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CapDEM Exercise Alpha:

Results and discussion

CapDEM Evaluation Team

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Technical Memorandum

DRDC Valcartier TM 2007-080

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Canada

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Abstract

The Collaborative Capability Definition Engineering and Management Technology Demonstration (CapDEM TD) project is investigating Capability Engineering (CE) in order to support the Capability-Based Planning (CBP) decision-making process. Prior to any commitment to institutionalization, a formal evaluation strategy has been devised to test and improve the Capability Engineering approach, a methodology based on the systems engineering paradigm and articulated around three axes: People, Process and Materiel. This memorandum presents the results and the main findings of Exercise Alpha, the first exercise of the three validation exercises. It focuses on two related but different perspectives: (1) the evaluation approach and methodology; and (2) the CE approach. Each of these areas is examined in detail, along with discussions, lessons learned and recommendations in order to help realize the best practices required for future exercises (e.g., Exercise Beta and Gamma).

Résumé

Le projet de Définition, d'Ingénierie et de Gestion Collaboratives des Capacités (DIGCap) investigate l'ingénierie de capacité (IC) comme moyen pour supporter le processus de décision de la planification axée sur les capacités (PAC). Avant un engagement à institutionnaliser, une stratégie d'évaluation a été développée pour tester et améliorer l'approche d'ingénierie des capacités, une méthodologie basée sur le paradigme de l'ingénierie de systèmes et articulé autour de trois axes : personnel, processus et matériel. Ce mémorandum présente les résultats et les conclusions de l'exercice Alpha, le premier exercice des trois exercices de validation. Il se concentre sur deux perspectives apparentées mais différentes: (1) l'approche et la méthodologie d'évaluation; et (2) l'approche d'IC. Chacune de ces catégories est examinée en détail, incluant des discussions, leçons apprises et recommandations. Leur rôle est d'aider à définir les meilleures pratiques requises pour les exercices subséquents (c'est à dire les exercices Beta et Gamma).

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Executive summary

CapDEM Exercise Alpha:: Results and discussion

C. Lalancette; M. Lizotte; C. Nécaille; W. Robbins; W. Waruszynski; DRDC Valcartier TM 2007-080; Defence R&D Canada – Valcartier; September 2009.

The Collaborative Capability Definition Engineering and Management Technology Demonstration (CapDEM TD) project is investigating Capability Engineering (CE) in order to support the Capability-Based Planning (CBP) decision-making process. Prior to any commitment to institutionalization, a formal evaluation strategy has been devised to test and improve the Capability Engineering approach, a methodology based on the systems engineering paradigm and articulated around three axes: People, Process and Materiel.

Exercise Alpha represents the first iteration of the strategy, and its aim is to debug the methodology (i.e., to solve any substantive problems) given a limited number of experimental subjects. The intent is to ensure internal, self-consistency within the axes and the evaluation constructs before proceeding to a larger experimental subject group (i.e., a broader group of team members, including CapDEM stakeholders). In addition to this overarching goal, specific objectives for each axis within CapDEM were defined for Exercise Alpha, including:

- **People:** To ensure that the necessary team roles and responsibilities are identified along with the selection of available individuals to participate in the exercise itself. To ensure that the principles of teamwork, and collaboration and information sharing are embedded into the Capability Engineering Team (CET) construct.
- **Process:** To ensure an understanding of how to initiate each of the Management and Technical processes.
- **Materiel:** To ensure that the Collaborative Engineering Environment (CEE)'s basic functionality is available and functional at the required level and is useful for the CET.

Thus, this memorandum presents the results of this first iteration, known as Exercise Alpha. The findings relates to the evaluation approach and methodology as well as the Capability Engineering approach. Even though, valuable people, process and material lessons were learned and improvements will be incorporated in the next exercises, the main recommendations concern the approach and methodology:

1. The scenario choice is crucial. For the next exercises, scenario selection should be based on the following criteria:
 - a. Knowledgeable people in the problem area must be available throughout the exercise.
 - b. The CET needs open access to sufficient existing data, enabling them to analyze information.
 - c. The problem to be solved must be clear to all participants (including SMEs).

