The Impact of Coalition on Command and Control in Joint Fires Operations

Abstract

Operations frequently require joint forces to work together with coalition partners. But combining diverse, multi-national groups can lead to unique challenges in an operational net-centric environment. Component members may differ in basic norms, culture, and beliefs, as well as in areas such as language, doctrine, and policy. Furthermore, differences in procedures can exist – for example, methods of prioritizing and directing resources, and criteria used to measure operational impact and success, may differ between Canadian forces and our allies. In short, there are a significant number of 'soft' issues specific to coalition operations that are expected to negatively impact command and control with respect to time, accuracy, and operational outcome. Moreover, their affect on operational effectiveness will increase when command and control teams are distributed, as in net-centric operations. Implementing appropriate solutions into areas of greatest risk will enhance command and control and reduce the impact of coalition diversity on interoperability. This paper reports on an investigation that identified those areas of greatest concern with respect to the influence of coalition in a Joint Fires Support environment. Based on the findings, recommendations that could ameliorate command and control and improve mission effectiveness are suggested, and future work discussed.

1. Introduction

The work reported in this paper is a component of a Defence Research and Development Canada (DRDC) Technology Demonstration Program (TDP), the Joint Fires Support (JFS) TDP. The focus of the JFS TDP is on Joint Fires Coordination, where the objective is to develop high level specifications required for request for fires by a spotter on emerging or time sensitive targets. The task of the Joint Fires Coordination Center is to prioritize targets for engagement and assign the most appropriate weapon system based on availability of resources within the joint, and coalition, force. Optimizing the fires support process will ensure that the engagement response time line is as short as possible and collateral damage and fratricide are minimal. To this end, a process is being followed through the JFS TDP that includes investigating various aspects of joint fires, including command and control, decision aids/tools, procedural processes, allocation of personnel, and desired weapon effects.

2. Background

Joint Fires Support (JFS) is the coordination and integration of indirect fire systems to provide fire support to land combat operations. Fires support is composed of land, air and sea-based weapon systems synchronized in delivering fires and effects with the objective of delaying, disrupting or destroying enemy forces, functions, and facilities. Effective planning and coordination of efforts, sensors, and fires across units and nations is essential to identifying and combining resources, thereby providing appropriate fire support to operations.

The goal of JFS is to provide commanders with options for handling dynamic and time-sensitive targets. The commander is required to synchronize shared resources to achieve the desired effect within a multi-component, and often multi-national force, and in an environment where decision making has moved from centralized to collaborative. The joint and coalition combined fires procedure allows land commanders greater flexibility in selecting the most appropriate capability to engage targets by coordinating actions and resources against a common objective.

Joint fires is clearly a complex process, and one in which interoperability is essential. Key elements of interoperability include inter-component liaison and battlespace management (Joint Fires Support Operating Concept, Feb 2008), both of which depend on effective communication. Communication affects the flow and availability of information that a commander uses to assess risks and make rapid

decisions. Furthermore, fundamental to mission success are decision support solutions supported by a robust C4I system.

The processes underlying Joint Fires Support necessitate the interaction and collaboration of multi-component, and often multi-national stakeholders, but assimilating heterogeneous units into a coordinated group has the potential to lead to performance issues related to interoperability. Some of these issues will revolve around integral differences in component norms derived from established doctrine, culture, procedures and policies. Differences between policy and procedure, and organizational structure and culture may affect operational continuity and consequently, the outcome of the mission. Furthermore, within a joint operational headquarters, a mix of formal and informal procedures may be used, policies and/or legal constraints may change, moral and ethical issues may differ between individuals and groups, and public opinion and roles may change as situations change. Complex situations involving the Canadian Forces in joint combined operations can also be impacted by differences in measures component members use to assess how well they are achieving JFS goals, as well as how they compare, prioritize, direct and share resources to achieve those goals.

Generally, working in multi-component, multi-national operations generates certain exclusive issues to the joint fires operation and many of these will affect the ability or willingness to communicate and collaborate with component members and thus will affect the level of interoperability attained and maintained that is essential for joint fires to be successful.

2.1   The impact of coalition

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. The issues 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 coordinate and collaborate with team-members representing different capabilities and nations contributing to an integrated coalition task force.

