Lance is a training exercise for the students of CFC Toronto to practice coalition operational planning. The exercise is designed to allow the students to practice the planning process with both UN and NATO-style inputs, and provides the opportunity for students to go through the different CFOPP steps. During the exercise, the students take on the roles of J1 through J6, as well as those of their staffs (Figure 4).

3.1 Aim and objectives

As stated in the Final Lance 2000 [5] document, "the aim of Exercise Final Lance is to practice the students in joint operational planning and decision-making at the Theatre level, thus confirming their knowledge of the major elements of the CFOPP, the Operational Art, and the functions/operations of a Combined Joint Task Force Headquarters." The objectives of the exercise are summarised as follows:

- conduct deliberate planning, using the CFOPP,
- conduct time sensitive planning,
- produce a campaign plan, and branch and sequel plans (including using computer support system),
- carry out execution of the plan,
- rules of engagement and multinational force generation planning (including deployment of troops and materials from different national locations assisted by a computer support system)
- exercise real-word media interaction,
- perform key staff functions within a Coalition Joint Task Force Headquarter (CJTF HQ), including component liaison team level,
- work and interact with a three-star Commander,
- understand and employ the many assets available to the CJTF (Amphibious, Space, etc.),
- formation and operation of relevant boards and committees at the Joint HQ level,
- employ a simulated JC2IS system and gain exposure to simulation and software assets for COA analysis and deployment planning tools (ITEM and ADAMS).

3.2 Exercise scenario

The Final Lance scenario [5] primarily involves three countries – Orangeland, Redland and Blueland – on the fictitious continent of Atlantis. Northern Atlantis erupted into armed conflict when Orangeland forces attack into Blueland's Manghalour Peninsula. The crisis involves ethnic Easterling refugees fleeing into Blueland to escape the violence in northeast Redland; a military coalition between Redland and Orangeland; and a dispute over access to oil reserves and historic land claims.

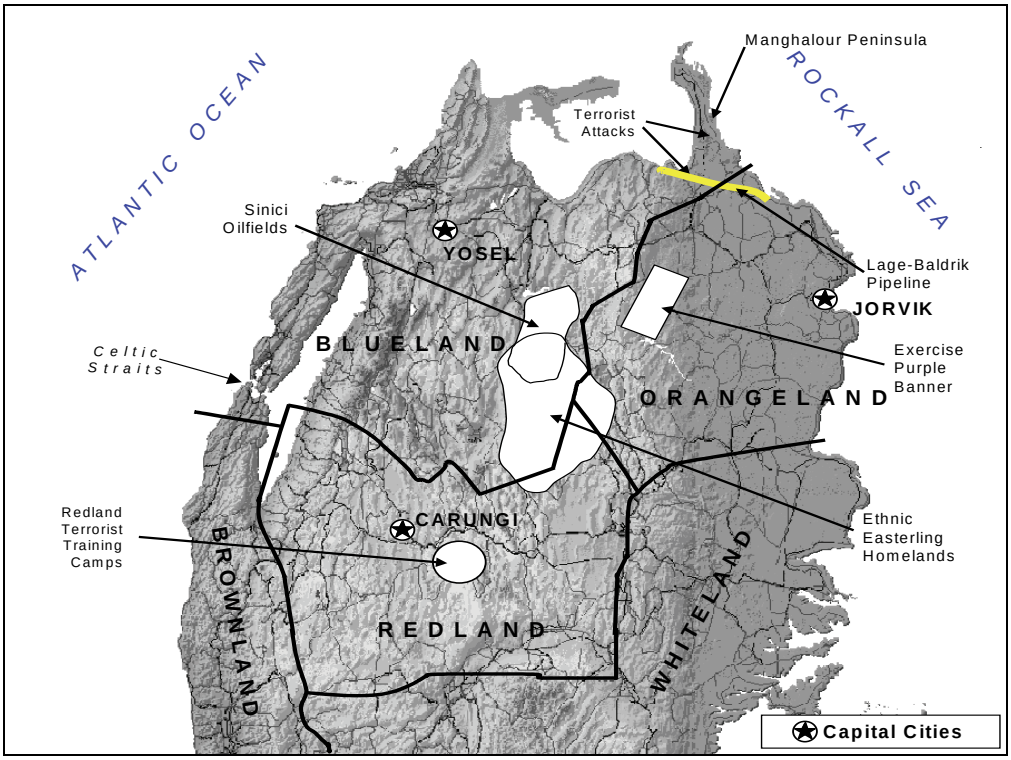

Figure 2. Geographic map of the crisis region [5]

Blueland is a modern and democratic country with a prosperous economy – in part due to the discovery of oil fields not far from the Orangeland border. In contrast, Orangeland and Redland are authoritarian states, facing rising political unrest and economic crisis at home. The President of Redland has pointed out the problems with the ethnic Easterling population in the north to justify high military expenditures, economic austerity and high security conditions. In 1999, Redland began to exert pressure on the Easterlings living in the border area between the three countries (Blueland, Redland and Orangeland). Large-scale human rights abuse by Redland forces has lead to a large number of Easterling refugees fleeing into Blueland, thereby constituting a threat to its internal stability and creating a humanitarian crisis (see Fig. 3).

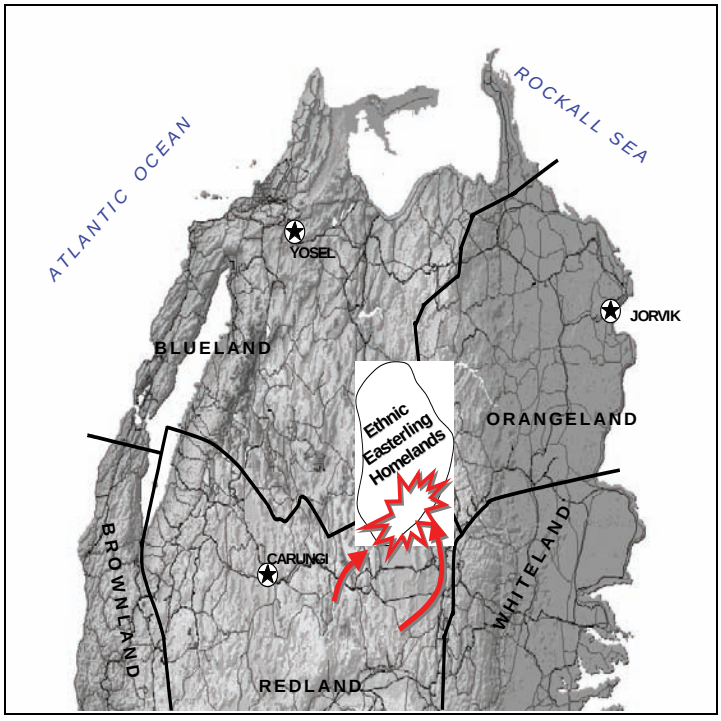

Figure 3. Ethnic crisis [5]

In response to this situation, and after many days of intensive consultations, the UN made a formal request to the Alliance Council to contribute to the peace support operation in the region, and to restore international peace and security. The Council accepted to conduct military operations to support UN, to assist Blueland in restoring its territorial integrity, to support humanitarian operations and insure free access to the region. (see [5] for a more detailed description of events leading up to the Manghalour crisis, including the historical background of the region).