2. CET members should have the right experience for their role. The priority of the exercise and the availability of participants need to be acknowledged by their managers, ensuring proper dedication to and availability for the exercise.
3. The Evaluation Team needs to incorporate a mentoring and coaching role into their responsibilities.
4. Focus group sessions would be more beneficial in attaining any meaningful results from the Subject Team members instead of employing various questionnaires.
5. The training component should be more practical in nature, specifically for CEP and CET. Their inclusion is to help realize the best practices required for future exercises (e.g., Exercise Beta and Exercise Gamma).

Sommaire

CapDEM Exercice Alpha:: Results and discussion

C. Lalancette; M. Lizotte; C. Nécaille; W. Robbins; W. Waruszynski; DRDC Valcartier TM 2007-080; R & D pour la défense Canada – Valcartier; Septembre 2009.

Le ministère de la Défense nationale (MDN) et les Forces canadiennes (FC) mettent actuellement en place une approche de planification axée sur les capacités (PAC) comme élément central de leur processus global d'affaires. Les principes de la PAC indiquent, qu'une fois définie, une capacité doit être mise en place et gérée adéquatement. Le projet de démonstration technologique « Définition, ingénierie et gestion des capacités collaboratives » (DIGCap) vise à définir et valider l'ingénierie des capacités (IC) dans le cadre de la défense canadienne, incluant la collaboration des différents partenaires du MDN et de l'industrie.

En se basant sur la portée et les implications potentielles de l'IC au sein du MDN, une stratégie d'évaluation formelle a été établie. Son but est d'aider à valider l'approche et à minimiser les risques associés avant toute démarche d'institutionnalisation de ce nouveau concept. Cette stratégie est structurée selon les trois axes de DIGCap : le personnel, le processus et le matériel.

L'Exercice Alpha constitue la première itération de cette stratégie. Son but est de déboguer la méthodologie proposée (c'est-à-dire de résoudre tout problème substantiel) avec un nombre limité de participants pour s'assurer de la cohérence interne selon les trois axes avant d'étendre l'expérimentation à un nombre plus grand de participants. De plus, des objectifs bien précis ont été définis pour chacun des trois axes de la DIGCap, dont :

- **Personnel:** S'assurer que les rôles et responsabilités de l'équipe sont identifiés lors de la sélection des ressources disponibles pour participer à l'exercice. S'assurer que les principes de travail d'équipe, de collaboration et de partage de l'information sont inclus dans le concept d'Équipe d'Ingénierie de Capacité (EIC).
- **Processus:** S'assurer de la compréhension de la façon d'amorcer chacun des processus techniques et de gestion.
- **Matériel:** Vérifier que les fonctionnalités de base de l'Environnement d'Ingénierie de Capacité (EIC) sont disponibles et fonctionnent au niveau requis.

Ce mémorandum présente donc les résultats de cette première itération, appelée Exercice Alpha. Ces résultats sont divisés en cinq catégories : L'équipe réalisatrice, l'équipe d'évaluation, le scénario, la méthodologie et la formation. Chacune de ces catégories est examinée en détail, incluant les discussions, leçons apprises et recommandations, afin de déterminer les meilleures pratiques pour les exercices ultérieurs (Exercices Beta et Gamma).

Les principales recommandations pour améliorer l'approche et la méthodologie sont (par ordre d'importance) :

1. Le choix du scénario est crucial. Pour les prochains exercices, la sélection du scénario devrait répondre aux critères suivants :

- a. Des ressources compétentes dans le domaine choisi doivent être disponibles tout au long de l'exercice.
 - b. L'EIC doit avoir accès à suffisamment de données existantes pour pouvoir analyser l'information.
 - c. Le problème à résoudre doit être clair pour tous les participants, y compris les experts du domaine.
2. Les membres de l'EIC doivent posséder l'expérience pertinente pour le rôle qui leur est assigné. La priorité de l'exercice et la disponibilité des participants doit être vérifiée et approuvée par leur gestionnaire, afin de s'assurer leur disponibilité tout au long de l'exercice.
 3. L'équipe d'évaluation doit inclure le monitoring et le coaching dans la liste de ses responsabilités.
 4. Des séances de « Focus Group » sont préférables à l'usage de questionnaires pour obtenir des résultats significatifs des membres de l'équipe réalisatrice.
 5. La formation doit être de nature plus pratique, surtout pour les composantes processus et personnelles.