An additional challenge for JFS within a coalition environment is that the number of potential coalition partners and operational environments (e.g., active conflict, peace-keeping, disaster relief, etc.) makes it difficult to identify the specific problems that will occur with all coalition partners in all environments. The Canadian Forces (CF) have 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 (e.g., France, Spain, Portugal, and the Netherlands) in which the development of a full set of common policies and procedures is not feasible. With this in mind, a proactive approach is warranted, whereby areas in which problems are most likely to occur are identified, and some of the more salient issues affecting mission outcome predicted. Through this process, ways to ameliorate potential break down in performance as it relates to the human operator and the JFS team of teams could be determined.

The work reported here focuses on the coalition aspects of JFS, with the aim of identifying areas of greatest concern to the functioning of a JFS operation when coalition military teams are integrated into a team of teams multi-national JFS service. Areas and issues identified are embodied in what we have termed 'soft' factors. Examples might be differences associated with operational doctrine, strategy, culture, procedure, and policy. As part of the work, recommendations with respect to ways of improving the JFS operation in the areas identified are proposed.

3.   Methodology

The method followed includes background research and familiarization with JFS in joint and coalition domains, data collection and interpretation, development of issues, implications, recommendations, and development of requirement for decision support tools.

3.1 Background research and JFS familiarization

A review of related literature and documentation was conducted to gain an overall understanding of the scope of the JFS environment and the conduct of JFS operations, and to develop an appropriate methodology for investigating coalition human factors issues pertaining to the JFS domain. In conjunction, a coalition JFS workshop was held in Canada. The goal of the workshop was to progress the various streams of research and work contributing to the JFS TDP. Approximately sixty participants from several nations attended. This workshop provided a useful venue for the human factors team to gain knowledge about the impact of coalition in JFS operations in general, but the workshop was also used specifically to access the knowledge base and expertise of subject matter experts on the topic of the impact of coalition in JFS operations. To this end the human factors team conducted a syndicate session in which SMEs were asked to identify potential areas with respect to 'soft' factors that might impact JFS operations from the perspective of combined coalition force operations. The goal was to use the information gathered in the syndicate session to assist in the preparation of questions that would guide later SME sessions planned for the data collection phase of this work.

The syndicate session itself generated a number of questions, but, as intended, its most useful outcome was generating a list of areas and issues that would be used to guide upcoming SME knowledge-gathering sessions. Listed below are the JFS issues generated:

- **Application of the Laws of Armed Conflict.** The Laws of Armed Conflict (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 in the conduct of military operations and related activities in armed conflict, however such conflicts are characterized. 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 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.

- **Rules of Engagement.** In military operations, the Rules of Engagement (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 the coalition partners are, and what roles they are expected to play. In the JFS context authorization and political imperatives can limit partners for specific operations and complicate 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 risk while others will not – some will assign their forces to certain operations while others will not.

- **Ethics / morals (personal and group).** The ethical or moral upbringing of individuals will affect their decision making and leadership styles and/or 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 these partners.

3.2   Data collection

The background research and syndicate session activity provided a high level perception of the soft factors that affect JFS joint and coalition force operations. These broad issues were used to develop a data collection methodology to more thoroughly examine the effect of each of the issues on the conduct of JFS operations. The method aimed to develop more detail about each of these issues through interviews with SMEs. To ensure that data represented the full breadth of the JFS domain, data collection efforts focused on three main participants, broadly categorized as the observer, the shooter, and the decision maker. SMEs from Canada and from a number of Canadian allies were interviewed.

Interviews were approximately two-hours in duration, and each interview involved two different techniques:

- **Semi-structured Critical Decision Method (CDM) interview.** Each SME session was structured to begin with a CDM interview (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 in validating the types of issues generated in the JFS workshop and in developing detailed information about the effects of these issues on specific operational situations. This portion of the interview was conducted by a human factors analyst and notes were taken by the interviewer and two other human factors engineers in attendance.

- **Structured interview.** At the conclusion of the CDM interview, a more structured interview using a set of questions prepared on the basis of the data gathered during the background research phase was conducted. 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 reasonable coverage of the list of questions with each SME. 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. Alternative and potentially more repeatable methods would have been to ask each SME an identical list of questions, or to have SMEs fill out a lengthy questionnaire. However, since there were a number of different positions involved, and each SME brought different experiences to the table, it would have been challenging to design a questionnaire that suit with them all. Also, questionnaires are more tedious for the SME and, in the project team's experience, tend to generate results that are not as rich as those produced by a more form-free interview method.