COMASC (Commander MASC) has provided the Council with its requirements, concept of operations, proposed command structure (Figure 4), a time-line for operations and his overall force requirements (see [5] for more detailed information about COMASC strategic assessment).

As specified in the scenario documentation, the key military tasks for the Alliance forces are:

1. prepare and deploy a Coalition Joint Task Force (CJTF) on short notice,

2. enforce a maritime embargo on arms to Orangeland,

3. secure Lines of Communications (LOCs), Ports of Departure (PODs) and lodgement areas,

4. deter/defeat any further aggression by Orangeland and Redland,

5. compel the withdrawal of Orangeland and Redland forces from Blueland,

6. assist UNHCR in providing humanitarian assistance and relief,

7. handover a stable situation to an appropriate follow-on force.

Finally, the scenario considers the nations of Whiteland and Brownland, and their involvement in the crisis. Figure 5 provides a geographic overview of the region, and the strategic distances involved.

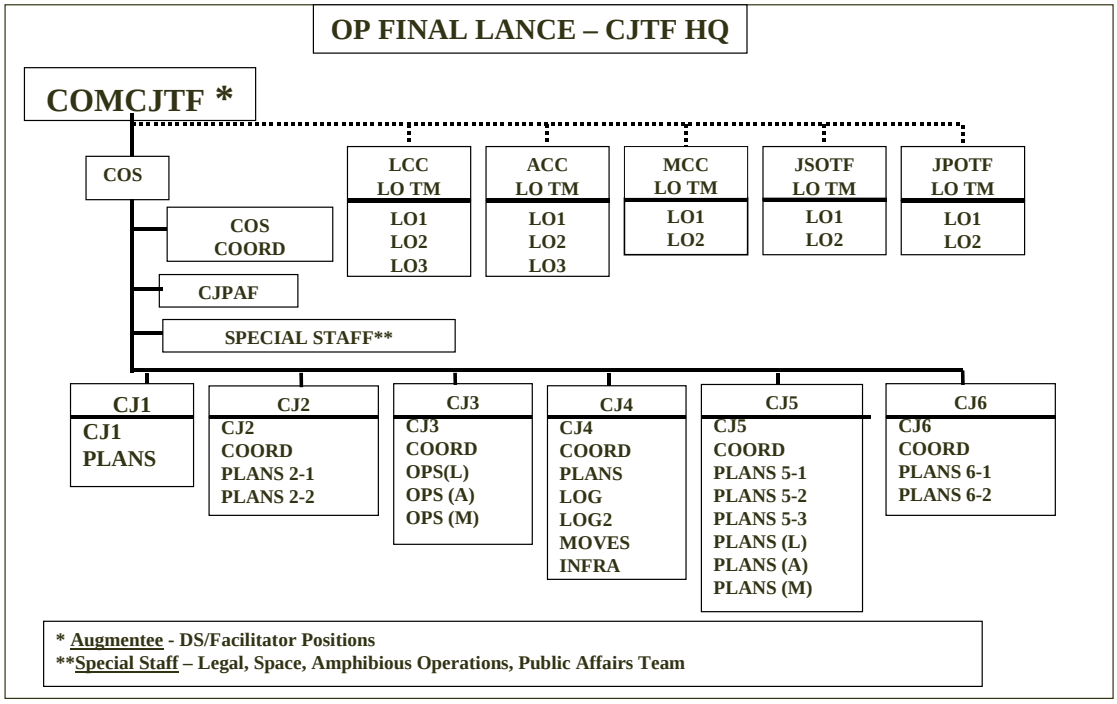

Figure 4. Command and Control arrangement for Final Lance Ex [5]

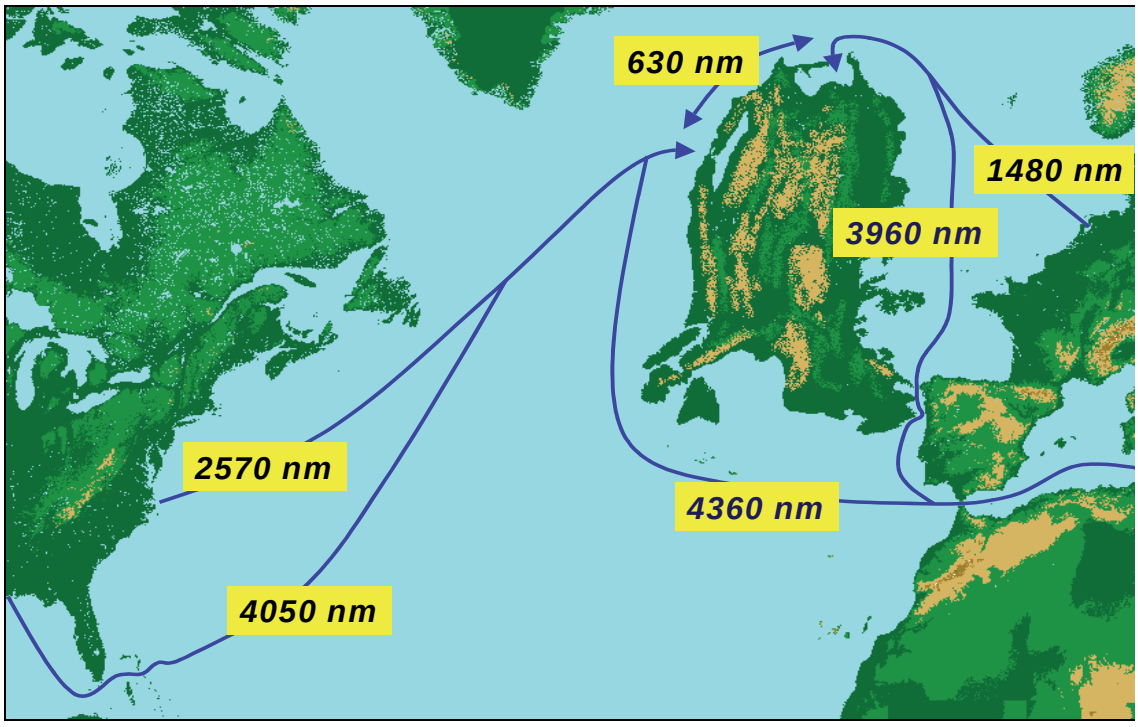

Figure 5. Strategic distance to the crisis region [5]