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The Evaluation Team would like to thank the Subject Team members for participating in Exercise Alpha to enable the Evaluation Team to debug the approach and methodology before moving forward with Exercise Beta. Their involvement made it possible to conduct Exercise Alpha and reach its main objectives.

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1 Introduction

The Collaborative Capability Definition, Engineering, and Management (CapDEM) Technology Demonstration Project (TDP) aims at defining and validating Capability Engineering (CE) [1] within the Canadian defence context, including collaboration with various Department of National Defence (DND) and industry stakeholders. Based on the scope and potential implications of employing Capability Engineering within DND, a formal evaluation strategy [2] has been devised to help assess the approach and minimize any associated risks prior to any commitment to institutionalize this new construct. This new CE construct is organized along three axes: People, Process and Materiel.

- **People:** The Capability Engineering Team (CET) concept represents a cross-functional, multidisciplinary team committed to applying and managing the CE process to help support Capability Based Planning.
- **Process:** The Capability Engineering Process (CEP) is an iterative and incremental process starting from capability shortcomings and finishing with a set of Investment Options and a recommendation in order to provide senior DND/CF personnel with relevant information for enhanced decision-making capabilities.
- **Materiel:** The Collaborative Engineering Environment (CEE) consists of a set of tools, technologies and facilities that will help facilitate information exchange and collaboration among engineers, subject matter specialists and managers at multiple, geographically distributed locations for the purpose of defining, developing and evaluating a capability.

Exercise Alpha represents the first iteration of the strategy, and its aim is to debug the methodology (i.e., to solve any substantive problems) given a limited number of experimental subjects. The intent is to ensure internal, self-consistency within the axes and the evaluation constructs before proceeding to a larger experimental subject group (i.e., a broader group of team members, including CapDEM stakeholders). Thus, this memorandum presents the results of this first iteration, known as Exercise Alpha [3].

This document is organized as follows: Chapter 2 briefly describes goals, purpose, outcomes and presents a summary of the exercise. Chapter 3 outlines the results of the exercise, in terms of the general evaluation methodology. Chapter 4 presents the results of the CapDEM approach on a per axis basis. Chapter 5 provides further discussion and analysis of the results while also putting forward recommendations for Exercise Beta. Finally, Chapter 5 concludes with a summary of the exercise and how its execution met the intent of the overall evaluation strategy.

2 Background

The primary goal of Exercise Alpha was to enable the Evaluation Team to “debug” the evaluation environment with a very limited set of experimental subjects. The intent was to ensure internal, self-consistency within the axes and the evaluation constructs before proceeding to a larger experimental subject group (i.e., a broader group of CapDEM stakeholders) with subsequent exercises (Beta and Gamma). The data collection will serve two purposes:

- Improvements to the approach and methodology; and,
- Evaluation of the CapDEM axes (People, Process and Material).

Therefore, participant feedback will enable improvements to the evaluation environment for the subsequent iterations.

In addition to this overarching goal, specific objectives for each axis within CapDEM were defined for Exercise Alpha, including:

- **People:** To ensure that the necessary team roles and responsibilities are identified along with the selection of available individuals to participate in the exercise itself. To ensure that the principles of teamwork, and collaboration and information sharing are embedded into the CET (principles outlined and supported by them).
- **Process:** To ensure an understanding of how to initiate each of the Management and Technical processes.
- **Material:** To ensure that the CEE’s basic functionality is available and functional at the required level and is useful for the CET.