Data from the interviews were recorded in note form by each member of the investigator team. 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. Once all the interviews were complete, notes were compared between investigators to come to a single set of consolidated observations.

3.   Results

3.2   Data Categorization

The two sets of data collection methods produced a broad set of data that required structuring and synthesis in order to be able to generate sets of specific implications and recommendations. To organize the data the SME feedback was grouped using a two-dimensional categorization approach as follows:

3.2.1   Work domain subsystems / subsystem functional purposes

In previous work, the work domain of JFS collaborative joint or coalition force operations was analyzed (Famewo, Taylor, Bruyn, Martin & Matthews, 2008). The work domain analysis resulted in an abstraction-decomposition space, and it structured the work-domain into a set of 8 subsystems, each of which had an integrated functional purpose. These subsystems with their functional purposes are a means 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. Accordingly, they form an appropriate high-level categorization for the coalition force operations issues captured from operators during data collection. The 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 battlespace 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.

3.2.2   Soft factor categories

The second dimension used to structure the data was derived from the human factors analysts' experiences with JFS through background research in the first phase of this work, 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. Operators perceive these issues to be mostly political and relatively ill-defined.

- **Rules of engagement.** Issues relating to challenges introduced by differences in the ROE held by various coalition partners. Operators perceive these issues to be military and well-defined.

- **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 by considering each point included in the 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 which documents the way in which each of the soft factors identified affects that subsystem.

3.3   Identification of issues related to the impact of coalition in JFS

Through the categorization process patterns in the data became apparent. One of the major findings was that similar summary statements existed across multiple subsystems. To further structure the data, summary statements were tabled along with information about which subsystem(s) each summary applied to and related summary statements were merged into common summaries which were identified as *issues* associated with the various soft factors in the JFS work domain.

The issues identified, the subsystem the issue impacts on, and potential implications in the JFS domain, are documented in the sections below.

3.3.1   Trust and Confidence (HQ Effectiveness)

- **Issue.** 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.

- **Subsystems affected**
  - Intelligence
  - Planning
  - C2
  - Coordination

- **Implications**

- 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.

- **Recommendations**
  - Exchange of personnel
  - Advanced planning tools
  - Common standards and training curriculum

3.3.2 Trust and confidence (force employment)

- **Issue.** 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.

- **Subsystems Affected**
  - Intelligence
  - Delivery of Fires
  - Logistics

- **Implications**
  - Efficient employment of forces. Some forces will be called upon more often while others are kept out of the fight.

- **Recommendations**
  - Exchange of personnel
  - Advanced planning tools
  - Coalition exercises

3.3.4 Language

- **Issue.** 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.

- **Subsystems Affected**
  - Intelligence

- ◆ Planning
- ◆ C2
- ◆ Coordination
- ◆ Communication
- ◆ Delivery of Fires

- **Implications**
  - ◆ Timelines – increased by the need to question, confirm, repeat, and translate.
  - ◆ Errors – misinterpretations

- **Recommendation**
  - ◆ Exchange of personnel
  - ◆ Common standards and training curriculum
  - ◆ Language support through technology
  - ◆ Coalition exercises

3.3.5   National Caveats

- **Issue.** 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.

- **Subsystems Affected**
  - ◆ Intelligence
  - ◆ Planning
  - ◆ C2
  - ◆ Coordination
  - ◆ Communication
  - ◆ Delivery of Fires
  - ◆ Logistics

- **Implications**
  - ◆ Workload is increased and planning takes additional effort because plans must allow for re-planning and re-tasking due to problems with national caveats.
  - ◆ 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

- **Recommendations**
  - ◆ Exchange of personnel

- ◆ Advanced planning tools
- ◆ Common standards and training curriculum
- ◆ Coalition exercises

3.3.6   ROE

- **Issue.** 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.

- **Subsystems Affected**
  - ◆ Intelligence
  - ◆ Planning
  - ◆ C2
  - ◆ Coordination
  - ◆ Communication
  - ◆ Delivery of Fires

- **Implications**
  - ◆ 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.)
  - ◆ 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).

- **Recommendations**
  - ◆ Advanced planning tools
  - ◆ Coalition exercises

3.3.7   Tactics, Techniques, and Procedures

- **Issue.** Coalition partners have different TTPs, and so have personnel or units who are more or less capable of interoperation with other coalition partners.

