



Canadian Forces in Joint Fires Support - Human Factors Analysis

Coalition Operations

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Abstract

The objective of this Human Factors analysis was: to focus on coalition aspects of Joint Fires Support; to identify potential issues where single force operational doctrine/ strategy/ culture/ procedure/ policy differ when units are engaged in collaborative joint or coalition force Joint Fires operations; and, to identify differences in principles that component members use to compare, predict, and direct resources, as well as Joint Fires Support success metrics.

The analysis consisted of background research; data collection (Critical Decision Method and Structured Interviews); data synthesis and interpretation; development of issues, implications, and recommendations; and the development of requirements for tools to ameliorate the primary issues identified.

The primary issues identified were: trust and confidence (headquarters effectiveness); trust and confidence (force employment); language; National Caveats; rules of engagement; tactics, techniques, and procedures; and training.

Recommendations aimed at ameliorating the issues were identified. They included: exchange of personnel; advanced planning tools; common standards and training curriculum; language support through technology; and coalition exercises.

The tool requirements focused on tools to support: planning; language issues; and tools to enhance trust.

None of the Subject Matter Experts interviewed were aware of any performance measures currently being used to measure joint fires support effectiveness.

Résumé

Cette analyse des facteurs humains visait à mettre l'accent sur les aspects coalisés de l'appui-feu interarmées et à cerner les questions éventuelles où la doctrine / stratégie / culture / procédure / politique opérationnelle d'une force unique diffère lorsque des unités participent à des opérations d'appui-feu interarmées concertées d'une force multinationale ou coalisée. Elle avait également pour but de définir les différences dans les principes sur lesquels les membres de ce regroupement se fondent pour comparer, prévoir et affecter les ressources ainsi que les mesures de réussite de l'appui-feu interarmées.

L'analyse a consisté à effectuer des recherches préliminaires, à recueillir des données (méthode de décision critique et entrevues structurées), à faire la synthèse et l'interprétation des données, à formuler les questions, les implications et les recommandations, de même qu'à élaborer les exigences quant aux outils nécessaires pour améliorer les principales questions cernées.

Les principales questions cernées étaient les suivantes : la confiance (efficacité du quartier général), la confiance (emploi de la force), la langue, les restrictions nationales, les règles d'engagement, la tactique, les techniques et les procédures et, enfin, l'instruction.

Nous avons formulé des recommandations visant à améliorer ces questions, notamment : échange de personnel, outils de planification avancée, normes et programme d’instruction communs, soutien linguistique grâce à la technologie, et exercices de coalition.

Les exigences liées aux outils étaient axées sur des outils de soutien de la planification et des questions linguistiques ainsi que des outils permettant d’accroître la confiance.

Aucun des experts en la matière (EM) interrogés n’était au courant de mesures de rendement utilisées à l’heure actuelle pour évaluer l’efficacité de l’appui-feu interarmées.

Executive summary

Canadian Forces in Joint Fires Support - Human Factors Analysis: Coalition Operations

**Curtis Coates; Gerard Torenvliet; Andrew Stewart; DRDC Atlantic CR 2009-203;
Defence R&D Canada – Atlantic; August 2010.**

Introduction: The overall purpose of this project was to conduct a human factors analysis aimed at identifying the soft factors regarding the differences in operational / strategy / doctrine / culture / procedure / policy that might affect outcome of a coalition joint fires mission. This work is part of the Joint Fires Support (JFS) Technology Demonstration Program (TDP) being conducted by Defence Research and Development Canada.

The human factors methodology included a review of literature, data collection from Subject Matter Experts (SME) with coalition operations experience, using a mixture of the Critical Decision Method and Structured Interviews, Data Synthesis by human factors specialists, and SME validation of synthesized results and recommendations.

The data were synthesized and organized by a Joint Fires Support subsystem and category framework, in order to identify coalition related issues. From the synthesized data, overarching issues and implication were identified. The recommendations contained in this report are based on the aforementioned data synthesis and have been validated by Subject Matter Experts.

Results: Issues identified are:

- **Trust and confidence** has an impact on coalition Headquarters effectiveness as it relates to the planning, coordination, and control of Joint Fires Support; and on Force Employment as it relates to the conduct of Joint Fires Support;
- **Language issues** affect interoperability during the planning, coordination, control, and conduct of Joint Fires Support;
- **National Caveats** complicate all aspects of coalition operations;
- **Rules of engagement (ROE)** have an impact on how military forces work together during the planning, coordination, control, and conduct of Joint Fires Support;
- **Differences in training** between coalition partners affect the ability to coordinate with these partners in the provision of Joint Fires Support; and
- **Differences in tactics, techniques, and procedures** between coalition partners affect the ability to coordinate with these partners in the provision of Joint Fires Support.

Recommendations:

- **The exchange of personnel** (at Staff College, headquarters, tactical units, and training establishments). Requires succession planning to ensure corporate knowledge is not lost;
- **Advanced planning tools** to assist with ROE issues, National Caveats problems, and may include such tools as the Joint Automated Deep Operations Coordination System (JADOCS) blue force tracking, and intelligence sharing techniques. These tools must allow for wargaming, and the generation of ‘courses of action’;
- **Common standards** and training curriculum should be instituted at all Joint Fires Support centres of excellence (training facilities) of nations participating in coalition operations;

- **Language support** through technology. Examples include online translation services, access to acronyms, phonetic spelling of common phrases, and text support; and
- **Coalition exercises** - conducted on a more basis (currently every 8-9 years).

Tool Requirements:

- **Tools to support planning issues**
 - ♦ **Coalition ROE and caveat support.** A tool or database to centralize information about ROE and National Caveats, and their usage, so that they can be accounted for in the operational planning process.
 - ♦ **Collateral damage estimate (CDE)/mensuration support.** A tool to understand individual nations' CDE as compared to those of NATO and other nations.
 - ♦ **Operation rehearsal tool.** A tool to support the rehearsal of operations in a way that takes, for example, differences in ROE, National caveat play, operational capabilities of different forces, into account.
- **Tools to support language issues**
 - ♦ **Terminology cross-referencing system.** A supplement to the current suite of operational planning tools with features that allow operators to cross-reference terms they may hear from coalition partners into terms they can more readily understand.
 - ♦ **Terminology Wiki.** A tool that allows operators to add terms to a terminology lexicon, quickly and without a significant amount of workload.
 - ♦ **On-the-fly translation.** A tool to provide quick translations of communications.
 - ♦ **Voice communication recording and playback.** A tool that allows an operator to review the contents of voice communications after the fact; a simple interface to play back recorded communications.
 - ♦ **FOO (Forward Observations Officer)/FAC (Forward Air Controller) (in the field) support.** Tools that would provide the aforementioned capabilities in the field.
- **Tools to enhance trust**
 - ♦ **Social networking.** A social networking tool (similar to the concept of Facebook, LinkedIn, MySpace or Plaxo) to help operators learn about and build trust with other operators in theatre.

Significance: This work provides detailed knowledge and information that outlines those areas and issues of most concern to the functioning of JFS when coalition forces are part of a JFS operation. The results from this work will serve to direct further development of ways to improve and enhance the capability of JFS coalition operations, and will guide the JFS Technology Development Program (TDP) in selecting appropriate avenues to pursue during the continued implementation, and exploitation phases of the TDP program. This work has the ability to impact real and potential future CF capabilities, concepts, doctrine, operations, and equipment

Future Plans: Future work should include further validation of the recommendations to establish the feasibility of implementation and their ability to positively impact the identified issues affecting coalition JFS. The requirements of the advanced planning and language tools should be developed further to allow for prototyping and evaluation of the concepts and their implementation.

Sommaire

Canadian Forces in Joint Fires Support - Human Factors Analysis: Coalition Operations

Curtis Coates; Gerard Torenvliet; Andrew Stewart; DRDC Atlantic CR 2009-203; R & D pour la défense Canada – Atlantique; août 2010.

Introduction : Dans l'ensemble, ce projet avait pour but d'effectuer une analyse des facteurs humains afin de déterminer les facteurs plus abstraits concernant les différences dans la stratégie / doctrine / culture / procédure / politique opérationnelle qui pourraient influencer sur l'issue d'une mission coalisée d'appui-feu interarmées. Ces travaux s'inscrivent dans le Programme de démonstration de technologies (PDT) d'appui-feu interarmées (AFI) exécuté par Recherche et développement pour la défense Canada.

La méthode d'analyse des facteurs humains a consisté notamment à examiner la documentation et à recueillir des données auprès d'EM possédant une expérience des opérations de coalition. Nous avons fait appel à la méthode de décision critique et à des entrevues structurées, à une synthèse des données par des spécialistes des facteurs humains, et à une validation par les EM des résultats de la synthèse et des recommandations.

La synthèse et l'organisation des données ont été effectuées au moyen d'un sous-système et d'un cadre de catégories de l'appui-feu interarmées afin de déterminer les questions liées à la coalition. Les questions et implications primordiales ont été définies à partir des données de synthèse. Les recommandations contenues dans le rapport sont fondées sur la synthèse des données susmentionnée et ont été validées par les EM.

Résultats : Les questions cernées sont les suivantes :

- La **confiance** influe sur l'efficacité du quartier général de la coalition dans la mesure où elle touche la planification, la coordination et le contrôle de l'appui-feu interarmées, et sur l'emploi de la force dans la mesure où elle concerne l'exécution de l'appui-feu interarmées.
- Les **questions linguistiques** ont une incidence sur l'interopérabilité durant la planification, la coordination, le contrôle et l'exécution de l'appui-feu interarmées.
- Les **restrictions nationales** compliquent tous les aspects des opérations de la coalition.
- Les **règles d'engagement (RE)** influent sur la façon dont les forces militaires travaillent ensemble durant la planification, la coordination, le contrôle et l'exécution de l'appui-feu interarmées.
- Les **différences dans l'instruction** entre les partenaires de la coalition influent sur la capacité d'assurer la coordination avec eux dans le cadre de la prestation de l'appui-feu interarmées.
- Les **différences dans la tactique, les techniques et les procédures** entre les partenaires de la coalition influent sur la capacité d'assurer la coordination avec eux dans le cadre de la prestation de l'appui-feu interarmées.

Recommandations :

- L'**échange de personnel** (au collège d'état-major, au quartier général, dans les unités tactiques et dans les établissements d'instruction) exige une planification de la relève pour faire en sorte que les connaissances collectives ne se perdent pas.
- Des **outils de planification avancée** pour aider à résoudre les questions de RE et les problèmes de restrictions nationales pourraient comprendre le JADOCs (système automatisé interarmées de coordination des opérations en profondeur), le système de suivi des forces bleues et les techniques de partage du renseignement. Ces outils doivent permettre les jeux de guerre et la production de « plans d'action ».
- Il faudrait instaurer des **normes et un programme d'instruction communs** dans tous les centres d'excellence de l'appui-feu interarmées (centres d'instruction) des pays qui participent à des opérations de coalition.
- Il faudrait assurer un **soutien linguistique** grâce à la technologie, p. ex., des services de traduction en ligne, l'accès à des listes d'abréviations, l'épellation phonétique des expressions communes et un soutien texte.
- Il faudrait effectuer des **exercices de coalition** plus fréquemment (ils ont lieu tous les huit ou neuf ans à l'heure actuelle).

Exigences en matière d'outils :

- **Outils pour résoudre les questions de planification**
 - ♦ **Soutien lié aux RE et aux restrictions de la coalition.** Outil ou base de données pour centraliser l'information sur les RE et les restrictions nationales, ainsi que leur utilisation, afin de pouvoir en tenir compte dans le processus de planification opérationnelle.
 - ♦ **Soutien lié à la mesure/l'estimation des dommages collatéraux (EDC).** Outil pour comprendre l'EDC de certains pays comparativement à celle des membres de l'OTAN et d'autres pays.
 - ♦ **Outil de répétition des opérations.** Outil pour appuyer la répétition des opérations d'une façon qui tient compte, par exemple, des différences dans les RE, les restrictions nationales et les capacités opérationnelles des forces en présence.
- **Outils pour résoudre les questions linguistiques**
 - ♦ **Système de renvois terminologiques.** Supplément à la gamme actuelle d'outils de planification opérationnelle, doté de caractéristiques permettant aux opérateurs de faire correspondre des termes utilisés par des partenaires de la coalition à des termes qu'ils peuvent comprendre plus facilement.
 - ♦ **Wiki terminologique.** Outil qui permet aux opérateurs d'ajouter rapidement des termes à un lexique, sans surcharge de travail.
 - ♦ **Traduction à la volée.** Outil qui permet de traduire rapidement les communications.
 - ♦ **Enregistrement et écoute de communications vocales.** Outil qui permet à un opérateur d'écouter le contenu de communications vocales après le fait; simple interface pour écouter des communications enregistrées.
 - ♦ **Soutien (sur le terrain) OOA/CAA.** Outils qui fourniraient les capacités susmentionnées sur le terrain.
- **Outils pour accroître la confiance**
 - ♦ **Réseautage social.** Outil de réseautage social (similaire au concept de Facebook, LinkedIn, MySpace ou Plaxo) pour aider les opérateurs à connaître d'autres opérateurs dans le théâtre et à créer un climat de confiance.