In achieving the above goals, specific outputs and outcomes were identified for each axis. They were as follows:

- **People**
 - ♦ Realize the experimental CET, including an understanding of its roles and responsibilities.
 - ♦ Use appropriate teamwork principles, collaborative tools and practices within the CET.
- **Process**
 - ♦ Familiarize the Subject Team with the Management and Technical processes.
 - ♦ Familiarize the Subject Team with the CEP deliverables.
 - ♦ Identify weaknesses in documentation (process and deliverable templates) so as to enable adequate application in subsequent iterations.
 - ♦ Identify process elements that will require particular attention during the training (e.g., anticipated issues or items difficult to understand).
- **Material**

- ◆ Familiarize the Subject Team with the basic tools to be used for the exercise(s).
- ◆ Utilize an initial, pre-established workflow between the various tools.
- ◆ Demonstrate and validate the utility of the selected collaboration tools.

In order to reach the objective, two teams were involved: an Evaluation Team and a Subject Team. The Evaluation Team supervised the whole exercise and recruited a Subject Team composed of five participants from DRDC Ottawa and DRDC Valcartier. The participants were initially engaged for a period of four weeks to work with a Canada COM-related scenario. However, the Subject Team encountered difficulties with this scenario, leading to a scenario change which delayed completion of the exercise by three weeks.

The reader should also note that, within the experimental bounds of Exercise Alpha, the People Axis, as represented by the CET, is also referred to as either 'participants' or as the 'Subject Team'.

3 Approach and methodology

The primary goal of Alpha Exercise was to “debug” the evaluation methodology before proceeding to the subsequent exercises. As such, it is important to evaluate the experimental framework to know how it should be adjusted for the next exercise. The main components of this framework are: the data gathering and analysis methods, the schedule and effort, the participants (both Subject Team and Evaluation Team), the scenario and the training. This chapter summarizes the main findings for each category.

3.1 Data gathering and analysis

The methods employed within Exercise Alpha to obtain participant data included: non-participant observations, questionnaires and feedback forms. All means proposed in the Alpha work plan to collect information were used during the exercise. Table 1 summarizes the data collection mechanisms during the Execution Phase of the exercise.

Table 1: Summary of data collection means and mechanisms

Means	Purpose	Times Used	Number of Respondents
Training Questionnaire	Evaluate the kick-off meeting and the training.	1	5 persons – Entire Subject Team.
Observation Form	Report observations of the Subject Team during their working sessions.	6	One or two members from the Evaluation Team attended each VTC meeting.
Intermediary Feedback Form	Monitor the Subject Team’s experience relative to each axis as well as the progression of the exercise in general.	5	Varied Number – Most of the Subject Team members completed the feedback form when the exercise started. However, as the exercise progressed, these forms were not filled out by all of the team members.
Final Questionnaire	Evaluate the CET’s overall experience within Exercise Alpha.	1	4 out of 5 Subject Team members completed the exercise (one member was unable to complete the exercise). The sample was too small to be able to obtain any meaningful results.
Meta Questionnaire	Evaluate the suitability of the means by which the evaluation was conducted, including the mechanisms and materials used.	1	4 out of 5 Subject Team members completed the exercise (one member was unable to complete the exercise).

Non-participant observations were used to gather qualitative data and information from the Subject Team. The focus for the Evaluation Team was to remain visible but separate from the rest of the group and to only observe the actions and interactions within the group setting. For the most part, non-participant observations enabled the Evaluation Team to gather first-hand data and information in a team setting. Usually, an observer was present in each ACCESS lab while the CET was carrying out their meetings. The language used during the meetings was observed to be an issue. Most of the meetings were held in the French language, which did not allow for English-speaking observers to take part in the observations of the meetings.