3.3 Deliverables

Due to the large number of students, the exercise was played out using two different CJTFs. In order to assure that the interaction had the feel of dealing with a three-star general, CFC Toronto hired two retired general officers – VAdm George and LGen Crabbe – to play Commander CJTF (COMCJTF) 1 and COMCJTF 2, respectively. The participants in Final Lance performed real life command and control activities and were required to produce a set of documents and briefings in accordance with the CFOPP. During the exercise, the participants produced briefings (mission analysis brief, information brief, decision brief, different planning briefs, daily COMD's and HQ briefings) and plans of operations (campaign, branch and sequel plans). They were also required to write ROEs; to develop joint targeting guidelines for the operations; and to manage public information planning and conduct of interviews. The staffs of the individual CJTFs were required to perform all the activities related to current operations, including the generation, war-gaming (manually and by computer) and prioritisation of different COAs. In addition, students were afforded the opportunity to practice the force generation process, and to monitor the flow of forces into theatre and logistics build-up and flow.

The importance of planning prior to action was central during this exercise, and the flow of information within the Command Post was considered as a major issue.

4. Automated tools used during the exercise

4.1 Command and control information system: MS Outlook

The only Command and Control Information System (CCIS) used during Final Lance was the CFC Toronto-modified version of Microsoft Outlook. All exchanges of information with COMASC and other related units (simulated by CFC staff) were performed using electronic messaging. Maps, pictures, intelligence reports were exchanged as attachments to these messages.

4.2 Allied Deployment and Movement System (ADAMS)

In order to support the deployment of forces from home bases, into the theatre of operations, the logistics simulation tool ADAMS was used (functionality represented in Figure 6). ADAMS is a system developed for SHAPE NC3I to assist in the strategic and operational level planning of force deployment. ADAMS includes many modules (SPM, DPM, DDM and GDM) linked to a central database (LogBase3.0); SPM is the Sustainment Planning Module, DPM is the Deployment Planning Module, DDM is the Deployment Display & Reporting Module and GDM is the General Deployment Module [5].

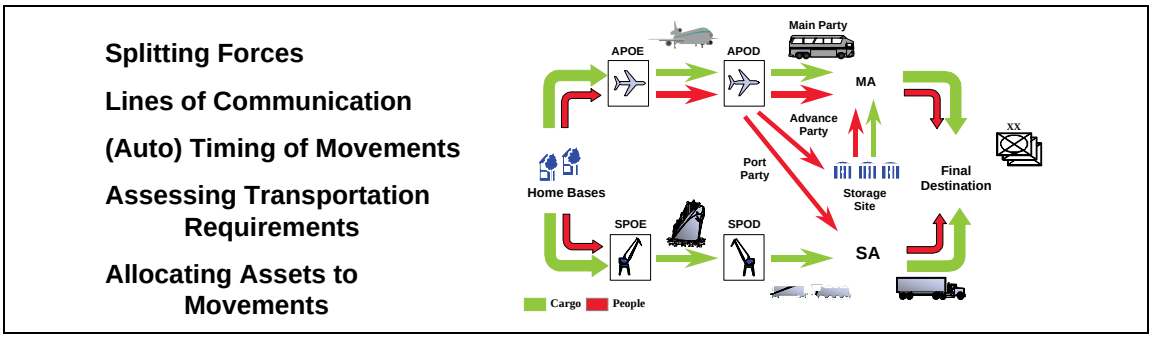

Figure 6. Planning module functionality [6]

LogBase3.0 is composed of three main modules: FDM, GEOMAN and TAM (Figure 7). The force database contains items of equipment, dimensions, properties, forces and force profile data, home bases, type unit holdings and hierarchical force organisation. The geographic database includes maps and map projects, geographical locations, infrastructure data and transportation networks. The transportation database contains transportation asset type data and transportation asset fleet data [7].

ADAMS is a computer support tool to help users simulate a Detailed Deployment Plan (DDP). The DDP is the ADAMS data file of what, where, when and how things are moving. It is necessary to develop a specific DDP for each unit to be moved, and then integrate all DDPs to simulate the overall force build-up in the theatre. For each movement component, the DDP includes the list of personnel, equipment and supplies

(and the MOT, LOC and movement schedule). ADAMS then represents and simply simulates the movement of forces and equipment based on a very large set of parameters, specified by the user. It should be noted, however, that ADAMS does not explicitly accomplish cognitive tasks – it simply assists the user in performing the tedious calculations involved in the movement of units from one point to another. Figure 8 shows the input interface to ADAMS.

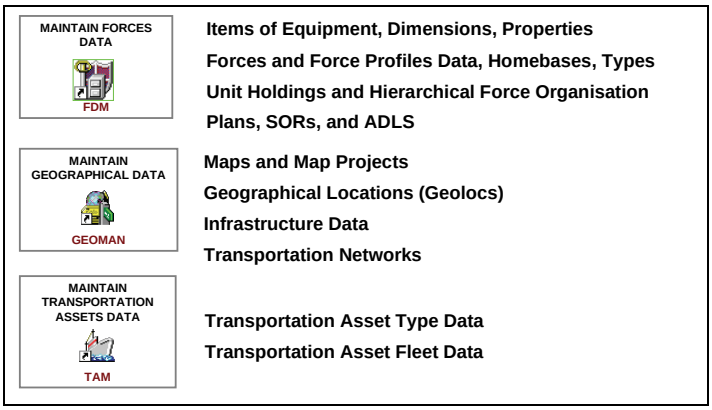

Figure 7. ADAMS data modules [6]