Importance : Ces travaux fournissent des connaissances et des renseignements détaillés qui décrivent les domaines et questions les plus préoccupantes pour le fonctionnement de l'appui-feu interarmées lorsque des forces coalisées participent à ce genre d'opération. Les résultats serviront à orienter l'élaboration future de moyens visant à améliorer et à renforcer la capacité des opérations coalisées d'appui-feu interarmées, et ils guideront les responsables du PDT AFI dans le choix des possibilités à examiner durant les phases de mise en œuvre et d'exploitation du PDT. Ces travaux peuvent avoir une incidence sur les capacités, les concepts, la doctrine, les opérations et l'équipement réels et éventuels des FC.

Project future : Les travaux futurs devraient comprendre une autre validation des recommandations en vue d'établir la faisabilité de la mise en œuvre et leur capacité d'influer de manière concrète sur les questions cernées qui touchent l'AFI de coalition. Les exigences des outils de planification avancée et des outils linguistiques devraient être élaborées plus à fond pour permettre le prototypage et l'évaluation de concepts et leur mise en œuvre.

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1 Introduction

1.1 General

When teams are required to work closely together and coordinate their efforts, differences between teams with respect to policy and procedure (such as those associated with rules of engagement (ROE)) and organizational structure and culture (such as army protocol vs navy; nation vs nation) may affect operational continuity, and consequently, the mission outcome.

These intra-team differences are typically moderated in single-force military operations by shared policies and procedures, and the development of a commonly understood organizational structure and culture. However, issues associated with team differences begin to find an expression in operations involving Joint Fires Support (JFS), in which air, sea, and/or land-based capabilities are coordinated toward a common effort of engaging both deliberate and dynamic targets through a planned fires/effects program. They find a much more challenging expression in the coalition JFS environment in which individual forces may potentially be required to transform or modify their operational strategy to collaborate with team-members representing different capabilities and nations to contribute to an integrated coalition task force.

An additional challenge with JFS in a coalition environment is that the number of potential coalition partners and operational environments (for example, active conflict, peace-keeping, or disaster relief) makes it difficult to identify the specific problems that will occur with all coalition partners in all environments. The Canadian Forces (CF) has solved this problem partially by developing common policies and procedures with other ABCA nations (America, Britain, Canada, and Australia). However, the CF continues to be involved in JFS with a sufficient number of other coalition partners (for example, France, Spain, Portugal, and the Netherlands) that the development of a full set of common policies and procedures is not feasible. It may, however, be possible to identify areas in which problems are most likely to occur and to predict what some of the more salient issues affecting mission outcome might be. If these areas can be identified, it should be possible to develop ways to ameliorate potential break down in performance as it relates to the human operator and the JFS team of teams.

The Human Factors analysis documented in this report focused on coalition aspects of JFS and identifies areas where single force operational doctrine/ strategy/ culture/ procedure/ policy may have an impact on the effectiveness of Joint Fires.

1.2 Project objectives

The overall purpose of this project is to conduct a Human Factors analysis in support of the JFS Technology Demonstration Program (TDP). The TDP is aimed at concept development, evaluation for force design, and the demonstration of technologies fostered by Defence Research & Development Canada (DRDC) and Canadian Industry in the context of real and potential future CF capabilities, concepts, doctrine, operations, and equipment. The TDP life cycle is 4 years and is broken down into formulation, definition, implementation, and exploitation phases.

The Human Factors analysis portion of the TDP as represented by the research documented in this report is intended to support the definition and implementation phases of the project. This research had three specific objectives:

- **Identification of issues.** The first objective of this research has three elements. First, it is to determine the primary areas of concern and issues with respect to differences in single unit (air, maritime, land) operational doctrine / strategy / culture / procedure / policy (hereafter called ‘soft factors’) that have an effect on the conduct of JFS (collaborative joint or coalition force operations). Second, it is to identify differences in the principles that component members of JFS use to compare, predict, and direct resources. Third, it is to identify the criteria used to measure how well JFS goals are achieved.
- **Development of recommendations.** The second objective of this research was to develop a set of recommendations aimed at ameliorating the issues identified and improving the success of coalition JFS operations.
- **Development of tool requirements.** Finally, a third objective of this research followed on from the completion of the first two. This objective was to develop requirements for tools to support officers in navigating the soft factors involved in operational planning in a coalition JFS context, and to support personnel in understanding the different languages (especially terminology and professional jargon) they may encounter in a coalition JFS environment.¹

1.3 Report purpose

The purpose of this report is to describe the work that was carried out to meet the objectives specified in Section 1.2. Specifically, this report documents the methodology followed and the results achieved, and also includes concluding material that summarizes the relevance of this work and makes recommendations for future work.

1.4 Report outline

This report consists of the following sections:

- Section One – Introduction
- Section Two – Methodology
- Section Three – Results and Discussion
- Section Four – Recommendations

It also includes the following Annexes:

- Annex A – Syndicate questions from JFS workshop
- Annex B – Structured interview questions

¹ This objective was added mid-way through the conduct of the project as an amendment to the original statement of work.

2 Methodology

2.1 General

This section describes the methodology followed to arrive at the results and recommendations presented in this report, and includes details of:

- the background research conducted to assist the team in gaining familiarity with the domain;
- the data collection activities that were conducted with members of the CF;
- the data synthesis and interpretation activities that were used to understand the data in the context of the project objectives;
- the development of issues, implications, and recommendations; and finally,
- the development of requirements for tools to support planning and the understanding of professional languages and terms across coalition partners.

2.2 Background research

We performed two activities to gain an understanding of the Joint Fires domain and potential coalition JFS issues. First, we reviewed documentation pertaining to the project that was provided to us by the project Scientific Authority (SA), and second, we attended a coalition JFS workshop. These activities ensured that we had an appropriate knowledge of the domain of coalition JFS to assist us in preparing for and conducting SME data collection activities. These activities are described in Sections 2.2.1 and 2.2.2 below.

2.2.1 Documentation review

To properly develop a methodology for investigating the soft factors that affect units engaged in JFS collaborative joint or coalition force operations, it was necessary to first develop an understanding of the scope and conduct of JFS operations. To help in obtaining this understanding, we reviewed the following documents:

- Canadian Chief of the Defence Staff (1999). *Firepower*. Canadian National Defence document no. B-GL-300-007/FP-001.
- Dooley, Patrick (26 June 2007). *Joint Fires Support Process Modelling – From As-Is to To-Be*. Unpublished presentation, Centre for Operational Research and Analysis Experimentation Operational Research Team.
- DRDC Canada (February 2008). *Joint Fires Support (JFS) TDP – JFS 101*. Unpublished presentation.
- Famewo, J.J., Taylor, T. E., Bruyn Martin, L. E., Matthews, M. and Keeble, R. (October 2008). Work Domain Analysis – (Section 4) in *Cognitive Work Analysis of Joint Fires Coordination*. Defence Research and Development Canada – Atlantic Contract Report, CR 2008-211.

- Jeffrey, Alfred (12 December 2007). *Joint Fires Support (JFS) TDP Weapons M&S*. Unpublished presentation, DRDC.
- JFS Project Team (14 February 2008). *Operating Concept for Joint Fires Support*. Unpublished manuscript.
- JFS Project Team (21 September 2007). *Strategic Context Analysis – Joint Fires Support – Draft v. 0.4*. Unpublished document.
- JFS Project Team (28 September 2007). *Joint Fire Support TDP Lexicon – Draft Document – Version 0.3*. Unpublished manuscript.
- JFS Project Team (Feb 4-6, 2008). *Joint Fires Working Group – Summary of Results*. Unpublished meeting minutes.
- JFS Project Team (January 2008). *Joint Fires Support TDP Overview – Draft, v. 0.4*. Unpublished manuscript.
- Lam, Sylvia & Woodward, LCdr Wally (2007). *Exploring command and control concepts for an Integrated Effect Coordination Cell using an Enhanced Tabletop Experimentation Approach – Report on the Integrated Effects Coordination Cell Exploratory Experiment (IECCEX)*. Defence Research and Development Canada - Ottawa Technical Memorandum TM 2007-286.
- Lam, Sylvia (2007). *Canadian Forces Joint Fire Support “As-is” Operational Architecture b. 1.1*. Unpublished report, Defence Research and Development Canada - Ottawa.
- *Overview of Joint Effects Support Technique Exploration and Refinement (JESTER) Joint Effects Coordination Centre (JECC) Model Process Activities*. Unattributed, unpublished document.
- US Joint Chiefs of Staff (13 April 2007). *Joint Targeting – Joint Publication 3-60*. Unpublished manuscript.
- US Joint Chiefs of Staff (13 November 2006). *Joint Fire Support – Joint Publication 3-09*. Unpublished manuscript.
- Woodward, LCdr Wally (26 June 2007). *Joint Effects Coordination Cell Exploratory Experiment (JECCEX) JFS WG Brief*, Unpublished presentation.
- Fraser, W. (2008). *JFS Metrics Collection and Analysis*. Unpublished presentation at JFS Community of Interest Working Group Interest Group, February 2008, Victoria, BC.

This documentation review was conducted informally, and was intended as a means of providing the Human Factors Engineering (HFE) analysts with appropriate background information, and as such, no formal documentation of the results of this work was produced.

2.2.2 JFS workshop

2.2.2.1 Introduction

A coalition JFS workshop was scheduled to be held concurrently with the beginning of the work on this project. Members of the HFE project team were requested to attend by the project SA, and

this workshop provided a useful venue for team members to gain more knowledge about coalition JFS operations in general, and specifically about the single force operational doctrine / strategy /culture /procedure / policy differences when units are engaged in JFS collaborative joint or coalition force operations. The workshop was held in Victoria, British Columbia from 4 to 6 February 2008. Its goal was to progress the various streams of research and work contributing to the JFS TDP. There were approximately 60 multi-national participants with presentations by all contributors to the JFS TDP.

As part of the workshop the HFE project team was asked to conduct a syndicate session to investigate the soft factors which affect JFS collaborative joint or coalition force operations. We used this opportunity to collect initial input on soft factors and related issues that would assist in the preparation of questions to guide the SME sessions we intended to conduct during the data collection phase of this work.

2.2.2.2 Results²

While the syndicate session generated a number of questions, its most useful outcome was a discussion of the issues around which questions should be asked to meet the project objectives. The list of questions generated in the syndicate working session in Victoria can be found in Annex A. The following is the list of potential JFS issues that was generated at the workshop:

- Application of the Laws of Armed Conflict (LOAC);
- ROE;
- National Caveats;
- Authorization / political imperatives;
- Tactical capability / response time / training;
- Cultural interpretation of success;
- Ethics / morals (personal and group); and
- Expectations of other coalition partners.

The following paragraphs provide background to the potential issues as they relate to the JFS problem area.

- **Application of the LOAC.** The LOAC arise from a desire among civilized nations to prevent unnecessary suffering and destruction while not impeding the effective waging of war. A part of public international law, LOAC regulates the conduct of armed hostilities. It also aims to protect civilians, prisoners of war, the wounded, sick, and shipwrecked. LOAC applies to international armed conflicts and the conduct of military operations and related activities in armed conflict. The Geneva Conventions are the basis of the LOAC. The application of LOAC includes the level of force allowed; one of the key principles is proportionality. The principle of proportionality establishes a link between the concepts of

² While this information does constitute a part of the results of this work, these results assisted us in developing the methodology for the data collection portion of the work, and they are included here to provide the reader with details of the method development.

military necessity and humanity. This principle implies that collateral civilian damage arising from military operations must not be excessive in relation to the direct and concrete military advantage anticipated from such operations.