Questionnaires were also employed within the Subject Team. The training questionnaire was useful to evaluate the training. All participants filled in this questionnaire and wrote constructive comments. The feedback forms did significantly augment the data obtained through the observations. It was also demanding for both teams: the Subject Team to fill it on a regular basis; and the Evaluation Team to compile the hand written questionnaires. The Evaluation Team discovered that the final questionnaire did not capture the desired data enough to make the results meaningful. There were only four participants at the end of the exercise; and as a result, the participants could not fully answer the questions. For example, the questionnaire had a complete list of questions pertaining to the three axes (i.e., People, Process and Materiel). However, some of the questions were interpreted differently by the participants because they did not really go through the process to know exactly how to answer the questions. For instance, the questions on the CEE elicited different answers. Questions which incorporated a ranking scale were also misinterpreted and did not yield any meaningful results.

A meta-questionnaire was used to determine if the efficacy of the methods employed for “debugging the environment” were appropriate to use in the following exercises. The Subject Team had a concern over the construction of the questionnaire and had difficulty in answering it properly. They did not understand some of the questions. They also stated that they had undergone a great deal of frustration throughout the whole exercise. As a result, some Subject Team members expressed negative criticisms about their experiences in this exercise.

To perform the analysis, the Evaluation Team started with a preparation step. Observations made by multiple observers were consolidated into a single document, data from the same type of data collection means were combined together, and averages were calculated for each scaled question. Feedback forms for specific dates were combined into a document containing all comments received. The Evaluation team then examined these pre-processed questionnaires, forms and observations. This examination revealed that the meta and final questionnaires did not give very many meaningful results. An additional analysis, however, concluded that it was possible to extract recurrent themes from the other data collection means. Unfortunately, using so many data collection mechanisms made the analysis more difficult. Additionally, it made it harder to extract the main themes as data came from many sources. At the end, the Evaluation Team discovered that the most useful sources of information were the training questionnaire, the observations, and comments written by the participants.

3.2 Work plan

An entire day (11 May 2005) was dedicated to a kick-off meeting and training session for each axis (see Agenda Annex 1). The event was held at DRDC Ottawa with the participation of all

Subject Team members and three Evaluation Team members. Two Evaluation Team members joined the kick-off meeting remotely. The exercise execution subsequently started on 16 May 2005 and ended on 30 June 2005. The main events of the exercise are summarized in Table 2.

The exercise unfolded as planned until 24 May 2005, at which time a problem surfaced (i.e., a scenario scoping problem). The problem was severe enough that the Evaluation Team decided to make adjustments to the exercise, and consequently, the exercise was temporarily suspended and resumed after a three day adjustment period. As a result of the revised plan, it was decided to delay the completion date of Exercise Alpha from 10 June to 30 June 2005, to accommodate the revised changes.

Table 2: Exercise Alpha execution summary

Activity	Date (2005)
Kick-off Meeting and Training	11 May
Exercise Start	16 May
Inception Phase Execution	16 May – 20 May
Scenario Problem	24 May
Temporary Suspension to the Exercise and Corresponding Adjustments	27 May – 30 May
Resumed Exercise	31 May
Continued Exercise Execution	31 May – 30 June

The schedule put forward by the Evaluation Team was designed to obtain timely and relevant feedback on the methodology to adequately prepare for Exercise Beta. This subsequent exercise was planned to start the following Fall. Exercise Alpha was intended to ensure that subsequent evaluation efforts would run smoothly in the next iteration. With this in mind, Exercise Alpha was deliberately designed to be short, substantively smaller than any subsequent exercises and not to be a long involved event. The effort required each participant to be available for two days a week for four weeks.

The schedule was found inadequate by the CET, as shown by these comments received during the course of the exercise:

- “...we had insufficient time to perform the tasks”;
- “Need extra time between meeting” ;
- “It is also difficult to do the work within the 2 days/week allocated” ; and
- “Evaluation Team underestimated time required to fill in templates”

The CET wanted more time to execute the exercise as they found the schedule to be unrealistic. Time management proved to be a key issue since it was a small exercise with a very short duration.