- **Subsystems Implicated**
  - ◆ Intelligence
  - ◆ Planning
  - ◆ C2
  - ◆ Coordination
  - ◆ Communication

- ◆ Delivery of Fires
- ◆ Logistics
- ◆ Manoeuvre
- **Implications**
  - ◆ There is no common Operational Planning Processes (note, however, that the OPPs of ABCA nations are similar).
  - ◆ Commanders intent
  - ◆ Errors/ Timelines (including Logistics support)
  - ◆ Targeting process gets bogged down
  - ◆ Decision making / C2 model can vary
  - ◆ 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
  - ◆ 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
  - ◆ Nations will spend time to confirm Tactics, Techniques, and Procedures of other Nations
- **Recommendations**
  - ◆ Exchange of personnel
  - ◆ Advanced planning tools
  - ◆ Common standards and training curriculum
  - ◆ Coalition exercises

3.3.8 Training

- **Issue.** 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.
- **Subsystems Affected**
  - ◆ Planning
  - ◆ C2
  - ◆ Coordination
  - ◆ Delivery of Fires

- ◆ Logistics
- **Implications**
  - ◆ Timelines are extended in planning and control functions
  - ◆ Different battle rhythms.
  - ◆ Workload is increased
  - ◆ Difference in negotiation skills can cause suboptimal allocation of taskings to units.
  - ◆ Safety - nations provide JFS with varying degrees of accuracy
  - ◆ 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.
  - ◆ Reluctance to call for fire (from certain Units)
- **Recommendations**
  - ◆ Exchange of personnel
  - ◆ Common standards and training curriculum
  - ◆ Coalition exercises

4. Validation of issues related to the impact of coalition in JFS

The line of reasoning from specific items of evidence collected from SMEs through issues and implications to recommendations was guided by SME input but not directly drawn from the SMEs. To ensure that the line of reasoning with respect to implications and recommendations were sound, a series of validation sessions with SMEs were conducted. These validation meetings approximately two-hour duration with pairs of SMEs attending each session. SMEs had similar profiles as those interviewed in the data collection phase so that there would again be complete SME representation across the 'kill chain'. The objective of the validation sessions was to work through the list of issues, subsystems, implications, and recommendations in detail, and to obtain comments on their validity from the SMEs. SMEs were drawn from the Canadian Forces Base (CFB) Valcartier and the human factors team conducted the sessions over two visits to the CF Base.

The SMEs were in agreement with the majority of the data with which they were presented, and made only minor comments to correct or supplement them. There was a month between the two validation meetings, and 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 findings presented in Sections 3.3.1 – 3.3.8 (above) and in the recommendations presented below.

5. Recommendations

5.1 Recommendations by soft issue category

Based on the issues identified and using the implications of those issues on the JFS services as a guide, recommendation for ameliorating those issues were developed. They are listed here in general form as they relate to the soft categories defined. The recommendations have been loosely grouped here but clearly there is a good deal of overlap between categories. The benefit and importance of planning was evident in many areas and has been added as a category for recommendation

- **Trust and Confidence.** Allow for more exchange of positions in foreign division-level positions, and integration of personnel into foreign units while in theatre. 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.

- **Language.** Exposure to phonetic pronounciation of STANAG (Standardized Agreement) terms and brevity words should be universal. An intelligent translation tool for translating military terminology, technical terms, and cultural language is highly recommended. Voice communication should always be supported by text chat to avoid misinterpretation and to provide a means of confirmation of communication.

- **National Caveats.** There needs to be a means for recording information about national caveats. Currently this information is known only by the officer in charge and is not documented anywhere. Working groups should be formed to discuss the application of national caveats and their implications and impact.

- **Rules of Engagement.** A system should be developed that groups nations or forces that are operating under similar ROE. There should be a coalition repository to store the ROE of all coalition partners, with allowance for private annotations from each nation about trends in ROE use. There should be briefings by national legal representatives with respect to their nation's ROE.

- **Training.** Implement opportunities for cross training in general, and cross training at command posts prior to deployment, as well as providing billets for foreign personnel at national Staff Colleges / War Colleges. Opportunities like these would provide a degree of consistency between training and certainly an understanding of how other nations are trained, as well as a look at their tactic techniques and procedures. If possible, develop common curriculum and shared standards between coalition partners. There should also be an emphasis on training in communication, understanding colloquialisms and cultural meaning of terminology. Differences here occur not only between nations but can also be apparent between forces or units. Training should be enhanced to include more esoteric subjects such as interpersonal skills, leadership training, and training and instruction in negotiating.