- **ROE.** In military operations, the ROE determine when, where, and how force shall be used. Such rules are both general and specific, and there have been large variations between cultures / nationalities throughout history. Where LOAC limits the use of force through principles such as proportionality the ROE provides the military with permission to use force under specific circumstances. In the Canadian military, the inherent right to self defence cannot be withheld by ROE.
- **National Caveats.** A national caveat is generally a formal written restriction that most nations place on the use of their forces. There are also unofficial “unwritten” caveats imposed by military superiors at home. North Atlantic Treaty Organization (NATO) tactical commanders usually know nothing of these unwritten caveats until they ask a deployed subordinate commander to take an action and the commander says, “I cannot do this.” Collectively, these restrictions can be unpredictable and can limit the tactical commanders’ operational flexibility.
- **Authorization / political imperatives.** These issues are related to who are the coalition partners and what roles they are expected to play. In the JFS context it can limit partners for specific operations and complicate such aspects of an operation such as logistics and the designation of targets on the joint targeting list.
- **Tactical capability / response time / training.** The tactical capability of a fire support unit directly affects the employment of the unit and the planning of operations. The intent of JFS is to support troops, normally dismounted, and the support should not increase the risk to the soldiers.
- **Cultural interpretation of success.** This factor relates to how different nations judge success and failure and can translate into risk aversion. It can complicate the planning process as some nations will accept operational taskings while others will not.
- **Ethics / morals (personal and group).** The ethical or moral upbringing of individuals will affect their decision making and leadership styles / abilities.
- **Expectations of other coalition partners.** Expectations are derived from first or second hand experiences, and translate into trust and confidence in the performance of coalition partners.

2.3 Data collection

2.3.1 Interview method

The background research activities (Section 2.2) helped us to understand, at a high level, the soft factors that affect the conduct of JFS collaborative joint or coalition force operations. These broad issues were used to develop a data collection methodology to allow us to learn more about the effect of each of these issues on the conduct of JFS collaborative joint or coalition force operations. We developed a data collection method that aimed to develop more detail about each

of these issues through interviews with SMEs. These interviews were planned to be two-hours in duration, and involved two different interview techniques:

- **Semi-structured Critical Decision Method (CDM) interview.** Each SME session was planned to begin with a CDM interview (see Crandall, Klein, & Hoffman, 2006) in which SMEs were asked to think about operational situations that were made more complex by the soft factors present in JFS collaborative joint or coalition force operations. The use of the CDM technique assisted us in validating the types of issues generated in the JFS workshop (see Section 2.2.2) and in developing detailed information about the effects of these issues on specific operational situations. This portion of the interview was conducted by a team-member experienced in facilitating CDM interviews, and notes were taken by the interviewer and two other team members in attendance.
- **Structured interview.** At the conclusion of the CDM interview, we conducted a semi-structured interview using a set of questions prepared on the basis of the data gathered during the background research phase (see Annex B). These questions were designed to identify issues along the first two dimensions indicated in the first objective of this work (see Section 1.2). In addition to the questions indicated in the questionnaire, to satisfy the third dimension of the first objective of this work, the structured interview also involved a discussion of the performance measures, if any, that SMEs knew to be in place for JFS. To prevent the interview from being too stilted, the questions were delivered in a semi-structured discussion format, led by one team member. Other team members interjected questions as required to ensure coverage of the list of questions with each SME.³

The goal in using these techniques was to foster an atmosphere in which SMEs would be comfortable recounting what they actually did in specific situations, instead of simply reciting the published doctrine and normative procedures.

Data from these interviews was recorded as notes from each investigator. A debrief session was held after each interview to clarify any concepts that were unclear to individual interviewers, to refine the techniques being used, and to ensure the interviews had the proper focus. Notes were compared between investigators in the days after each interview to come to a single set of consolidated notes.

2.3.2 Subject matter experts

To ensure that we collected data representing the full breadth of the JFS domain, our data collection efforts focused on three main participants in the JFS domain, broadly categorized as the observer, the shooter, and the decision maker. For full coverage, it was important that all three levels of the ‘kill-chain’ were included in the data collection process.

We were able to interview SMEs from Canada and from a number of Canadian allies. The SMEs consulted are listed in Table 1 and Table 2 below.

³ An alternate, and potentially more repeatable, method would have been to either ask the questions in the questionnaire serially, or to have SMEs fill out a lengthy questionnaire. However, while this technique tends to be more repeatable, it is more tedious for SMEs and, in our experience, tends to generate results that are not as rich as those produced by a more free-form method.

Table 1: Canadian SMEs consulted during the data collection project phase

Subject Matter Expert	Current Position	Relevant Experience	Date Interviewed
Major Wade McHattie (representing decision maker)	Experimentation Team Lead Joint Fire Support Project Canadian Forces Experimentation Center	Kandahar Air field; Regional Command (RC) South – Dutch lead headquarters (HQ) with some Americans, Canadian, UK... changed half-way through to a British HQ which brought about many changes in the organization and the order of battle; UK lead, multinational HQ; Canadian point of contact for battle damage, fire support advice and liaison.	24 April 2008
Captain Crabbe (representing shooter)	Operations Officer Regimental FAC Standards Officer 2nd Regiment, Royal Canadian Horse Artillery	Bosnia Forward Observation Officer (FOO)/Forward Air Controller (FAC) Instructor Close Air Support (CAS) Leader – Gagetown 2 I/C Battery 2 Brigade E Battery Fire Support Coordination Centre (FSCC) Officer – TFK (FSCC is the joint contact for FOO/FAC)	30 April 2008
Sergeant Croft (representing observer)	Fire Support Coordination Centre NCO, 2nd Regiment, Royal Canadian Horse Artillery	Rotation 07-01 – FOO dismounted. Attached to an infantry company	30 April 2008
Sergeant Sajadi (representing observer)	Fire Support Coordination Centre NCO, 2nd Regiment, Royal Canadian Horse Artillery	AMFL – Allied Command Europe Task Force Kandahar (TFK) 07/01 Fire Support Control Centre – shift supervisor Rotation 0 Kabul	30 April 2008
LCol Gagne (representing decision maker)	Second-in-Command 2nd Regiment, Royal Canadian Horse Artillery	Rotation 07/01 TFK Staff Officer RC South	30 April 2008

Table 2: Foreign SMEs consulted during the data collection project phase

Subject Matter Expert	Current Position	Relevant Experience	Date Interviewed
Lieutenant Colonel Tom Schadegg, USAF (representing decision maker)	Chief, Joint Fires Integration Branch Joint Capability Integration and Fires Division (J85) United States Joint Forces Command	F-15E Weapon Systems Operator	15 May 2008
Mr. Herb Foret, Jr. US Department of Defence (DOD) Contractor (representing shooter)	Systems Analyst	Retired USAF F-16 Pilot with experience related to Unmanned Aerial Systems (UAS)	15 May 2008
Mr. Mike Shifflet, DOD Civilian (representing shooter and observer)	Deputy, Joint Fires Integration Branch Joint Capability Integration and Fires Division United States Joint Forces Command	Retired US Army Officer with experience in Field Artillery, Army Aviation (CH-47), Defense Acquisition, and Unmanned Aircraft Systems	15 May 2008
Mr. Tom Jucks, DOD Contractor (representing shooter)	Systems Analyst	Retired US Army Field Artillery Officer	15 May 2008
Maj Heikki Mansikka, Finnish Air Force (representing shooter and observer)	Finnish Exchange Officer to US Joint Forces Command (USJFCOM)	F-18 Pilot	15 May 2008
Mr. Bill Mitchell, DOD Contractor (representing decision maker)	Systems Analyst	Retired US Marine Corps Officer with experience in Marine Corps Aviation (CH-46) and Information Operations	15 May 2008

2.4 Data synthesis

2.4.1 Data categorization

Our data collection activities resulted in a broad set of data which, to be usable for the purpose of generating a set of implications and recommendations, required structuring and synthesis. We used a two-dimensional categorization to help structure the data, as follows:

- **Dimension 1: Work domain subsystems / subsystem functional purposes.** Previous work conducted for DRDC (Famewo, Taylor, Bruyn Martin, & Matthews, 2008) has analysed the work-domain of JFS collaborative joint or coalition force operations with a work-domain analysis, resulting in an abstraction-decomposition space for this work domain. This analysis structured the work-domain into a set of subsystems, each of which was found to

have an integrated functional purpose. These subsystems with their functional purposes are a high-level way of expressing both the high-level functional decomposition of the work-domain and the reason why each of the subsystems has been instantiated within the work-domain of JFS collaborative joint or coalition force operations. Accordingly, they seemed to form an appropriate high-level categorization for the issues we learned about from operators during our data collection activities. These subsystems with their functional purposes are as follows:

- ♦ **Intelligence.** The intelligence subsystem has been instantiated to collect, maintain, integrate and analyze all relevant data/information to promote and maintain situational and battle space awareness for support of land combat operations through joint fires.
- ♦ **Planning.** The planning subsystem has been instantiated to continually prioritize and plan fires that will put into effect Commander's Intent and optimize resource allocation.
- ♦ **Command & Control (C2).** The C2 subsystem has been instantiated to make decisions and provide guidance to enable joint fires to support land combat operations, to implement plans and direct units to achieve Commander's Intent as expressed by planning objectives, and to develop the Commander's Intent based on political and operational goals.
- ♦ **Coordination.** The coordination subsystem has been instantiated to synchronize fires (lethal and non-lethal) in time, space and purpose between land, sea and air units to support land combat operations.
- ♦ **Communication.** The communication subsystem has been instantiated to enable information to be exchanged between system components to support situational and battlespace awareness.
- ♦ **Delivery of fires.** The delivery of fires subsystem has been instantiated to deliver fires with accuracy in accordance with Commander's Intent.
- ♦ **Logistics.** The logistics subsystem has been instantiated to provide management of ordnance and resources (including personnel) to support delivery of fires.
- ♦ **Manoeuvre.** The manoeuvre subsystem has been instantiated to enable assets to move into position to achieve desired effects in accordance with Commander's Intent.
- **Dimension 2: Soft factor categories.** The second dimension was derived from our experiences with JFS since commencing with the background research phase of this work (see Section 2.2), which indicated that the soft factors that affect the conduct of JFS collaborative joint or coalition force operations typically fall into the following categories:
 - ♦ **Trust and confidence.** Issues relating to the allocation of trust and confidence based on reputation and preconceived notions of a coalition partners' ability to perform in a given situation or environment.
 - ♦ **Language.** Issues relating to potential or actual confusion created by differences in languages and terminology between coalition partners.

- ◆ **National Caveats.** Issues relating to challenges introduced by differences in operational and tactical decision-making and conduct due to perceived or actual effects of National Caveats.
- ◆ **ROE.** Issues relating to challenges introduced by differences in the ROE held by various coalition partners.
- ◆ **Training.** Issues relating to challenges introduced by real or perceived differences in training and skill among personnel from coalition forces.
- ◆ **Tactics, techniques, and procedures.** Issues relating to challenges introduced by differences in the conduct of operations by coalition members, and the potential misunderstandings that these differences can cause.

This categorization scheme was applied to the data collected by considering each point included in our consolidated notes and categorizing them by subsystem and soft factor category as appropriate. *Summary statements* were added to related items of evidence to indicate the broader issue indicated by the evidence. This resulted in a set of tables, each corresponding to a subsystem, which documents the way in which each of the soft factors identified affects that subsystem. These tables are not included in this report but can be obtained from the contract Scientific Authority.

2.4.2 Issue identification

While the categorization of the source data (see Section 2.4.1, above) resulted in a large amount of data, the two-dimensional structure allowed the project team to begin to see patterns in the data. Most importantly, similar summary statements were noticed across multiple subsystems. This finding led us to bring all the summary statements into a single table along with information about which subsystem(s) each summary applied to. Related summary statements were merged into common summaries which, at this point, were identified as *issues* in the JFS work domain related to the various soft factors in effect.

The process of issue identification was iterative, with various team members working separately to consolidate the issues, which in team meetings were then modified as necessary and provisionally validated as an appropriate reflection of our data collection activities.

The issues that were identified are documented in Section 3.2.3, in a larger table that also includes the recommendations that were developed (as described in the next section).

2.4.3 Recommendation development

After the issues in the JFS work domain related to the various soft factors in effect were identified, the project team met to develop *recommendations* to ameliorate those issues. We found that this task was facilitated by first developing the *implications* that follow from each of the *issues* that were identified. These *implications* typically pointed clearly to one or more *recommendations*, and were an effective bridge between the *issues* and the *recommendations*.

The recommendations that were developed can be found in Section 3.2.3.

2.4.4 Validation

The work of data synthesis described in Sections 2.4.1 - 2.4.3 was done based on data collected from SMEs. However, the line of reasoning from specific items of evidence collected from SMEs through issues and implications to recommendations was not directly influenced by SME input. To ensure that our lines of reasoning and the recommendations were sound, we convened a series of SME meetings to validate this work.