3.3 Subject Team

Three main criteria drove the selection of the Subject Team members: availability, willingness to participate and geographic location. Even though experience was not listed as a key criterion, the Evaluation Team tried to recruit individuals with the right experience for a specific role in the exercise. Practically speaking, it was impossible to achieve. The team ended up being a mix of senior and junior individuals, some fitting perfectly with the role assigned to them, and others fitting to a lesser degree.

The Evaluation Team recruited five participants between DRDC Valcartier and DRDC Ottawa to serve as a CET within Exercise Alpha. The roles within the Subject Team included:

- Project Manager/Chief Architect: assumed by an Engineer from Ottawa
- Requirements Engineer: assumed by a Defence Scientist from Ottawa
- Business Architect: assumed by a Defence Scientist from Ottawa
- Solutions Architect: assumed by a Defence Scientist from Valcartier
- Technology Architect: assumed by a Defence Scientist from Valcartier

The Evaluation Team asked each member to devote an average of two days of effort per week to complete the exercise.

The Subject Team lost one member two weeks before the end of the exercise. This member was not replaced due to scheduling issues and, consequently, the Subject Team completed the exercise with only four members.

The availability of each team member was supposed to be ensured throughout the duration of the exercise. The reality proved to be different, as shown by these comments from the intermediary feedback forms:

- “Missing one member (unavailable – we must accommodate)”;
- “Not sure to be available at certain dates because of many travels”; and
- “Other demands on our time have not been reduced at all. It almost feels as if we are being asked to work extra two days/week”.

The availability of some team members became a problem. It prevented them from fully committing to the exercise. It also forced others to take over responsibilities of different participants. Distractions were also an issue: some participants were often interrupted during the meetings, going back and forth from their offices. Consequently, the continuity of attention to the effort was sometimes jeopardized.

During Exercise Alpha, the Subject Team had two main responsibilities. First, they had to execute a CEP instance as a CET enabled by the CEE; and second, to provide feedback to the Evaluation Team. They achieved both responsibilities quite well. They tried to follow the CEP and worked as a team. However, they did not use the CEE as much as it was prescribed. They completed and returned all training and final questionnaires to the Evaluation Team. Most participants filled out the intermediary feedback forms at the beginning of the exercise but their rate of completion decreased as the exercise progressed.

3.4 Evaluation Team roles

As part of ensuring the implementation of Exercise Alpha, the Evaluation Team organized the exercise and its environment, oversaw its high-level execution, provided support to the Subject Team and served as trainer, observer, data collector and results analyst.

The main responsibilities of the Evaluation Team during the exercise were put forward to the Subject Team at the kick-off meeting. They consisted in:

- Assessing the CET, CEP and CEE axes;
- Providing the tools and mechanisms to gather the data; and,
- Providing the instructions and overview of the CEP, CEE and the CET.

However, these responsibilities did not meet the expectations of the Subject Team as these comments on the final questionnaire proved:

- There was “insufficient Evaluation Team support” across the entire exercise;
- The observer team “did not foresee a number of issues that slowed them down”; and
- The observation team was “too passive”

The CET wanted more active involvement from the Evaluation Team. At each meeting, the Evaluation Team observed frustrations by the CET members, as they were always expecting the observers to provide direction and input into the discussion. The participants expected that the Evaluation Team would provide coaching and direction to the Subject Team. However, the design of Exercise Alpha did not allow for a coaching mechanism to be incorporated. The focus was on debugging the environment, and it was integral to see if the Subject Team members were able to generate meaningful results in an independent manner.

3.5 Scenario

As indicated in the evaluation strategy [2], the intent of Exercise Alpha was to “debug” the methodology. The outputs and outcomes described in the work plan [3] were very basic (e.g., appropriate use of teamwork principles, identification of process documentation weaknesses and, basic familiarization with the tools). Consequently, the choice of the scenario for Exercise Alpha was not a major concern for the Evaluation Team. The goal was to provide some data to play with while experimenting team dynamics, elements of the process and basic tool functions.