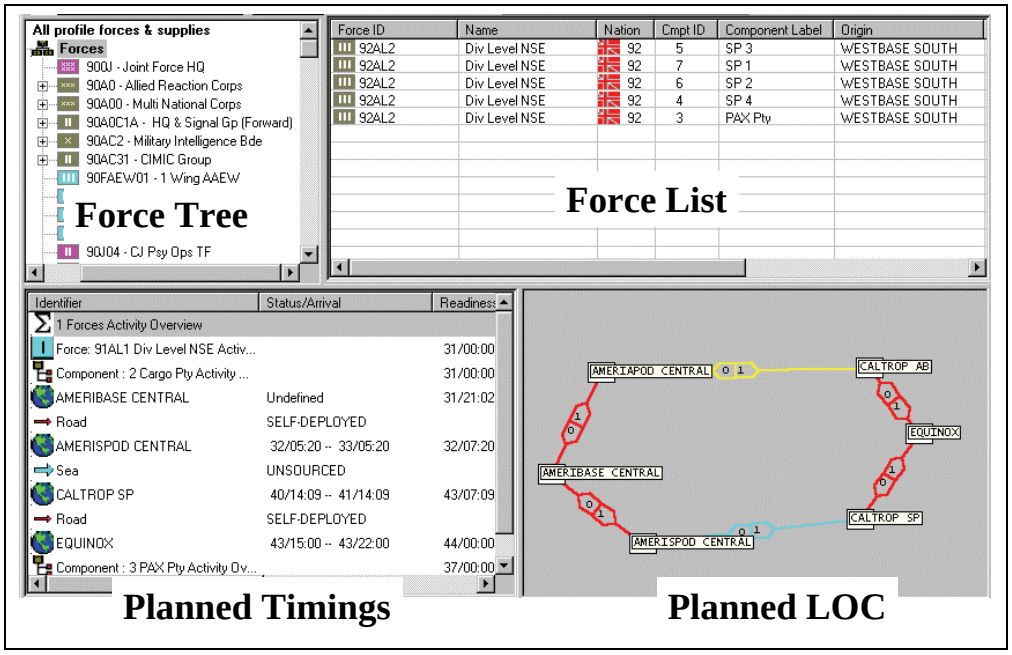

Figure 8. Deployment planning views [6]

ADAMS offers many deployment and analysis tools (Figure 9). It is possible to visualise the deployment plan with animation, and to track the transportation of units (Figure 10). Secondly, it is possible to produce different charts and reports in order to analyse the infrastructure workloads (Figure 11).

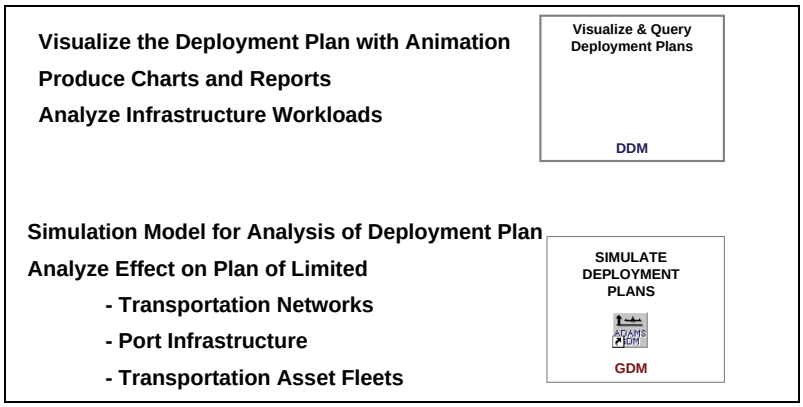

Figure 9. Deployment display and analysis [6]

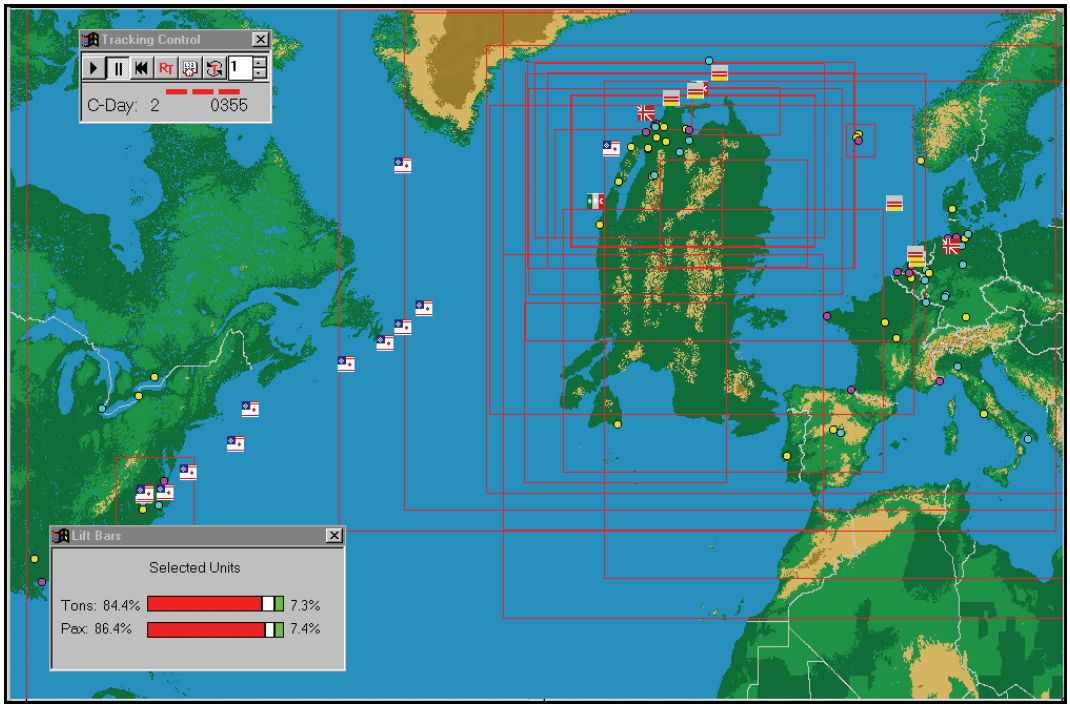

Figure 10. Deployment planning views [6]