These validation meetings were planned as two-hour meetings with pairs of SMEs. Requests were made to identify SMEs with similar characteristics to those interviewed in the data collection phase (see Section 2.3.2), so that there would again be SME representation across the ‘kill chain’. The objective of these meetings was to work through the table of *issues, subsystems, implications, and recommendations* in detail, and to obtain comments on their validity from SMEs.

Members of the project team visited with SMEs at Canadian Forces Base (CFB) Valcartier on two separate occasions, as detailed in Table 3, below.

Table 3: SMEs consulted during the data validation project phase

Subject Matter Expert	Relevant Experience	Date Interviewed
Maj Smith	14 years in regular forces; served in Bosnia as a FAC, and has served as a gunnery instructor. Has conducted JFS exercises at Regiment/Brigade level. In theatre was the commander of a 155mm Howitzer battery.	25 June 2008
MWO Angel	24 years in regular forces. Served as FSCC Warrant Officer in Battle group HQ.	25 June 2008
Capt Cloutier	8 years in regular forces; served as FSCC in Rotation 4. Spent 1.5 years as a FOO/FAC. Most joint experience is at the battle group level.	23 July 2008
Capt Raymond	15 years in regular forces; served in reserves prior to that. Spent 10 months at Joint Task Force (Afghanistan) (JTF(A)) FSCC, and supported the coalition and other nations.	23 July 2008

The SMEs were in agreement with the majority of the materials with which they were presented, and made only minor comments to correct or supplement them. As there was a month between the two validation meetings, the changes indicated in the first meeting were incorporated and reviewed at the second meeting. The SMEs at the second meeting were in agreement with the changes proposed by the first group of SMEs, and themselves added some additional comments. Those comments were incorporated to produce the version of the findings presented in Section 3.2.3.

2.4.5 Consolidation of recommendations and feasibility

After the final version of the findings presented in Section 3.2.3 was produced, the project team met to consolidate the recommendations that were developed into a list of five high-level recommendations that could be pursued by the CF to help operators more successfully navigate the effects of soft factors that affect the conduct of JFS collaborative joint or coalition force operations.

These recommendations are presented in Section 3.3 along with a brief comment on their feasibility.

2.5 Development of tools requirements

2.5.1 General

While the data collection and analysis phase of this project, described in Sections 2.3 - 2.4, achieved the first two project objectives (see Section 1.2), the third project objective – to develop requirements for tools to help operators navigate and mitigate some of the effects of the issues that were identified – still remained to be achieved. The project SA reviewed the recommendations that were developed (see Section 3.3) and requested that we develop the requirements for two types of tools:

- Advanced planning tools (reference recommendation 2), and
- Tools for language support through technology (reference recommendation 4).

Our objective was to develop requirements for these tools, and accordingly the majority of the work toward achieving this objective was done through consultation with SMEs. The consultation and requirements development process we followed is described in the sections below.

2.5.2 High-level requirements identification

A workshop was held on 3 October 2008 for the purpose of consulting with SMEs and working with their experience to brainstorm some initial high-level requirements for tools to support planning and language. Two SMEs already consulted in earlier phases of the project, LCol Gagne and Maj McHattie (see Table 1 in Section 2.3.2 for their profiles), participated in this workshop along with the JFS TDP project SA, Dr. Alfred Jeffrey, and members of the project team.

The objectives of this workshop were to review the project results to date and to brainstorm broadly about the varied types of tool support that could be offered to support the planning and language recommendations developed. Once a number of different tools had been identified, the workshop had as its final objective to develop high-level requirements for these tools.

2.5.3 Requirements development

The high-level requirements definition workshop resulted in the identification of a number of tools ideas along with some brief ideas of the requirements for those tools. In addition to tools to support planning and language, the workshop also resulted in the identification of a tool, social networking (like the civilian Facebook), to assist in the development and maintenance of inter-personal trust.

The project team conducted a number of team meetings to flesh out the requirements for these tools, and also supplemented their ideas with input from SMEs consulted during a syndicate session at a JFS symposium held on 8 October 2008. The result of this work was a series of short

descriptions of proposed tools, which include a set of high-level requirements and some more detailed design ideas that could be enacted to achieve those requirements.

2.5.4 Requirements validation

The final step in the development of tools' requirements was to validate and extend the high-level requirements through an additional workshop with SMEs. To achieve this, the project team met with two SMEs, Maj McRory and Capt Underhill, on 20 November 2008. These SMEs were similar in profile to previous SMEs consulted in the course of this work, but since they had not previously been consulted it was hoped that they would be able to provide comments from a fresh perspective. The workshop was held at CFB Kingston and was 3 hours in duration, during which the project team introduced the overall project and then presented each individual tool concept for discussion. Each team member took notes of the discussion which were consolidated in a debrief session held shortly after the meeting.

The SME comments from the consolidated set of notes were integrated into the descriptions of the proposed tools, and these revised descriptions are presented in Section 3.4.

3 Results and discussion

3.1 General

During the data synthesis portion of the work, SME feedback was grouped by work domain subsystems / subsystem functional purposes (category 1), and soft factor categories (category 2), as explained in Section 2.4.1. The SME feedback was then consolidated into summary statements that captured the intent of like statements from the SME participants.

The CMC HFE team used the two dimensional framework and the summary statements to identify implications for each issue, as well as to make recommendations regarding a possible means to address the issues in a coalition joint fires context.

It should be noted that none of the SMEs that participated in this work were aware of any performance measures that are currently being used, or have previously been used, to measure joint fires support effectiveness. Consequently, we were not able to identify any criteria used to measure how well JFS goals are achieved (the third element of the first project objective; see Section 1.2). To be clear, this does not mean that such criteria do not exist, but only that these criteria were not known by the SMEs that we consulted.

3.2 Data synthesis

3.2.1 Synthesis by subsystem

As described in Section 2.4.1, the previous work by Famewo *et al.* (2008) provided a decomposition of the JFS system into eight subsystems. These subsystems were used to group the results of the data collection and provide a framework for the interpretation and results.

More detailed information on the data gathered can be obtained from the contract Scientific Authority.

3.2.2 Synthesis by category

The final step in our data synthesis was to distil the issues out of the data referenced in Section 3.2.1, and to transform them to present the specific issues within each category along with the subsystems related to each issue. This view on the data assisted us in focusing on specific issues, formulating implications, and making recommendations.

Table 4: Data synthesis for the *trust and confidence* category

	Intelligence	Planning	C2	Coordination	Communication	Delivery of fires	Logistics	Manoeuvre
Summary statements – Trust and confidence category								
Coalition partners (at the organizational level) have different trust levels for sharing information with one another. These levels of trust supplement formal agreements to direct the ways in which intelligence is disseminated.	✓							
Individuals also have different levels of trust for sharing information with one another across coalition boundaries.	✓							
Operators must have confidence that they are privy to the right information to conduct a nation's operations in a coalition context.	✓							
Operators must convey and package intelligence in a way that is credible and believable by other coalition partners.	✓							
Past knowledge of other nation's actions (success or failure on operations) affect the planning process.		✓						
Trust and confidence in the leadership (leaders from other nations) has a trickle down affect.			✓					
Trust and confidence are best built through direct contact.			✓					
Coalitions are very much political in design and nature with bureaucracy amongst some nations is a large issue.			✓					
There are cross-cultural challenges when working in a coalition environment.				✓				
Close planning can assist with coordination.					✓			
Commanders' intent is best communicated with an integrated and coordinated team.					✓			
Increased trust and confidence allows for more delegation which can lead to a more flexible organization.						✓		
Positive previous experience with national partners is an important factor that leads to increased confidence, willingness to participate, and reduced mission timelines.						✓		
Having trust and confidence in intelligence products, as well as in other troops, is essential in establishing sufficient criteria to deliver effects.						✓		
Continually changing priorities, and lack of perceived focus on troop support, leads to uncertainty in coalition operations.							✓	
Nations need to be confident of collaborators tactics, techniques, and procedures prior to deploying with them as a unit; this has the potential to increase timelines and delay deployment and re-supply.							✓	

	Intelligence	Planning	C2	Coordination	Communication	Delivery of fires	Logistics	Manoeuvre
Summary statements – Trust and confidence category								
Reports of nation's capabilities quickly permeate through the coalition organization and can lead to both positive or negative preconceptions and willingness to participate with subject nations.							✓	

Table 5: Data synthesis for the *language* category

	Intelligence	Planning	C2	Coordination	Communication	Delivery of fires	Logistics	Manoeuvre
Summary statement – Language category								
Operators must manage different meanings of terms related to intelligence classification.	✓							
The time / level of effort in planning is compounded by language issues.		✓						
Language misunderstandings happen everyday – these are apparent within the C2 element of JFS.			✓					
In a multi-lingual environment, you need to ensure that orders are understood and written properly.				✓				
Differences in terminology can make planning difficult.				✓				
Language is an important factor in communications, because terms may not be understood at all, or in the same way, by different cultures.					✓			
There are many abbreviations to work through in communications, and this is complicated by the coalition context.					✓			
Having a common language (for example, brevity terms, English) is not sufficient in itself to eliminate language issues which delay timelines, a common understanding of the intended meaning of the terms is also critical.						✓		

Table 6: Data synthesis for the *National Caveats* category

	Intelligence	Planning	C2	Coordination	Communication	Delivery of fires	Logistics	Manoeuvre
Summary statement – National Caveats category								
National Caveats affect the way that intelligence products are disseminated.	✓							
Operational planning must consider all National Caveats and make considerations when they may or may not be exercised.		✓						
Planning is one aspect of Coalition operations that increases workload – “planning is a major problem (60-70 people at planning meetings in Afghanistan)		✓						
In order to prevent rework, each participant’s ROE must be fully understood when planning operations.		✓						
At the C2 level National Caveats are political tools that may be used by leaders to the detriment of the overall operation.			✓					
National Caveats are part of the work environment at the operational HQ level.			✓					
Nations will not always agree to attack targets on the Joint Targeting List.				✓				
Participation in conflict can be determined by the interpretation of the activity of a potential target vis a vis a nation’s National Caveats.				✓				
Some communications channels are important, but can only be used if personnel from the nation owning the equipment are present.					✓			
National Caveats affect interconnectivity between coalition partners.					✓			
Differences in the political climate of nations affect their usage of National Caveats.						✓		
Force employment limitations can be imposed by National Caveats.						✓		
There are no explicit rules indicating when National Caveats will be called upon; they can be the result of political pressure while other times they may be used at the discrimination of the commanding officer at the time of a given situation.						✓		
In situations of TIC National Caveats are seldom evoked as the collective safety of the coalition troops is recognized as being the larger objective.						✓		
National Caveats are used to avoid participation in operations/ activities that do not support a nation’s individual objectives or tactics.							✓	

Table 7: Data synthesis for the **ROE** category

	Intelligence	Planning	C2	Coordination	Communication	Delivery of fires	Logistics	Manoeuvre
Summary statement – ROE category								
Intelligence products can assist operators in exercising the ROE.	✓							
ROE are a constant consideration when planning missions and generally partners must operate under the most restrictive ROE.		✓						
Dealing with ROE adds to workload. More staff work is generated and response time is increased – providing an advantage to the adversary.		✓						
As clear as ROE are meant to be they are still open to interpretation by nations.			✓					
ROE when dealing with coalitions increase the workload within the C2 organization.			✓					
ROE need to be coordinated to plan JFS in a coalition environment.				✓				
ROE are quite well defined and less susceptible to interpretation (than National Caveats).						✓		
Instances of troops in contact (TIC) create sufficient conditions where nations will “work” their ROE to participate in collective defence.						✓		
Different national ROE create discrepancies in the levels of force applied to situations.						✓		

Table 8: Data synthesis for the **training** category

	Intelligence	Planning	C2	Coordination	Communication	Delivery of fires	Logistics	Manoeuvre
Summary statements – Training category								
The level of training with respect to operational planning and JFS affects the employment of forces.		✓						
Training at the C2 level affects the ability to operate an effective HQ.			✓					
There were differences between coalition nations in terms of the timeline for operations planning.				✓				

	Intelligence	Planning	C2	Coordination	Communication	Delivery of fires	Logistics	Manoeuvre
Summary statements – Training category								
The coalition environment introduces novel training requirements, as new equipment and systems may be resident as coalition assets.						✓		
Familiarization training on coalition assets, coalition partners ROE, and operating standards would reduce confusion and decrease response timelines.						✓		
Varying level of tactical training may contribute to delays in response timeline or lead to unsafe operating conditions.						✓		
Training as a facilitator/ negotiator is an important factor in being able to coordinate support from other nations and can greatly reduce timelines.							✓	
Understanding the disparate systems operating in coalition environments is difficult and can lead to increased timelines in executing operations.							✓	