The exercise started with a planned scenario based on the new DND/CF command structure known as “Canada COM”. However, because the Subject Team felt they were missing information, the Evaluation Team decided to change the capability gap being used for the exercise. The second scenario (based on a more common “collaborative environment” need) was simpler and did not require a lot of organizational-specific background information to be understood.

The CET was not comfortable to just “play” with the data. The scenario and its secondary importance for the Evaluation Team were severely criticized by the CET. The CET had difficulty to perform their tasks with dummy data. They felt real data would have eased their tasks, as demonstrated within the following comments:

- “If the content is not important, it is hard to fill in the blanks”; and
- “It is difficult to deal with a hypothetical case”

In addition, the CET challenged the utility of the effort using dummy data. They had a difficult time accepting that they should not focus on the content. They questioned the relevancy of an exercise with dummy data. The following comments are good sample of the CET’s opinions:

- “If you start with a dummy activity the rest is meaningless”; and
- “How meaningful is this fill-in-the-blanks exercise with no content”

The scenario was not explicit enough for the Subject Team and, as a result, they had difficulties in understanding where they would obtain information for understanding the requirements. The CET wanted more information as these comments show:

- “There is a lack of context. We would need to bring in a SME for more input”; and
- “Better background documents would ease the problem of working on a hypothetical talks”

Consequently, the CET seemed overwhelmed by the size and quantity of information needed to precisely analyze the given problem. They quickly felt that they had insufficient background information to perform tasks.

To address their discomfort with the scenario, the Evaluation Team provided a second scenario. However, the CET still did not find the scenario to be appropriate. In opposition to the first one, some of them deemed it to be too simplistic.

3.6 Training

Training was held on 11 May 2005 just after the kick-off meeting. It was divided into three parts according to the three CapDEM axes: People, Process and Materiel. Individualized binders containing all training materials were distributed to each team member.

The People axis’ training focussed on team dynamics, and lasted approximately 90 minutes. The team then performed a sample exercise to understand the concepts. Training on the process then followed, in which the trainer presented an overview of the Capability Engineering Process and its components (activities, deliverable, stages and timeline). This portion of the training lasted

two hours. The remaining part of the day (approximately 90 minutes) was devoted to training on the Materiel axis. It presented a number of short introductory sessions on the various tools selected for use within Exercise Alpha (which was to be a subset of the overall CapDEM CEE). Unfortunately, some parts of the training had to be compressed due to time constraints.

At the end of the training, each participant completed the training questionnaire. These questionnaires and observations made by the Evaluation Team members during the training day are the two data sources used to evaluate the training. Most questions in the training questionnaire used a scale format, where 1 represented the most favourable score and 5 the least favourable score.

As the results in the training questionnaire indicated, the CET training portion was really enjoyed by the participants, and was quite effective. Each question regarding CET training obtained an average score of 1.8 and better (see Annex B) which gives an overall score of 1.4 for CET training. From a group of individuals entering the training room at 9:00 in the morning, the Evaluation Team members observed the formation of a team and the strengthening of the team spirit throughout the whole day.

In terms of the Process and Materiel axes, scores indicate the training was well received but not as highly as the CET training. The average score for each question regarding those axes reached 1.8. Both CEP and CEE training achieved 2.1 as an overall score. The questions which asked if the engineering tools demonstration and CEP training were sufficient received 2.6 as an average score. This indicates that the Subject Team did not perceive the Process and Materiel training sessions to be as sufficient. The participants were quickly overwhelmed by the amount of new concepts and materials to be absorbed in such a short time period. As they took their participation in the exercise very seriously, they quickly developed a feeling of anxiousness about their ability to reach the goal (i.e., to complete a CEP iteration) given the time and resources allowed.

The Subject Team members rated each trainer favorably (1.6 and higher) regarding their knowledge, communication skills and preparation. The performance of the CEP trainer could have been improved, according to one of the CET members: the “CEP trainer would’ve been clearer if he used some examples”. The training presentations were mostly theoretical, thus making it even more difficult for the trainees to develop a feeling of self-confidence on the application of the subject material. Concerning the tools, the trainees expressed the need for practical training. Most of them (although not all) had never used the tools presented, and expressed the wish to use the tools they were familiar with instead of the ones proposed.