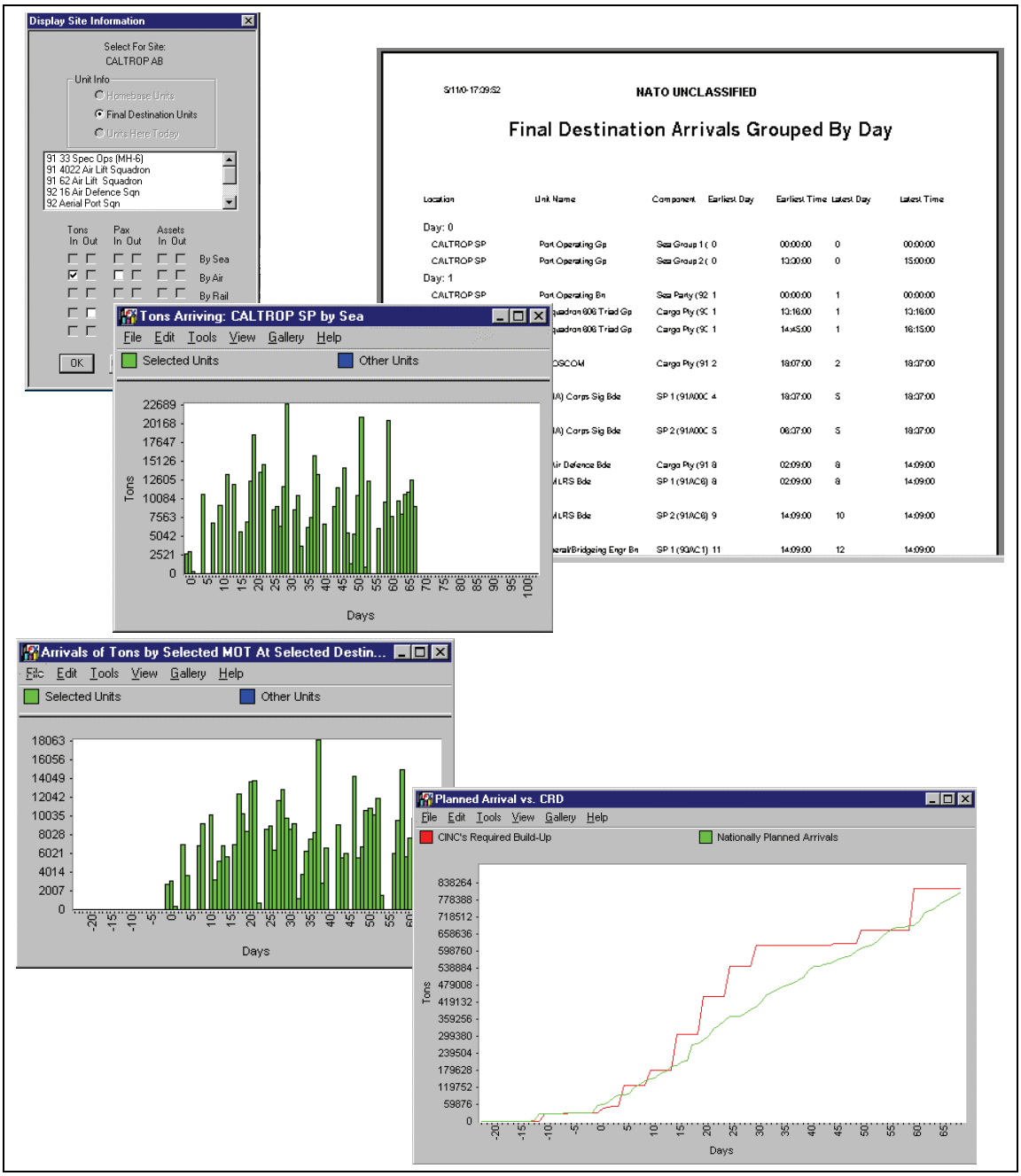

Figure 11. Deployment display reports [6]

4.3 Integrated Theatre Engagement Model (ITEM)

ITEM was used during Final Lance to support semi-automated war-gaming of two COAs (one from each CJTF). According to the ITEM user-manual, ITEM is primarily a two-sided, interactive computer model for theatre-level naval campaigns. ITEM campaigns consist of the major types of naval engagements, including attacks against

land targets by naval forces and land-based aircraft. ITEM campaigns are conducted using standard naval capabilities attributed to ships, aircraft, and installations. These are defined in ITEM, at a level of detail that is appropriate to a theatre-level model. It is important to note that ITEM is a data independent analytical tool. By being data independent, the analyst and tactician are free to impart whatever traits they deem to be desirable for a given situation [8].

The ITEM model operates under the UNIX operating system with an X-Windows graphical interface. When ITEM is first started, two displays are shown on the computer monitor, the map window and the command window. ITEM offers different functionalities, such as force planning, event scheduling and reporting, data management, and elements definition tables. The elements considered in ITEM are modelled, as shown in Table 1. All elements in ITEM are created from either the "Red" or "Blue" force planning windows. These windows are used to create, review, or modify specific instances of the following types of elements: aircraft, minefields, air bases, Maritime Patrol Areas (MPAs), air defence regions, Nuclear Strike Options (NSOs), battle groups, ships, components, ship classes, Conventional Strike Options (CSOs), Submarine Patrol Areas (SPAs), installations, and weapons.

Table 1. *ITEM model of the elements [8]*

ELEMENT	SOME ATTRIBUTES CONSIDERED WITHIN ITEM
Weapons	Range, speed, probability of hit, detectability index, the Circular Error Probable (CEP) , available yields and heights of burst for nuclear weapons
Aircraft	Speed, range, detectability index, sortie rate, mission duration, nuclear weapon delivery accuracy (expressed as a CEP), air-to-air long and short ranges missiles. The user can define standard conventional loads and standard nuclear loads of weapons for aircraft using the weapons that were previously defined.
Anti-submarine warfare (ASW) aircraft	The acoustic figures-of-merit for the aircraft's sonobuoys, the number of buoys the aircraft can monitor, and the probability the aircraft will be able to conduct an attack given that it detects a submarine. The user can define standard conventional loads and standard nuclear loads of weapons for aircraft using the weapons that were previously defined
Ships and ship classes	Speed, detectability index, Anti-Air Warfare (AAW) probability of detection, number of effective Combat Air Patrol (CAP) aircraft, probabilities of kill for two terminal defence systems, the AAW zone to which the ship is assigned in its battle group (outer or inner zone), an AAW zone coverage factor. The ASW characteristics of a ship include radiated noise, active sonar source level, active and passive sonar figures-of-merit, acoustic target strength, torpedo countermeasure probability of kill, the ASW zone to which the ship is assigned in its battle group (long-range, outer, or inner zone) and an ASW zone coverage factor. Ships can have one area and one point defence Surface-to-Air Missile (SAM) system, a long range and a short range ASW weapon system, two Anti-SUrface ship Warfare (ASUW) systems, and two land-attack weapon systems. Weapons from the list of previously defined weapons can be assigned to each of the systems and the salvo sizes for the systems can be specified individually.