Table 9: Data synthesis for the *tactics, training, and procedures* category

	Intelligence	Planning	C2	Coordination	Communication	Delivery of fires	Logistics	Manoeuvre
Summary statement – Tactics, training, and procedures category								
Differences in tactics, techniques, and procedures can affect the way that intelligence is collected.	✓							
There currently exist specific procedures to request information within the coalition.	✓							
Intelligence is shared by ensuring that coalition nations have personnel inserted into the coalition intelligence groups.	✓							
The application of a common “operational planning process” is required to prevent increased workloads.		✓						
Complete planning requires additional factors.		✓						
The style of C2 has impacts on many aspects of a coalition operation.			✓					
Coalition partners are not always familiar with or notified of the equipment that will be used by each other; this can cause misunderstandings.			✓					

Summary statement – Tactics, training, and procedures category	Intelligence	Planning	C2	Coordination	Communication	Delivery of fires	Logistics	Manoeuvre
The C2 structure slowed the process. Issues that take more time are: logistics, ammo requests, food, water, force protection, convoy generation.			✓					
Tactics, Techniques and Procedures can affect how commander's intent is disseminated.			✓					
Common procedures assist in smooth coordination.				✓				
It is difficult and time consuming to target or plan operations on time sensitive targets in a coalition environment.				✓				
Ground forces were not always well coordinated between coalition nations; battle-space synchronization can be a major problem.				✓				
In a conventional war, the JFS capability could be compromised by a large target list.				✓				
Knowledge of techniques, tactics, and procedures is essential to planning JFS in a coalition environment.				✓				
In some situations, deconfliction is best achieved through procedural means.				✓				
Some required work seems to fall through the cracks in a coalition environment.				✓				
NATO doesn't procure communications equipment, and so there is a large challenge in systems integration.					✓			
Coalition operations place strains on the communications infrastructure.					✓			
Communications channels are important, and Satcom and beyond-line-of-sight communications are a precious commodity.					✓			
Critical persons in the decision chain (for example, planning, FOO, FAC) must be aware of all coalition partners ROE as well as coalition asset capabilities, limitation, and kinetic effects.						✓		
Tactical level support is not complicated by participation in coalition activities.						✓		
A base level of standardized training regarding the conduct of joint fires would decrease confusion and response timelines.						✓		
Exposure to multi-nation tactics, techniques, and procedures would reduce to instances of directed request for support and allow for a more flexible operations environment.						✓		

Summary statement – Tactics, training, and procedures category	Intelligence	Planning	C2	Coordination	Communication	Delivery of fires	Logistics	Manoeuvre
Aspects of the battlespace environment (for example, geography, unarmoured vehicles, and multi-national priorities) make logistical support and re-supply difficult and may lead to increased response timelines.							✓	
Commanders intent and mission objective must be clear and accurate prior to deployment to reduce the dependence on logistics support and re-supply.							✓	
Coordinating assets with other nations involves negotiation and increases timelines.								✓
Participation in coalition activities required assurance of appropriate tactics, techniques, and procedures, prior to deployment, which increased timelines.								✓
Air support from allied nations worked effectively in the coalition environment.								✓

3.2.3 Overall synthesis with implications and recommendations

The following table contains the coalition joint fires issues related to soft factors that were identified, and the associated implications and recommendations. A summary of the recommendations is provided in section 3.3.

Table 10: Overall data synthesis with implications and recommendations

Summary Issue	Subsystem(s) affected	Implication	Recommendations
Trust and confidence (HQ effectiveness). Trust and confidence at the HQ level is established through individuals' one-on-one exposure to each other. The more trust and confidence you have that your coalition partners have an accurate understanding of their troops' ability to support an activity the easier the planning process will be, relevant information will be more available, and workload will be more distributed throughout the coalition HQ.	<ul style="list-style-type: none"> ▪ Intelligence ▪ Planning ▪ C2 ▪ Coordination 	<ul style="list-style-type: none"> ▪ Information may or may not be shared with other nations due to factors such as: source of the information or how it was obtained, and previous experience with the other nation. It is important to be able to filter which information is sent out and to whom. ▪ Unless in a coalition with ABCA nations, allocation of work can be an issue, including levels of workload and style of delegation can be effected. The 80/20 rule is applicable at a coalition HQ, where 20% of the people are doing 80% of the work. ▪ Extra staff review – trusted staff will be required to review the work/recommendations from certain groups/persons until trust and confidence is developed. 	<ul style="list-style-type: none"> ▪ Allow for more exchange positions in foreign division-level positions. This will allow for a better knowledge of cross-coalition differences in equipment, working style, and terminology. ▪ Cross training / billets for foreign personnel at national Staff Colleges / War Colleges. ▪ Common curriculum. ▪ Shared standards
Trust and confidence (force employment). Trust and confidence at the force employment level is established through corporate knowledge of or experience with the capabilities of other forces. For example, one coalition partner may gain trust in the capabilities of another coalition partner through direct or second-hand experience, and this trust may or may not reflect that partner's actual capabilities or willingness to fight.	<ul style="list-style-type: none"> ▪ Intelligence ▪ Delivery of Fires ▪ Logistics 	<ul style="list-style-type: none"> ▪ Efficient employment of forces. Some forces will be called upon more often while others are kept out of the fight. 	<ul style="list-style-type: none"> ▪ Integration of personnel into foreign units. ▪ Plans must allow for flexibility in terms of which coalition partner ends up performing a task, because the partner to be employed may have to change. Ability to plan numerous Courses of Action (COAs) based on friendly force participation. ▪ Conduct ABCA coalition exercises more frequently than the current 8-9 year schedule.
Language. There are three types of language differences that can cause confusion in coalition operations: (1) differences in the actual language spoken (for example, German vs. English); (2) differences in the military language used (for example, STANAG compliant vs. not STANAG compliant); and (3) differences in understanding of specific terms of a shared actual or military language. These three factors can prevent proper understanding of the meaning of communications across coalition boundaries.	<ul style="list-style-type: none"> ▪ Intelligence ▪ Planning ▪ C2 ▪ Coordination ▪ Communication ▪ Delivery of Fires 	<ul style="list-style-type: none"> ▪ Timelines – increased by the need to question, confirm, repeat, and translate. ▪ Errors - misinterpretations 	<ul style="list-style-type: none"> ▪ Allow for more exchange positions in foreign division-level positions. This will allow for a better knowledge of cross-coalition differences in equipment, working style, and terminology. This should be augmented with succession planning that then captures the corporate knowledge generated from the posting. ▪ Cross-train at command posts prior to deployment. ▪ ABCA coalition exercises more frequently than the current 8-9 year schedule. ▪ C2 planning tool with a robust lexicon. ▪ Training with an emphasis on communications - colloquialisms, cultural meaning of terminology, etc. ▪ Exposure to phonetic pronunciations of STANAG terms and brevity words. ▪ Support voice communications with text chat. ▪ Provide an intelligent translation tool (military terminology).
National Caveats. Reflect the changing political will of a country, and are open to interpretation by a commanding officer. Consequently, there are no hard and fast rules as to how these caveats will be applied, and knowledge of their effect can only be known for a specific request at a specific point in time.	<ul style="list-style-type: none"> ▪ Intelligence ▪ Planning ▪ C2 ▪ Coordination ▪ Communication 	<ul style="list-style-type: none"> ▪ Workload is increased and planning takes additional effort because plans must allow for re-planning and re-tasking due to problems with National Caveats. 	<ul style="list-style-type: none"> ▪ Information about National Caveats needs to be recorded and available as opposed to only being kept in officers' heads. ▪ Planning tool that supports the development of multiple alternative plans (based on National Caveats) to provide flexibility of operations as nations join and leave the fight. ▪ War gaming exercises that develop skills in making and switching

Summary Issue	Subsystem(s) affected	Implication	Recommendations
	<ul style="list-style-type: none"> Delivery of Fires Logistics 	<ul style="list-style-type: none"> Timelines are increased as planning either takes potential playing of National Caveats in to place or need to negotiate once a NC is played. Effective employment of forces Sharing of intelligence products is complicated 	<ul style="list-style-type: none"> between alternative plans. Inclusion of exchange officers in National HQ-level planning. Tracking of National Caveat play; must be available within the planning tool. Planning of operations that take into account National Caveats and balance the work. Working groups that discuss application of National Caveats. Rules within a C2 planning tool which allows for seamless transfer of information to predetermined nations. Reduce the fidelity of or access to intelligence products as required to protect the intelligence source.
<p>ROE. ROE are not well understood across all coalition partners. Further, ROE are open to subtle differences of interpretation. Consequently, personnel learn through experience that there are some partners who are willing to 'work' their ROE as a means to allow for participation in an operation, while other partners are more prone to use their ROEs to block participation.</p>	<ul style="list-style-type: none"> Intelligence Planning C2 Coordination Communication Delivery of Fires 	<ul style="list-style-type: none"> Workload is increased by the need to know all coalition partners ROE Interpretation (difference between hostile act or hostile intent vs a non-military criminal act etc.) <ul style="list-style-type: none"> Impacts level of force applied Ability / willingness to participate - a coalition force is required to operate under the most restrictive ROE in affect (for example, a group composed of more than one nationality may be restricted from a given task if it is not allowed under all nations' ROE). 	<ul style="list-style-type: none"> Provide a system that will group nations/forces that are operating under similar ROE. Coalition repository to store the ROE of all coalition partners. Briefings by national representatives (lawyers) on their nation's ROE. Coalition repository to store the ROE of all coalition partners, with allowance for private annotations from each nation about trends in ROE use.
<p>Tactics, techniques, and procedures. Coalition partners have different TTPs, and so have personnel or units who are more or less capable of interoperation with other coalition partners.</p>	<ul style="list-style-type: none"> Intelligence Planning C2 Coordination Communication Delivery of Fires Logistics Manoeuvre 	<ul style="list-style-type: none"> There is no common Operational Planning Processes (note, however, that the OPPs of ABCA nations are similar). <ul style="list-style-type: none"> Commanders intent Errors/ Timelines (including Logistics support) Targeting process gets bogged down Decision making / C2 model can vary <ul style="list-style-type: none"> centralized = flexible decentralized = fast (requires more trust and confidence in subordinate commanders) Battle space coordination is made more difficult by discrepancies between capabilities Airspace de-confliction <ul style="list-style-type: none"> workload Increased workload related to work with multiple circuits/ systems (HQ JFCC will have multiple radios to talk to all fires support units) Increased workload for FOO/ FAC Increased timelines 	<ul style="list-style-type: none"> Cross training / billets for foreign personnel at national Staff Colleges / War Colleges. Exposure to several decision making models - development of courses of action. Planning tool that provides for multinational input to the Joint Targeting List Cross training / billets for foreign personnel at national Staff Colleges / War Colleges. Exposure to several decision making models - development of courses of action. Allow for more exchange positions in foreign brigade/formation HQ positions. This will allow for a better knowledge of cross-coalition differences in equipment, working style, and terminology. Common tactical blue force tracking tool Common tactical blue force tracking tool Common equipment (not very likely) One common tool that allows for communications in support of JFS More training on the procedures of other nations. Cross training. More training on the procedures of other nations.

Summary Issue	Subsystem(s) affected	Implication	Recommendations
		<ul style="list-style-type: none"> Nations will spend time to confirm Tactics, Techniques, and Procedures of other Nations 	<ul style="list-style-type: none"> Cross training.
Training. Coalition partners have different standards for the content and conduct of training, and so have personnel who are more or less capable of action at a level comparable with other coalition partners. In addition, some coalition partners may also have different standards for promoting personnel to senior ranks.	<ul style="list-style-type: none"> Planning C2 Coordination Delivery of Fires Logistics 	<ul style="list-style-type: none"> Timelines are extended in planning and control functions <ul style="list-style-type: none"> Different battle rhythms. 	<ul style="list-style-type: none"> Cross training / billets for foreign personnel at national Staff Colleges / War Colleges.
		<ul style="list-style-type: none"> Workload is increased 	<ul style="list-style-type: none"> Common curriculum. Shared standards
		<ul style="list-style-type: none"> Difference in negotiation skills can cause suboptimal allocation of taskings to units. 	<ul style="list-style-type: none"> Enhanced training to include more esoteric subjects such as interpersonal skills, leadership, and negotiations.
		<ul style="list-style-type: none"> Safety - nations provide JFS with varying degrees of accuracy 	<ul style="list-style-type: none"> Embedding instructors in other nation's schools. Common curriculum. Shared standards
		<ul style="list-style-type: none"> Timelines - nations with lower levels of proficiency will take more time to respond to calls for fire, or will be less accurate requiring additional support. 	<ul style="list-style-type: none"> Embedding instructors in other nation's schools. Common curriculum. Shared standards ABCA and broader NATO coalition exercises.
		<ul style="list-style-type: none"> Reluctance to call for fire (from certain Units) 	<ul style="list-style-type: none"> Integration of personnel into foreign units while in theatre.