- **Tactics, Techniques, and Procedures.** Many of the recommendations under Training apply to increasing understanding and knowledge about other nations' TTPs. In general, more training in the procedures of other nations is required. Embedding instructors in other nations schools would help. It is recommended that ABCA coalition exercises, and broader NATO exercises, should be conducted more frequently than the current 8-9 year schedule that exists now.

- **Planning Support.** A command and control planning tool should be developed that has a comprehensive lexicon and that can support the development and mission rehearsal of multiple alternative plans. This would provide the capability for war gaming so that skills can be developed, plans tested for the best plan, and the system should be able to provide flexibility of operations as nations join and leave the operation. Plans must be flexible in terms of which coalition partner performs a task because component members may change. The planning tool should be able to track national caveat play and take national caveats into consideration when developing plans – balancing workload. The planning tools should allow for seamless transfer of information to pre-determined nations.

5.2 Consolidated recommendations

The list below provides a consolidated list of recommendations across the various soft issue categories.

- **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. 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.

- **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 caveat and ROE play.

- **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).

- **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.

- **Coalition Exercises.** ABCA participation in coalition exercises (held more frequently than currently held, every 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.

6.   Development of tool requirements

Based on the objective of the overall JFS TDP two areas were identified to progress further with respect to developing support tools to help mitigate some of the effects of the issues that had been identified. Three areas were chosen for further development:

- Advanced planning tools

- Tools for language support through technology

- Tools to enhance trust

A workshop was held 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 participated in this workshop along with members of the JFS project team.

The objectives of this workshop were to review the 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. This 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 one significant 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, which were supplemented by input from a JFS symposium. The result of this work was a series of short descriptions of proposed tools, which included a set of high-level requirements and some more detailed design ideas that could be enacted to achieve those requirements.

7. Validation of tool requirements

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. These personnel 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 3 hours in duration, during which the project team introduced the overall project and then presented each individual tool and these revised descriptions.

8. Tool Requirements

8.1 Tools to support planning issues

- **Coalition ROE and national 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.

- **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 as 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.

- **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. SMEs noted that this kind of tool would allow simulations to be rehearsed with participants at different remote locations. SMEs commented that a fire suppport synchronization plan would be a beneficial output from the rehearsal.

- ◆ **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. The design should leverage existing simulation tools.

8.2 Tools to support language issues

- **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 partner.**

  - ◆ **Requirement/concept.** 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**

  - ◆ **Requirement/concept.** 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.

- **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 they are required to submit requests to some centralized organization, operators should be able to add terms to this lexicon quickly and without a significant amount of workload.

  - ◆ **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 these data only requires minimal maintenance by a set of administrators who establish the reliability of the data after they 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 described in Tool Concept i) (terminology cross-referencing system).

- **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.

- **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. SMEs noted that this type of support is part of the US Solider Waveform radio and would be very useful.

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

- **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.

8.3   Tools to enhance trust

- **Virtual 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 virtual web-based 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 deep.

    - *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 NGO's and CIMIC 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 would be synchronized to coalition partners' servers.

9. Discussion

The objective of this work 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 findings presented in this report provide the information required to make decisions regarding the avenues to pursue that 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 of 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 exercices* (more frequent then 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 informed decisions can be made regarding appropriate avenues to pursue during the continued implementation, and exploitation phases of the program.

10. Limitations

There were some limitations regarding the data collection and data validation portion of this research:

- 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 provided a wealth of expertise on the subject area.

- A third limitation is that the data are based on a relatively small population of SMEs and additional consultation with a greater number of experts should be conducted to better establish the soft issues identified and to ascertain their impact on real and future Canadian Forces capabilities, concepts, doctrine, operations, and equipment.

11. Summary of Recommendations

It is recommended that:

- The recommendations provided within this paper 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.

12. References

Crandall,B., Klein, G., and Hoffman, R.R. (2006). *Working minds: A practioners's guide to cognitive task analysis*. Cambridge, MA: MIT Press.

Famewo, J. J., Taylor, T. E., Bruyn Martin, L. E., and Matthews, M. L. (2008). *Work domain analysis of 'to-be' Joint Fires Support (JFS) System*. (Chapter to be included in the JFS Cognitive System Engineering Report - DRDC Atlantic CR2008-211). Humansystems Inc..