Table 1. *ITEM model of the elements [8]*

ELEMENT	SOME ATTRIBUTES CONSIDERED WITHIN ITEM
Target installations on land	User-defined target category, priority, country, latitude and longitude, air defence region, and the probability of kill of its terminal air defenses. Its vulnerability index (VNTK number) and its size (R95 distance) represent the hardness and size of the target from a nuclear weapon perspective. These are the standard parameters required by the PDCALC (Probability of Damage CALCulation) code used in the ITEM model to compute the probability of damage to an installation from a nuclear strike. The Joint Strategic Targeting Planning Staff (JSTPS) provides this code. ITEM also allows the user to define an installation in more detail for conventional strike purposes. Defining installation components to represent the sub-elements of an installation does this. For example, an installation defined as a "C3 Site" could have components defined as "antenna array" and "bunkers". The user can define any number of components and any one installation can include up to four components.
Conventional weapon effectiveness against installations	Defined by the user in terms of expected damage to the individual components. Each component can also have an associated repair rate that ITEM uses to adjust the expected cumulative damage on the target to reflect repair and reconstituting effects.
Air bases	Defined as other fixed installations except that the installation components for an air base are defined as runway surfaces, aircraft shelters, aircraft revetments, and aircraft in the open. Air bases have inventories of weapons and aircraft assigned to them. Air bases also can have Maritime Patrol Areas (MPAs) assigned to them if they have maritime patrol aircraft at the air base. Each MPA, defined as a quadrilateral on the map, is assigned a single type of ASW aircraft. An air base can have any number of MPAs assigned and a single type of aircraft at the air base can be assigned to more than one MPA. ITEM computes the number of aircraft available for ASW patrols and distributes them over the MPAs. The user also can define an area probability of detection for an MPA to simulate the performance of an area surveillance system covering the MPA.

Within ITEM, the user can form individual battle groups by grouping surface ships and submarines together. Battle groups, rather than individual ships, conduct all surface ship and submarine transits, although a battle group can consist of only a single ship or submarine. Battle groups are assigned to an OPerating AREA (OPAREA), defined as a quadrilateral, and it is assumed that the battle group is patrolling randomly within this area (equal probability to be anywhere in the area at any given time). In the same sense, submarines are assigned to SPAs, also defined as quadrilateral areas, and any number of individual submarines can be assigned to a single SPA. It is assumed that the submarines are uniformly distributed throughout the SPA, and that they are randomly patrolling the area. The user classifies land-based targets, including air bases, as either NSOs or CSOs. Air bases or battle groups schedule all attacks against NSOs or CSOs. An NSO or CSO can consist of a single installation [8].

ITEM has a graphical interface consisting of a map display and a data display. ITEM uses the World Data Base II maps to display battle group positions, SPAS's, MPAs, minefields and the locations of air bases and other land installations for selected NSOs

or CSOs. These elements can also be defined on the map. To get information about an element, the user simply clicks the mouse on a map icon representing that element.

ITEM is a time-step Monte Carlo simulation [8]. The user schedules future events and commands ITEM to run a specified number of time steps. ITEM then computes the outcomes of all engagements scheduled during the time period covered by the time steps. The user schedules certain events explicitly for a designated time and with a specified priority. Other types of events are scheduled automatically by ITEM, if the user has established the requisite conditions for the event to occur. The user can explicitly schedule the following engagements: battle groups versus battle groups, battle groups versus submarines, submarines versus battle groups, land-based aircraft versus battle groups, battle groups versus land-based installations, and minefields versus submarines and surface ships. ITEM uses tactical models to determine force attrition and weapon expenditure.

ITEM schedules the following engagements automatically if the user has defined the proper conditions: submarines versus submarines in overlapping patrol areas, battle groups versus submarines in patrol areas, maritime patrol aircraft versus submarines in overlapping patrol areas, minefields versus submarines and surface ships and land-based aircraft versus conventional strike options. For example, ITEM will automatically schedule events if the user assigns a submarine to a patrol area intersecting an enemy patrol area, or schedules an air base to attack a conventional strike option. The user also can direct ITEM to manoeuvre a battle group to any point, and to close with another battle group by designating a chase event [8].

Air base damage is computed to determine the number of aircraft lost in an attack and to determine whether the runway surfaces can support take-offs during the next model time-step. Three damage states are defined for ships: fully operational; mobile, but combat systems inoperable; and immobile or unseaworthy [8]. The effectiveness of nuclear strikes against land targets is determined by using the probability of damage.

ITEM uses weapon systems effectiveness data tables, number of engagements tables, and probability of kill (or expected kill) tables in order to run the attrition and expenditure simulation. The weapon systems data specifies the maximum number of engagements that a platform can conduct during an encounter, and the probability of damage or the expected damage per hit produced by a specific weapon on the target. The number of engagements table contains the maximum number of engagements that a platform is assumed to attempt against an enemy platform. The probability of kill tables contain the battle damage assessment for each weapon. Moreover, ITEM uses a set of global variables that affect multiple modules within the model.

5. Comments and discussions

Of all of the exercise activities, it is those associated with COA selection and analysis that are most closely related to the research activities of the authors. Therefore, in the following sections, our comments will focus primarily in these areas and, to a lesser extent, on the plan development and current operations activities.

5.1 COA management

The Commander's planning guidance, followed by several information and assessment briefings, is what initially triggered the development of COAs. It appeared to us that the COA development process was somewhat unstructured (i.e. no formal process). Both teams proceeded, through entirely different paths, to attempt to achieve consensus among the team members. Based on the Commander's guidance and directives – which included evaluation criteria – each team was required to produce different COAs, and to perform a partial analysis of them. They then presented these results to the Commander during an information briefing, and he selected two COAs to be further analysed. One COA was analysed by manual war-gaming (by the team members) and the other was analysed by the automated systems (ADAMS and ITEM, see Chapter 4). The chosen COAs were war-gamed against the "worst-case" and "most likely" scenarios characterizing potential enemy behaviour. It is important to note that the goals of the war-gaming were to detect any problems with the COAs, and to evaluate them against each of the evaluation criteria provided by the Commander.