3.3 Consolidation of recommendations and feasibility

This section consolidates the recommendations presented in Section 3.2.3, and also provides some comments on the feasibility of implementing each recommendation. This information is provided in Table 11, below.

Table 11: Consolidation of recommendations and feasibility

Recommendation	Coalition Joint Fires Issues Addressed	Feasibility															
<p>1. Exchange of personnel. The opportunity to create an active Exchange of Personnel between ABCA nations (at minimum) at Staff Colleges, training establishments, headquarters, as well as embedded in tactical units, is seen as a means to assist operators in navigating the effects of many of the soft factors that have an effect on the conduct of JFS collaborative or coalition force operations.</p> <p>If implemented, there will need to be a large emphasis placed on succession planning to ensure corporate knowledge gained by the exchange personnel is not lost during successive posting cycles.</p>	<ul style="list-style-type: none"> ▪ Trust and confidence (HQ effectiveness) ▪ Trust and confidence (force employment) ▪ Language ▪ National Caveats ▪ Tactics, techniques, and procedures ▪ Training 	<table border="1" data-bbox="938 562 1393 659"> <thead> <tr> <th colspan="5">Feasibility</th> </tr> <tr> <th>Low 1</th> <th>2</th> <th>Medium 3</th> <th>4</th> <th>High 5</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> </tbody> </table> <ul style="list-style-type: none"> ▪ The concept of exchange of personnel is embraced by all levels of the CF, however, given the current personnel shortage it would be remiss of Commanders to further stress their units by allowing personnel to be sent to exchange postings. ▪ To cause an increase in exchanges there would need to be a strong champion pushing for exchanges in each of the force generation commands (Chiefs of the Maritime, Land, and Air Staff (CMS. CLS, CAS)). ▪ The Chief of Military Personnel (CMP) organization would need to develop an Human Resources strategy that identified the exchange of personnel to foreign militaries as a critical enabler for future operations. ▪ There needs to be effective succession planning to ensure exchange personnel are properly employed after the exchange posting. ▪ Given the change required, feasibility is deemed to be low in the short term and medium in the long term. 	Feasibility					Low 1	2	Medium 3	4	High 5	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Feasibility																	
Low 1	2	Medium 3	4	High 5													
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>													
<p>2. Advanced planning tools. Through the HFE analysis of the soft factors that have an effect on the conduct of JFS, it became evident that there is a need to develop/ procure Advanced Planning Tools focused on command and control planning, blue force tracking, intelligence sharing, war-gaming and the generation of courses of action, national</p>	<ul style="list-style-type: none"> ▪ Trust and confidence (HQ effectiveness) ▪ Trust and confidence (force employment) ▪ National Caveats ▪ ROE ▪ Tactics, techniques, and procedures 	<table border="1" data-bbox="938 1472 1393 1568"> <thead> <tr> <th colspan="5">Feasibility</th> </tr> <tr> <th>Low 1</th> <th>2</th> <th>Medium 3</th> <th>4</th> <th>High 5</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> </tbody> </table> <ul style="list-style-type: none"> ▪ Given the developments in computer gaming technologies the ability to create planning tools that incorporate the issues created by coalitions in JFS should be highly feasible in the short term. 	Feasibility					Low 1	2	Medium 3	4	High 5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Feasibility																	
Low 1	2	Medium 3	4	High 5													
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>													

Recommendation	Coalition Joint Fires Issues Addressed	Feasibility
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caveat and ROE play.

- There would need to be extensive research into the operational requirements for the planning tools. Coalition Joint Fires is a complex environment where different Nations may have different or conflicting planning tool requirements.
- There may be a significant programming cost associated with the development of advanced planning tools; associated with the complexity of the required algorithms for some advanced tools.
- Affected organizations will have to choose to use the tools and training will inevitably be required.

3. Common standards and training curriculum. The HFE analysis revealed that there is a need to develop, and use, Common Standards and Training Curriculum at the JFS centres of excellence (training facilities) of ABCA nations (at minimum) (for example, create a standards cell that is responsive to a coalition based oversight committee).

- Trust and confidence (HQ effectiveness)
- Language
- National Caveats
- Tactics, techniques, and procedures
- Training

Feasibility				
Low 1	2	Medium 3	4	High 5
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- Common Standards and Training Curriculum will impact on how individual militaries conduct business.
- There may be substantial cost associated with implementing any changes to training materials, publications, trainers and simulators.
- There will be a need to collaboratively reach agreement on the common standards and training curriculum to be adopted.

4. Language support through technology. The development of tools and technology for language support will help address Coalition Joint Fires issues associated with language. Some suggestions for language tool development are online translation services, access to acronyms, phonetic spelling of common phrases, and text support.

- Language

Feasibility				
Low 1	2	Medium 3	4	High 5
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- Language Support through technology would benefit all levels of the JFS kill chain; from tactical to operational (planning).
- Implementation will be difficult at the tactical level (translation tools would be cumbersome in the field, and operations at the tactical level should not require translation), however, it will be much easier at the operational / planning level.
- There may be substantial programming costs associates with the development of novel tools; however, the cost may be reduced if 'off the

Recommendation	Coalition Joint Fires Issues Addressed	Feasibility															
		<p>shelf' solutions can be sourced.</p> <ul style="list-style-type: none"> ▪ The effectiveness of language support tools will be impacted by the time sensitive nature of the activities being carried out at each level. ▪ There will need to be consideration regarding the rules around the employment of language tools (for example, translation tools should not be used operationally but rather as a rough guide). ▪ Given the operational spectrum, feasibility is deemed to be medium regarding support in planning and at the operational level, but low at the tactical level. 															
<p>5. Coalition exercises. ABCA participation in coalition exercises (held more frequently than the current 8-9 years) provides a means to assist operators in navigating the effects of many of the soft factors that have an effect on the conduct of JFS collaborative or coalition force operations.</p>	<ul style="list-style-type: none"> ▪ Trust and confidence (force employment) ▪ Language ▪ National Caveats ▪ ROE ▪ Tactics, techniques, and procedures ▪ Training 	<table border="1" data-bbox="935 743 1395 846"> <thead> <tr> <th colspan="5">Feasibility</th> </tr> <tr> <th>Low 1</th> <th>2</th> <th>Medium 3</th> <th>4</th> <th>High 5</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> </tbody> </table> <ul style="list-style-type: none"> ▪ Coalition Exercises will need to be planned and executed on a regular basis to fully recognize their potential benefit. ▪ There may be substantial cost associated with planning time, exercise time; personnel and equipment - movement of troops and equipment to fully support a large scale multinational exercise will be expensive. ▪ Considering the operational spectrum, there is a high to medium feasibility to conduct exercises routinely at the operational headquarters level, however, there is lower feasibility at the tactical level. 	Feasibility					Low 1	2	Medium 3	4	High 5	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Feasibility																	
Low 1	2	Medium 3	4	High 5													
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>													

3.4 Tools requirements

3.4.1 General

This section presents the requirements for a set of proposed tools to ameliorate the effects of the soft factors that can affect the conduct of coalition JFS operations, and so is a preliminary step to achieving recommendations 2 (Advanced planning tools) and 4 (Language support through technology) from Section 3.3.

3.4.2 Tools to support planning issues

3.4.2.1 Coalition ROE and caveat support

Requirement. A fundamental characteristic of coalition operations planning is the requirement to navigate other nations' ROE and National Caveats. While both ROE and caveats are based on formal policies, operators' experience of these policies is that they are subject to interpretation of each of the nations involved in an operation. Accordingly, it would be useful if a tool or database could be developed to centralize know information about each coalition partners' ROE and National Caveats, to log operational interactions with those ROE and National Caveats, and to maintain a summary of the current understanding of each coalition partners' ROE and National Caveats so that the same can be adequately accounted for in the operational planning process.

Concept. It is likely that this requirement would be best satisfied by a collaborative website that could be used as a repository for documentation related to each coalition partners' ROE and National Caveats, and that would also house a number of formal documents for logging experience with those ROE and National Caveats, and for maintaining a summary of those experiences. It is also possible that the most relevant form for summarizing experiences with ROE and National Caveats could be a checklist of things to consider (or rules) when working with a specific nation.

SME Validation. The following SME comments were captured during the tool validation session that was conducted as described in Section 2.5.4:

- Concept Validation
 - ◆ While Nations sign up for ROEs and caveats, they tend to come at you (especially caveats) out of nowhere, and late in the game (planning process);
 - ◆ Spreadsheets do exist and are maintained to help tackle this issue;
 - ◆ Currently there are different interpretations of ROE terms; there needs to be 1 understanding of ROE terms (at minimum a baseline definition).
- Requirements Input
 - ◆ This type of tool could be incorporated into a target view; you select a target and what needs to be done, and the tool tells you who can do it and who cannot;
 - ◆ A tool like this should plug into a planning tool (e.g., JADOCS), so that for any specific targeting requirement you are presented with a set of options (e.g., weapon-target pairing);
 - ◆ A tool like this could be viewed as a refinement of weapons-target pairing; JADOCS knows target location, location of forces, what fire assets are available, what aircraft are in the air;
 - ◆ It may be difficult to log a nation's interpretation of ROE and caveats, because as personnel change those interpretations can change.

3.4.2.2 Collateral damage estimate / mensuration support

Requirement. Different nations involved in a coalition operation may have different ways of performing Collateral Damage Estimates (CDEs), which makes it difficult to speak in a common language. To make communication and planning easier, it would be useful for operators to have a tool that would map individual nations' CDE against those of NATO and other nations.

Concept. This tool could range from a simple as a paper-based conversion chart to a more complex conversion calculator that could be called up as needed during the operational planning process.

SME Validation. The following SME comments were captured during the tool validation session that was conducted as described in Section 2.5.4:

- Concept Validation
 - ◆ The Americans, Brits, and NATO have tools to do this;
 - ◆ There is no uniformly direct correlation between Brit, US, NATO CDE; so for coalition targets, each nation will want to do CDE with their own tool (algorithms are different between nations);
 - ◆ The guiding tool is the NATO CDE tool, which is a laptop computer with a high resolution photo of the target area to which you add the coordinates of attack and weapon; the tool gives you regions around the target and the type of damage that would result (red, yellow, green zones).
- Requirements Input
 - ◆ Currently these tools are housed on standalone laptops because the imagery is classified, as is the tool to do the calculation;
 - ◆ Ideally these tools should be integrated within JADOCs (or other planning tool);
 - ◆ Currently nations don't agree on algorithm for a mean altitude (mensuration).

3.4.2.3 Operation rehearsal tool

Requirement. Since the coalition context is complex, it can be difficult to properly account for all of the coalition-induced factors (for example, ROE differences, national caveat play, differing capabilities of different forces, etc.) involved in an operation. Consequently, operators require a tool that supports the rehearsal of operations in a way that takes all of these factors into account.

Concept. Planners should be supported with an operational rehearsal tool that allows them to progress an operation to various stages, and that will prompt them to consider the effect of the coalition induced factors at relevant points, and to accordingly adjust their estimates of success.

SME Validation. The following SME comments were captured during the tool validation session that was conducted as described in Section 2.5.4:

- Concept Validation

- ◆ Great simulation tools exist for army operations where people can operate simulated tanks and infantry;
- ◆ Currently a lot of people are required around the rehearsal table, and a simulation type of rehearsal could allow this to be done at a number of remote locations.
- Requirements Input
 - ◆ The proposal should leverage existing simulation tools and add in knowledge about ROE and caveat play;
 - ◆ The fire support piece needs to be tied back into these simulation tools;
 - ◆ It would be good if a fire support synchronization plan could be output from the rehearsal; currently rehearsal does not result in a fire support synchronization plan.

3.4.3 Tools to support language issues

3.4.3.1 Terminology cross-referencing system

Requirement. The Joint Automated Deep Operations Coordination System (JADOCS) has been designed as a tool to support standard joint operations workflows, but each of the nations within a coalition may customize the terminology used by the operator interface to label functionality. Consequently, operators working in a coalition environment may require support to understand the different ways in which coalition partners might speak about specific terms or functions of the tool.