The manual war-gaming session was essentially an oriented brainstorming session. At the beginning, the Chief of Staff (COS) presented the overall objectives of the campaign, the individual operational objectives and the operation's centre of gravity. The J3 Chief Controller then presented the aim of the manual war-gaming and J3 Ops explained the war-gaming session rules. J2 presented the most dangerous COAs, and then J5 presented the COA to be war-gamed manually. J3 Ops again reminded everyone of the Commander's evaluation criteria, and provided the sequence for the war-gaming sessions (13 minutes for each round, with a 10 minute break between two rounds). Each round was run as follows:

- J5 presented the Alliance main effort and end states,
- Deep Ops: Information Operations (J6), Deception (J6), Psychological Ops (LO), SOF-SOF (LO),
- Close battle (manoeuvre-fire power): Maritime Command and Control, Air Command and Control and Land Command and Control,
- Rear/Sustainment (J4),
- Command and Control (J6),

- Enemy actions assessment (J2 staff),
- Alliance counter actions,
- Identify critical decision points, if any.

The results of each round of the manual war-gaming were reported on a synchronisation matrix (see annexe A) and, after each round, J3 Ops asked each member to assess the COA evaluation, according to the criteria. Manual war-gaming sessions typically lasted four to six hours.

The computer supported war-gaming sessions, on the other hand, began on Friday afternoon, and continued through the weekend – delivering their results only on Monday afternoon. Given the large discrepancy in time required for the two methods, we were curious to determine the magnitude of difference in the quality of the two methods. Was the quality of the computer supported and manual war-gaming sessions similar, and did they provide approximately the same level of useful information to evaluate and compare COAs? As expected, the answer was 'no'. The level of detail provided by the automated process was considerably higher. If fact, the COA selected by the CJTF for computer-aided war-gaming was generally his preferred COA, and, therefore, the one for which he required the highest level of detail. The manually war-gamed sessions served more to introduce the students to the war-gaming process, than to actually evaluate individual COAs. Of the two days required for the computer-aided war-gaming sessions, however, the exercise staff spent much of that time simply inputting data into ADAMS and ITEM. As the computer-aided war-gaming sessions were run over the weekend, the exercise staff was also required to make decisions on behalf of the students in response to unexpected events or outcomes in the process.

The next step of the process required the students to assess the two COAs, based on the results of the war-gaming sessions, and present the results of their analysis to their Commander. Then, during the decision briefing, the Commander decided which COA would be executed.

It is interesting to note that the Commanders were often able to assess evaluation criteria solely based on their own personal experience, and that each provided different evaluation criteria for their team. This suggests that different Commanders may consider different criteria for the same situation.

The two Commanders were clearly inundated with large quantities of information during the different briefings. The COS played a major role in co-ordinating the efforts of his team, and in keeping the Commander well informed. This permitted the Commander to focus on individual aspects of the COAs – to provide more specific guidance, or to initiate separate brainstorming sessions, as required.

The evaluations of the COAs according to the different criteria were assessed using an ordinal scale, with three levels: Green, Yellow and Red. For each COA, a consensus was reached among the different members of each CJTF HQ. Then, based on the decision matrices, the Commanders were able to make their decisions.

5.2 Planning

During Final Lance, each CJTF HQ was required to develop the individual Statements of Requirements (SORs) for their selected COA. These SORs included information about the units required by the COA and their base of origin, availability and final destination. Then the ADAMS team, assisted by representatives from SHAPE NC3A, input these SORs to ADAMS. As mentioned previously, exercise staff members were required to make decisions on behalf of the students about transportation requirements, transportation platforms, lines of communication, allocation of assets and timings. Exercise staff were also required to develop tactical plans, as these are not included in the COAs (this level of detail is left to the individual warfare commanders) but is required in order to run ITEM. This effort typically corresponded to 2 person-days for each COA. ADAMS then calculated the arrival time for individual units, and the force build-up in-theatre, and ITEM was used to fight the actual battles.

Once a COA was selected, the planning phase was initiated. Plan development was iterative and took into consideration a wide range of information, from a number of different sources. The quality of the information available seemed to vary considerably, and this fact was confirmed by one of the Commanders, who indicated that he relied primarily on his own experience, rather than on a large variety of dynamic and uncertain data. The process of generating decision points gave rise to "branch planning" (contingency planning), which further refined the current plan. Although the organisational structure for the various staff functions (J1-J6) is fairly clear, the domain complexity makes the task of completely defining the problem structure (or a hierarchy) very difficult. Despite the attention paid by the authors to this part of the exercise, the precise cognitive process leading to plan construction still remains largely unclear.

Once a plan was developed, the details for its execution fell within the purview of J3 (Current Operations). Although this involved a lower level of planning, in terms of required detail, and involved a shorter time scale (4-7 days), it was still at a relatively high level. J3 and his staff were required to coordinate with the Air, Land and Maritime Component Commanders (ACC, LCC, MCC), in order to determine their individual requirements, and to work out any plan adjustments caused by individual component constraints. Once all of the constraints were accounted for, it was necessary to re-review the execution phase to ensure that it still conformed to the COA-developed plan. The detailed tactical plan was then brought back to CJTF for final approval and/or modification, and then release for execution at the component level.

5.3 Support tools

While ADAMS is a powerful tool for supporting the planning process, it is also very rigid. Primarily a tactical system, it requires that plans be detailed down to the tactical level to properly simulate the logistical flow of personnel and equipment into the theatre of operations. In its current state, the simulation of five COAs would require the commitment of 10 full person-days. The authors believe, therefore, that it might be

worth investigating the possibility of modifying ADAMS, in order to limit the simulation to the operational level.

ITEM is used to war-game the COAs, and provided output at regular intervals, in campaign time, with respect to the damage suffered by ships, aircraft, and land installations, and the number of weapons expended on both sides. ITEM also permits the user to save the current battle so that campaign options can be explored by conducting trial engagements with one set of parameters and then returning to the earlier state if the engagement outcomes suggest an alternative set of parameters should be explored.

ITEM was originally designed by SAIC to explore nuclear warfare options – and to carry out a primitive form of war-gaming – to give the Commander a basic mechanism for comparing COAs. Although SAIC is currently developing more sophisticated map displays, it is unclear at this stage what future modifications will be made to ITEM. The tactical information for each COA is provided by ADAMS, and also by the exercise support staff. According to the exercise staff, many features of ITEM are regarded as frustrating and time consuming. In fact, many details, while necessary for playing ITEM, were not deemed to be pertinent for the operational planning, and the outcome of some of the events in ITEM were difficult to explain. Interestingly, ITEM was considered by the exercise staff to be more useful for the simulation of land engagements than for the naval ones, even though it was developed primarily to simulate naval campaigns. An alternate tool currently being developed for NATO, called JANUS, actually integrates the functions of ADAMS and ITEM, and is expected to replace both of these tools in the next 12 to 18 months.

6. Collaboration workshop

As result of our participation in Final Lance, LCol Grant was invited to visit DRDC Valcartier in October 2000. During this visit, a workshop was held in order to provide more formal presentations on the technologies currently being developed at DRDC Valcartier; and to further discuss their potential relevance to CFC Toronto. During the workshop, CFC Toronto personnel took the opportunity to brief DRDC Valcartier's scientists – from several different groups –on the nature of their work, and the constraints they work under. During this meeting, an outline for a memorandum of understanding -- to facilitate collaboration between CFC Toronto and DRDC Valcartier – was established.

7. Conclusion

DRDC Valcartier's participation in Final Lance was a tremendous learning experience. It enabled us to gain a more detailed appreciation of CFOPP, and it also provided us with an opportunity to see the existing computer support tools, ITEM and ADAMS, in operation. Even during the short course of our stay, we were able to identify several research areas that could be beneficial to the college. These include: machine learning to support user modelling and war-gaming activities (assuming proper models related to environment and enemy's behaviour), and case-based reasoning and simulation to support "what-if analysis". It is clear that the design of automated (or semi-automated) decision-aids for the development and comparison of COAs (ex. using multicriteria decision analysis) would be beneficial in support of the CFOPP. Furthermore, lower level command and control information systems and decision aids (e.g. tactical mission planning at the component level) could also be a valuable addition. The identification of evaluation criteria that might be applicable for different types of situations could also be of value to the decision maker in the selection of appropriate evaluation criteria.

During our participation in the exercise, we discovered that much of the information presented to the students was also relevant to others, problem domains that DRDC Valcartier is involved in, such as the COP21 Technology Demonstrator project. As a result, numerous documents, including a description of the COA process, and the ensuing Campaign plan, were made available to us for further analysis. The exercise also provided an excellent opportunity to observe the doctrine currently being taught and how it is applied in the context of joint and coalition operations.

A closer level of collaboration between DRDC Valcartier and CFC Toronto would provide an opportunity to observe and assess the benefits of new decision support tools as they pertain to CFOPP. It would then also be possible to assess the value of these tools, identify creative ways for improvement, and highlight potentially new research and development areas of interest to the Canadian Forces.

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Annexe A: Synchronisation matrix

Time		Pri of depl	G TO G+10	G +10 TO G+20	G +20 TO G+30	G+30 TO G+40	G +40 TO G+50
Phase			Phase 2 Stage 1- Lodgement				Phase 2 Stage 2 -
En Action - J2	**Orangeland**						
	Redland						
Own Decision Points							
Deep Ops - J6/JSOF/JPO	**Alliance**						
MANOEUVRE	**MCC**						
	ACC						
	LCC						
FIRE POWER	**MCC**						
	ACC						
	LCC						
INFORMATION OPS - J6							
SUSTAINMENT - J4/J1							
COMMAND - J6	**CJTF HQ**						
REMARKS							

List of symbols/abbreviations/acronyms/initialism

Acronym	Description
AAW	Anti-Air Warfare
ACC	Air Component Commander
ADAMS	Allied-Deployment And Movement System
ASUW	Anti-Surface Ship Warfare
ASW	Anti-Submarine Warfare
C3	Command and Control and Communication
CAP	Combat Air Patrol
CCIS	Command and Control Information System
CAP	Combat Air Patrol
CEP	Circular Error Probable
CFC	Canadian Forces College
CFOPP	Canadian Forces Operations Planning Process
CJTF	Coalition Joint Task Force
CJTF HQ	Coalition Joint Task Force Headquarter
COA	Course Of Action
COAs	Courses Of Action
COMASC	Commander MASC
COMCJTF	Commander CJTF
COMD	Commander
COP21	Common Operational Picture 21
COS	Chief of Staff
CSOs	Conventional Strike Options

DDRM	Deployment Display & Reporting Module
DDP	Detailed Deployment Plan
DPM	Deployment Planning Module
DRDC	Defence Research and Development Canada
FDM	Force and Equipment Data Manager
GDM	General Deployment Module
GEOMAN	Geographical and Infrastructure Data Manager
HQ	Headquarter
ITEM	Integrated Theatre Engagement Model
JANUS	
JC2IS	Joint Command and Control Information System
JOPP	Joint Operations Planning Process
JSTPS	Joint Strategic Targeting Planning Staff
LCC	Land Component Commander
LOC	Line of Communication
LOCS	Lines of Communications
MASC	Major Alliance Strategic Command
MCC	Maritime Component Commander
MOT	Method of Transportation
MPA	Maritime Patrol Area
MPAs	Maritime Patrol Areas
NATO	North Atlantic Treaty Organisation
NC3A	NATO Consultation, Command and Control Agency
NSOs	Nuclear Strike Options

OPAREA	Operating Area
PDCALC	Probability of Damage CALCulation
PODS	Ports of Departure
RFIs	Requests for Information
ROEs	Rules of Engagement
SAIC	Science Applications International Corporation
SAM	Surface to Air Missile
SOF	Special Operating Forces
SOPs	Standard Operating Procedures
SORs	Statements of Requirements
SPA	Submarine Patrol Area
SPAs	Submarine Patrol Areas
SPM	Sustainment Planning Module
TAM	Transport Asset Data Manager
TD	Technology Demonstration
TDP	Technology Demonstration Program
UN	United Nations
UNHCR	United Nations High Commissariat for Refugees
VNTK	Vulnerability Index

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The participation as observers in a Theatre-level joint operational planning exercise – Final Lance (which was held in CFC from 23 May to 7 Jun 2000) allowed DRDC Valcartier defence scientists to better understand the operational planning process and the actual capabilities available to military officers to accomplish this process.

The report includes a brief overview of the Canadian Forces Operational Planning Process (CFOPP) and a description of the Final Lance exercise. It then describes the authors' observations of the execution of the planning process in this exercise, and concludes with ideas for possible future collaboration with CFC Toronto.

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