Design concept. The JADOCS interface should be supplemented with features that allow operators to cross-reference terms they may hear from coalition partners into terms they can more readily understand, and vice-versa:

- **Support for understanding terms used by coalition partners.** To support operators in interpreting terms they might receive from other coalition partners, they should have access to a searchable lexicon of terms. However, just as people rarely consult large online help files, military personnel are unlikely to consult a large, dictionary-like lexicon. So, instead of only providing access to this lexicon in a document-viewing or database-searching interface, a system service should be developed that will subtly highlight terms that appear on operators' screens for which there are equivalent terms in the lexicon. This could be applied not just to the JADOCS interface, but also to the contents of chat messages, emails, documents, etc.

Operators should also be provided with a facility to filter the suggestions provided by this service so that, for example, Canadian operators could turn off the highlighting for all terms commonly used by the Canadian Forces.

- **Support for promoting understanding in conversation with coalition partners.** Since military language, like any professional language, is full of arcane terms and jargon, it can be useful for operators to know when they might be using terms that others might not understand. The same highlighting strategy described above could allow operators to better appreciate the jargon they are using in written communications, so that they could anticipate where misunderstandings might occur.

SME Validation. The following SME comments were captured during the tool validation session that was conducted as described in Section 2.5.4:

- Requirements Input
 - ◆ Investigate having the tool expand ambiguous acronyms;
 - ◆ The lexicon should start from recognized list of acronyms;
 - ◆ The lexicon should flag the source of the acronym;
 - ◆ Investigate the potential of natural language processing of the context of an acronym to highlight the most likely option (SMEs would like to see the tool look at sentence structure to prioritize the list of possible acronyms);
 - ◆ The JADOCs interface (or other planning tool) area should perhaps be dealt with by standards and procedures, e.g., the JADOCs Joint Configuration Management team;
 - ◆ When writing an acronym, perhaps have a pop-up to allow you to select the correct phrase; if an acronym is not identified, have a “is it one of these” pop-up window;
 - ◆ This feature needs to be available at both ends (sender and receiver); especially if the writer does not have the tool.

3.4.3.2 Terminology Wiki

Requirement. The usefulness of a terminology cross-referencing system rests on the availability of a lexicon that is current and that can be quickly updated as new terms are discovered. Since operators will be discouraged from entering terms into a lexicon if submission involves even a lightweight administrative process managed by some centralized organization, operators should be able to add terms to this lexicon quickly and without a significant amount of overhead.

Design concept. Recent experience on the world-wide web (for example, Wikipedia) has demonstrated that large volumes of reliable data can be developed and maintained by distributed authors, and that this data only requires minimal maintenance by a set of administrators who establish the reliability of the data after it has been posted. This same idea could be adopted for the development of a terminology lexicon. For example, functionality could be added to the operator interface so that operators could select terms in their documents, emails, or chat conversations that were not yet in the lexicon, and then launch an interface to add them. The term-adding interface could have three fields: term, definition (potentially by selecting a corresponding term from a drop-down list), and coalition partner using the term. Note that operators could also add terms that, while not military jargon, do have significantly different meanings across coalition partners (for example, ‘jumper’).

Terms added to the interface could be reviewed periodically by trained staff for errors and duplication. Further, the terminology cross-referencing interface could include flags to indicate if a term had been reviewed or not so that operators could determine its reliability.

Finally, a wiki-style lexicon could be expanded to many different types of content. For example, in addition to providing a lexicon, it could also provide a glossary of terms or lists of abbreviations, and could also include a phonetic pronunciation key and spoken examples to help operators identify, understand, and use foreign terms. As the types of content expanded, the

lexicon could be provided with its own operator interface to supplement the lightweight interface provided via the terminology cross-referencing system (Section 3.4.3.1).

SME Validation. The following SME comments were captured during the tool validation session that was conducted as described in Section 2.5.4:

- Requirements Input
 - ◆ Rather than allowing distributed authors to contribute directly, SMEs would like the abbreviations to be approved by a separate board on a separate time schedule; currently there is an Army Terminology Board that reviews/ approves/ rejects terminology;
 - ◆ It was acknowledged that although a review board may take longer, they could make do with spelling things out rather than having too many entries.

3.4.3.3 On-the-fly translation

Requirement. In a coalition context, operators may be passed communications in languages they do not understand. It could be useful to provide operators with a lightweight tool to access rough translations of these communications more quickly than they could be translated by a human interpreter.

Concept. Operators should be provided with functionality to allow them to highlight text in a document and quickly obtain a rough translation. This tool should attempt to automatically detect the language for which the request is being made, so that the operator does not have to spend time specifying the language to be translated.

SME Validation. The following SME comments were captured during the tool validation session that was conducted as described in Section 2.5.4:

- Concept Validation
 - ◆ The tool is potentially fine; the use needs to be governed, especially so that it isn't used to translate operational material;
 - ◆ Translations of orders is not desirable - too many undesirable drawbacks;
 - ◆ You could only use such a tool to get the rough gist of something and to learn if you need to investigate it more;
 - ◆ Any translation needs to be highlighted as not for operational use.

3.4.3.4 Voice communication recording and playback

Requirement. The preceding tool concepts have focused on language issues with textual communications, but it is also possible that operators will misunderstand voice communications. Since it is not always possible to ask personnel to repeat what they have said, operators should be provided with a way to review the contents of voice communications after the fact.

Concept. All voice communications should be automatically recorded and operators should be provided with a simple interface to play back these communications.

SME Validation. The following SME comments were captured during the tool validation session that was conducted as described in Section 2.5.4:

- Concept Validation
 - ◆ This is already a part of the US Soldier Waveform radio, which is to say that this could be useful;
 - ◆ This would be useful for boards of inquiry (it could essentially form a radio log);
 - ◆ Operationally, this may not be overly useful, however, in the field, it could be useful to record communications from the sender so that you make sure the message has gotten through; in the field it can be difficult to re-establish communications.
- Requirements Input
 - ◆ There would need to be some logic in place to know/ verify that a message has gotten through to the receiver.

3.4.3.5 FOO/FAC (in the field) support

Requirement. Although personnel in the field, in contact with enemy troops, should be receiving orders from their own nation's command chain, it still is possible that they will come in contact with language issues. Consequently, it would be helpful if personnel in the field could get the benefit of the preceding tool concepts.

Concept. Unfortunately, it will be difficult to provide personnel in the field with the rich types of support that can be provided to personnel in command posts. This is because the preceding tool concepts are directed for implementation in a sit-down computing environment, and this is not the reality of field operations. So, instead of providing operators in the field with specific tools to be able to cope with any language issues encountered, it will likely be more efficient to develop communications protocols that operators can use to ask questions about language issues. This could also be supported by training that focuses on the important differences in language between coalition partners and after-action reviews that focus on this aspect of communications.

SME Validation. The following SME comments were captured during the tool validation session that was conducted as described in Section 2.5.4:

- Concept Validation
 - ◆ If operators on the field had a Blackberry type device, they could use it for a lot of things outside of time-sensitive combat work; to support this, all of the language tools proposed could be useful;
 - ◆ It is very difficult to support pointy end guys with this stuff; when there are difficult language issues it is not clear that there are language tools that could help (e.g., Portuguese squad in direct contact with an American Apache trying to support a TIC);

- ◆ Currently this communication is done by phone conversation. This is a “here and now” requirement; these guys do not get off the phone unless they are convinced both parties have it correctly.
- Requirements Input
 - ◆ Fire orders should always conform to standards (fire discipline);
 - ◆ Should be reflective of concept of operations language;
 - ◆ A wiki type tool would not be useful for time sensitive operations, however, it would be useful in slower times.

3.4.4 Tools to enhance trust

3.4.4.1 Social networking

Requirement/concept. In the context of coalition operations, operators must work with many other personnel, and personnel frequently change as a result of HQ turnovers. Social networking tools (like Facebook, LinkedIn, MySpace or Plaxo) have been identified as potentially relevant for this environment to help operators to learn about and build trust with the other operators in theatre.

The specific requirements of a social networking tool for a coalition context are as follows:

- **Indexing and search.** While operators might frequently search for other operators by name, it is also likely that they might search by role (for example, to find the person responsible for a specific function directly after an HQ turnover). Consequently, personnel within the social network should be searchable by role as well as by name.
- **Profile information.** A military social network should allow operators to enter information about their professional experience (both operational and educational).
- **Network organization.** Facebook, perhaps the most developed social networking tool, has three types of organization. The lowest tier of organization is ‘networks’, which correspond to cities, schools, or workplaces. Each user belongs to one or more networks, and these networks are used to prioritize search results and advertising. The second and most used tier of organization is the personal network, in which people can link themselves to people with whom they have personal contact. A third tier of groups organizes people around similar interests. Similar organizations could be used in a military context, where the first tier of organization could be by coalition nation or mission, the second tier could be the contacts that individuals work with day-by-day, and the third tier could be networks of individuals who, while they do not work directly together, share similar professional interests.
- **Role substitution.** To support HQ turnovers, the networks should support the substitution of new personnel in new roles, so that the new personnel can rapidly learn and become integrated into the networks of their predecessor. This could also require a fourth level of network organization, by role, so that individuals could keep their personal networks intact over a transfer but pass on their role-based network to another person.

- **Role learning.** To support HQ turnovers, a social networking tool should also allow for the production of pictures of the network corresponding to various different roles, to allow new personnel to understand who they will be communicating with and how those communications might be processed to a few links up or down the organizational hierarchy.
- **Process and chain of command maps.** Again, to support HQ turnovers, it would be useful if a social networking tool could include information on relevant processes, chains of command, and their points of contact to allow personnel to easily transition into a new role.
- **Support for NGO's and Civil Military Co-operation (CIMIC).** A military social networking tool should also extend to JIMP to foster collaboration between the military and all agencies required to meet a mission's objectives. NGOs and CIMIC organizations could be treated as separate coalition partners with whom social networks could be built.
- **Security.** Since a coalition social network would be intended for use in a multi-nation context, it will be necessary for a social networking tool to be supported by a robust security framework in which only specific sets of data were synchronized to coalition partners' servers.

SME Validation. The following SME comments were captured during the tool validation session that was conducted as described in Section 2.5.4:

- Concept Validation
 - ♦ Exchange officer thought this would be a wonderful tool to support him in communicating with his force back home;
 - ♦ This could be very useful for virtual teaming.
- Requirements Input
 - ♦ Include military CV, operational experience, credentials and authentication (so that you know who it is you are getting orders from);
 - ♦ Perhaps provide a history of who was in a particular role;
 - ♦ There is an issue of accountability; there needs to be a way to validate you are who you say you are (this is an enterprise infrastructure/service type of issue).

4 Conclusions and recommendations

4.1 General

The Human Factors program carried out during this project effectively identified the primary areas of concern and issues with respect to differences in single unit (air, maritime, land) operational doctrine / strategy / culture / procedure / policy that have an effect on the conduct of JFS (collaborative joint or coalition force operations). The program identified differences in the principles that component members of JFS use to compare, predict, and direct resources. Importantly, it was identified that none of the Subject Matter Experts consulted knew of any criteria currently being used to measure how well JFS goals are achieved.

Through the Human Factors analysis a comprehensive set of recommendations aimed at ameliorating the issues identified and improving the success of coalition JFS were developed. The program was also able to establish requirements for tools to support officers in navigating the soft factors involved in a coalition JFS context.

All of the issues, recommendations, and tool requirements identified were able to be developed and validated with Canadian Forces Subject Matter Experts. Through the support of the Canadian Forces Subject Matter Experts the Human Factors Program was able to effectively contribute to the definition and implementation phases JFS Technology Demonstration Program (TDP).

4.2 Conclusions

As mentioned, the objective of this Human Factors analysis was to focus on coalition aspects of Joint Fires Support to identify potential issues where single force operational doctrine/ strategy/ culture/ procedure/ policy differ when units are engaged in collaborative joint or coalition force Joint Fires operations, and to identify differences in principles that component members use to compare, predict, and direct resources, as well as Joint Fires Support success metrics.

Through a review of the findings presented in this report the JFS Technology Demonstration Program (TDP) has the information required to make decisions regarding appropriate avenues to pursue during the continued implementation, and exploitation phases of the program which will have the ability to impact real and potential future CF capabilities, concepts, doctrine, operations, and equipment.

The development and validation of the issues and implications revealed that the soft factors that affect the success of coalition Joint Fires Operations are:

- Trust and confidence at the coalition Head Quarters level. Decreased levels of trust and confidence at this level impact the planning, coordination, and control of Joint Fires Support;
- Trust and confidence at the force employment level. Decreased levels of trust and confidence regarding force employment impact how forces are utilized thus impacting the overall conduct of Joint Fires Support;

- Language issues. Language issues affect interoperability among coalition forces during the planning, coordination, control, and conduct of Joint Fires Support;
- National Caveats. While National Caveats are often well established, their interpretation and use are often seen as nebulous thus complicating all aspects of coalition operations and impacting trust and confidence at the coalition headquarters level, trust and confidence at the force employment level, and rules of engagement interpretation and usage;
- Rules of engagement (ROE). Published ROE have an impact on how military forces work together during the planning, coordination, control, and conduct of Joint Fires Support. However, their interpretation and usage can be less predictable thus impacting trust and confidence at the coalition headquarters level and trust and confidence at the force employment level;
- Differences in training. Differences in training between coalition partners (in particular, when dealing with non-ABCA nations) affect the ability to coordinate with these partners in the provision of Joint Fires Support and affect trust and confidence at the coalition headquarters level and trust and confidence at the force employment level; and
- Differences in tactics, techniques, and procedures. Differences in tactics, techniques, and procedures between coalition partners (in particular, when dealing with non-ABCA nations) affect the ability to coordinate with these partners in the provision of Joint Fires Support thus affecting trust and confidence at the coalition headquarters level and trust and confidence at the force employment level.

The development and validation of the recommendations to ameliorate the issues identified above produce the following options:

- The exchange of personnel (including at Staff College, headquarters, tactical units, and training establishments. The exchange of personnel will have an impact on the issues of trust and confidence (HQ effectiveness), trust and confidence (force employment), language, National Caveats, training, and tactics, techniques, and procedures;
- The development/ acquisition of advanced planning tools (i.e., JADOCS, blue force tracking, and intelligence sharing techniques). These tools must allow for wargaming and the generation of 'courses of action' based on aspects such as nations playing the National Caveat card and the grouping of forces by like rules of engagement). The development/ acquisition of advanced planning tools will have an impact on the issues of trust and confidence (HQ effectiveness), trust and confidence (force employment), National Caveats, rules of engagement, and tactics, techniques, and procedures;
- The use of common standards and training curriculum (should be instituted at all Joint Fires Support centres of excellence (training facilities) of nations participating in coalition operations). The use of common standards and training curriculum will have an impact on the issues of trust and confidence (HQ effectiveness), language, National Caveats, training, and tactics, techniques, and procedures;
- Language support through technology (language issues can be addressed with online translation services, access to acronyms, phonetic spelling of common phrases, and text support); and

- Coalition exercises (more frequent than currently held). Coalition exercises will have an impact on the issues of trust and confidence (force employment), language, National Caveats, rules of engagement, training, and tactics, techniques, and procedures.

The development and validation of tool requirements to ameliorate the issues identified above produce the following options:

- Planning Support Tools
 - ♦ Coalition ROE and caveat support tool.
 - ♦ Collateral damage estimate / mensuration support tool.
 - ♦ Operation rehearsal tool.
- Language Support Tools
 - ♦ Terminology cross-referencing system tool.
 - ♦ Terminology Wiki.
 - ♦ On-the-fly translation tool.
 - ♦ Voice communication recording and playback.
 - ♦ FOO/FAC (in the field) support tools.
- Tools to Enhance Trust
 - ♦ Social networking tools.

As summarized above, this report contains the most current, validated, information regarding soft issues affecting coalition Joint Fires Support operations from which the JFS Technology Demonstration Program (TDP) can make informed decisions regarding appropriate avenues to pursue during the continued implementation, and exploitation phases of the program.

4.3 Limitations

The limitations regarding the data collection and data validation portion of this research are twofold:

- The first limitation is centered on the timing of the program; specifically regarding the availability and access to Canadian and Non-Canadian Subject Matter Experts. Many of the personnel with expertise regarding coalition joint fires support operations were either deployed, or had just returned from deployment thus limiting the numbers and availability of subject matter experts.
- The second limitation is centered on the novel aspect of the subject matter of the program. Coalition Joint Fires operations are, relatively speaking, in the infancy of their development. As a result, there are comparatively few Canadian and Non-Canadian Subject Matter Experts in this area. However, this being said, it should be noted that the subject matter experts identified in Section 2.3.2 provided a wealth of expertise on the subject area.

4.4 Recommendations

It is recommended that:

- The recommendations provided within this report be investigated further to better establish their feasibility regarding their ability to positively impact the soft issues identified that affect coalition joint fires operations and regarding their feasibility to impact real and potential future CF capabilities, concepts, doctrine, operations, and equipment;
- The requirements for advanced tools be further developed allowing for prototyping and evaluation of the concepts and their implementation; and
- Any exchange programs, tools developed, common standards and training curriculum adopted, or coalition exercises conducted as a result of this research, be evaluated as to their effectiveness at achieving their intended function by a wide range of personnel.

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Annex A Syndicate questions from JFS workshop

1. CF Joint Doctrine is not well understood. What is your understanding of other nations experience with their joint doctrine and will this affect the coalition?
2. How would national objective reservation impact on the coordination of joint fires within the coalition? Please give an example.
3. How will the different levels of training/ knowledge base that each coalition partner provides affect the decision making process of JFCC?
4. How do you resolve issues arising from the coalition forces ability to conduct time sensitive operations (fires) in which critical information cannot be passed and therefore the operation is against the coalition nations ROE?
5. What are the implications on joint forces with cultural differences within a coalition with respect to tolerance for collateral damage?
 - a) Is it the Commander of the coalition, or of nations, that will have to assess and appoint targets?
 - b) Will the authority to engage always be the “designated” commander?
6. How will the different levels of training/ knowledge base that each coalition partner provides affect the decision making process of Joint Fires Support?
7. Will JFS adapt to National Caveats?
8. Will JFS adapt to national ROE?
9. Will JFS adapt to national delegated authority?
10. Should JFS consider non-declared assets?
11. Will JFS consider a “lexicon” (NATO/ coalition)?
12. How will JFS deal with multi access security and trust in the loop?
13. How will JFS merge/ analyze/ de-conflict various inputs?
14. Will JFS give the “best option” or ranked range of options?
15. If a ranked range of options – based on what prioritized criteria?
16. How will JFS manage risk? Using what criteria?
17. How will JFS harmonize with the coalition?

18. How do you allow the shooter to act on his own?
19. (National Caveats and the differences in ROEs) Coalition ROEs are sometimes unknown; would you expect to release your ROE and any caveats on them to the coalition partners and vice versa?
20. (National Objectives/ Reservations) How would National Objectives/ Reservations impact on the coordination of Joint Fires within a coalition?
21. (Interoperability – Languages) How do you overcome the differences in languages in respect to Joint Fire Coordination?
22. (Interoperability – Doctrine) How do you overcome the differences in doctrine in respect to joint fires coordination? (i.e., US forward observers request fire while Canadian forward observers order fire)
23. (Interoperability – Equipment) How do you overcome the differences in equipment in respect to joint Fire Coordination?
24. (Interoperability – Culture) How do you overcome the differences in culture in respect to Joint Fire Coordination?
25. (Interoperability – Technology) How do you overcome the differences in technology in respect to joint fire coordination?
26. How will JFS deal with Multi-access security and trust in the loop?

Annex B Structured interview questions

B.1 General

1. Have you ever had to deal with National Caveats in Fires Operations?
2. Have you ever had to deal with Rules of Engagement in Fires Operations?

B.2 Rules of Engagement/ National Caveats

3. Who needs to know other nations ROE during coalition operations?
4. How has collaborating with Countries/Units, with differing ROE, affected your ability to complete your tasks?
5. How complicated are ROE for coalition JFS operations versus direct Fire Support operations (infantry ops)?
6. How has collaborating with Countries/Units, with differing National Caveats, affected your ability to complete your tasks?

B.3 Commanders Intent

7. How does the clarity of the Commander's Intent affect the conduct of your tasks?
8. Is the Commander's Intent distributed differently for coalition operations?

B.4 Intelligence

9. Do National Caveats around intelligence affect your ability to do your tasks?
10. With respect to intelligence, does operating with unfamiliar units/ persons impact your ability to conduct your tasks?
11. Are you ever preoccupied (concerned) with what other nations may not be sharing with you?

B.5 Resource Allocation

12. How is Resource Allocation affected by having coalition members with differing capabilities, authority, and willingness?
13. How are Resource Allocation challenges currently addressed by the coalition?

B.6 Language/ Terminology

14. How has having a coalition partner, with a different Primary Language, affected the completion of your tasks?
15. How have differences in Terminology affected the performance of your tasks?
16. Have you encountered a Terminology-related delay of your unit's request for support?

B.7 Workload

17. What aspects of coalition operations increase your workload over direct fire support?
18. What causes your workload to be increased during coalition operations?
19. Is selecting the most appropriate weapons effect more difficult in a coalition environment?
20. Is tracking the inventory of weapon effects more complicated in a coalition environment?
21. In a coalition environment does the process used to designate and prioritize targets change?

B.8 Team Collaboration/ Trust

22. What is your degree of trust that your requests for action will be accomplished in the way you requested?
23. How are orders given from other nations acknowledged?
24. How are you made aware that your orders, or request, have been carried out during fire support operations?
 - a. Is the feedback loop the same during coalition operations?
25. What factors affect the way you view your coalition team members?
 - a. What gives you a warm fuzzy about your team?
 - b. How do you feel about working in distributed teams?
 - c. Are there any tools/techniques that could help in decreasing the distance / increasing the effectiveness of coalition teams?

B.9 Training

26. In a coalition do differences in individuals or units capabilities, affect the way that you request for, or plan effects?

27. In a coalition do differences in individuals or units training, affect the way that you request for, or plan effects?

28. How are you made aware of coalition partners capabilities/ training?

B.10 Technology

29. How do differences in communication capability affect your ability to work with other nations?

30. How do different levels of technology affect coalition operations?

B.11 Success Metrics (MOE/MOP)

31. How do you define success in a joint fires request?

32. What metrics are being used to measure joint fires effectiveness?

a. Do the metrics change in coalition operations?

33. Have other units ever carried out your requests differently than you intended?

a. During fire support operations?

b. During JFS operations?

c. During coalition JFS?

d. Does this occur more frequently in coalition operations?

34. Do you know if nations within a coalition have ever declined a tasking?

B.12 Deconfliction/ Battlespace Management

35. How do you de-conflict when a request conflicts with National Caveats?

36. What impacts Battlespace Management when dealing with a coalition?

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List of symbols/abbreviations/acronyms/initialisms

ABCA. America, Britain, Canada, and Australia	IECCEX. Report on the Integrated Effects Coordination Cell Exploratory Experiment
C2. Command & Control	JADOCS. Joint Automated Deep Operations Coordination System
CAS. Chief of the Air Staff, Close Air Support	JECC. Joint Effects Coordination Centre
CDM. Critical Decision Method	JECCEX. Joint Effects Coordination Cell Exploratory Experiment
CF. Canadian Forces	JESTER. Joint Effects Support Technique Exploration and Refinement
CFB. Canadian Forces Base	JFS. Joint Fires Support
CIMIC. Civil Military Co-operation	JTF(A). Joint Task Force (Afghanistan)
CLS. Chief of the Land Staff	LOAC. Laws of Armed Conflict
CMP. Chief of Military Police	NATO. North Atlantic Treaty Organization
CMS. Chief of the Maritime Staff	RC. Regional Command
DRDC. Defence Research & Development Canada	ROE. Rules of Engagement, Rules of Engagement
FAC. Department of Defence, Forward Air Controller	SA. Scientific Authority
FOO. Forward Observation Officer	TDP. Technology Demonstration Program
FSCC. Fire Support Coordination	TFK. Task Force Kandahar
HFE. Human Factors Engineering	UAS. Unmanned Aerial System
HQ. Headquarters	USJFCOM. United States Joint Forces Command

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The objective of this Human Factors analysis was to focus on coalition aspects of Joint Fires Support to identify potential issues where single force operational doctrine/ strategy/ culture/ procedure/ policy differ when units are engaged in collaborative joint or coalition force Joint Fires operations, and to identify differences in principles that component members use to compare, predict, and direct resources, as well as Joint Fires Support success metrics.

The analysis consisted of background research; data collection (Critical Decision Method and Structured Interviews); data synthesis and interpretation; development of issues, implications, and recommendations; and the development of requirements for tools to ameliorate the primary issues identified.

The primary issues identified were: Trust and confidence (Headquarters effectiveness); Trust and confidence (force employment); Language; National Caveats; Rules of Engagement; Tactics, techniques, and procedures; and Training.

The recommendations aimed at ameliorating the issues identified were: exchange of personnel; advanced planning tools; common standards and training curriculum; language support through technology; and coalition exercises.

The tool requirements focused on tools to support: planning; language issues; and tools to enhance trust.

None of the Subject Matter Experts interviewed were aware of any performance measures currently being used to measure joint fires support effectiveness.

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