The training was given on-site at a DRDC location; thus, while convenient, it was very difficult to have the attention of some participants, as their offices were too close to the training room. As a result, they were constantly in and out of the training room.

4 CapDEM axes results

From the CapDEM perspective, the main findings of Exercise Alpha can be categorized along its three axes. The next sections summarize these results for the People, Process and Materiel axes.

4.1 People

In terms of the People axis, several themes emerged in analyzing Exercise Alpha's results. These include: resolution of conflicts, commitment and motivation, and level of comfort with roles and responsibilities. These results were extracted from the Subject Team's intermediate feedback forms and the Evaluation Team's observation reports.

Resolution of conflicts. Generally speaking, the Subject Team focused on resolving issues as they arose in the CET. The Subject Team collaborated very diligently and worked very hard at going through the "process as a team". The CET members were keen to work at the exercise and were very willing and accommodating whenever necessary. There were a couple of key instances, however, where the Subject Team had a difficult time in resolving issues. For example, changes to the scenario were brought about by CET members feeling uncomfortable with using dummy data. Concerns from the team focused around being able to complete the objectives even though they felt that they were "lacking information/background material, "AS IS" architecture and identification of stakeholders". Although Exercise Alpha was designed to debug the environment, the team contended that if you start with a dummy activity, the rest is meaningless. The Evaluation Team, however, did not anticipate that extensive information for the scenario would be required. The Subject Team felt that they could not try to debug the environment without really going through an understanding of the scenario. As a result, the CET confronted the Evaluation Team and stated that a new scenario would be more beneficial than the current one. The Evaluation Team was forced to put forward a new scenario. However, difficulties still emerged in filling out the information required against the deliverables. Despite additional issues with the second scenario (namely, too simplistic), the CET felt that it was important to complete the tasks at hand as best as possible. The time allotted for the completion of the tasks was also an issue for the CET. The CET felt that they never had sufficient time to complete their tasks (e.g., "difficult to do the work within the allocated two days/week"). This issue was evidenced throughout the exercise. Moreover, the Subject Team also expressed some difficulty in resolving issues as a team. As issues arose, they were able to resolve some issues related to team effort. However, some Subject Team members tried to resolve their issues outside of the team. The mixed messages between group meetings and off-line discussions led to some problems in resolving conflicts within the team environment.

Commitment and motivation. From a commitment and motivation standpoint, the Subject Team was very keen on completing the tasks at hand and ensuring that the objectives for Exercise Alpha would be carried out successfully. The Subject Team was determined to complete each task, and reiterated this notion to the Evaluation Team. At times, however, the level of commitment and motivation waned due to a number of key issues. Issues regarding time constraints were observed by the Evaluation Team, namely that the Subject Team had a difficult time committing themselves to the full duration of the exercise (e.g., number of times the Subject Team had to meet per week). The Subject Team felt that they needed more time to work on the

exercise. The lack of information associated with the scenario/capability gap also affected the commitment and motivation of the Subject Team. The Subject Team felt that it needed more information in order to carry out the exercise. This affected the morale of the team throughout the exercise.

Level of comfort with roles and responsibilities. Some of the Subject Team members were not very comfortable in their roles and responsibilities, perhaps due to a lack of experience in fulfilling their roles. A few Subject Team members took over some others' responsibilities, particularly when a team member was lagging behind the rest of the team. This had a positive as well as a negative impact on the rest of the team. Although it was appreciated that one of the team members took on another's responsibilities, a few of the team members felt that individual team members did not benefit from truly understanding their individual roles and responsibilities. The Subject Team members also questioned the Evaluation Team with respect to the demands of their roles and responsibilities (e.g., "Do you realize what you are asking us?").

4.2 Process

In terms of the process axis, several themes emerged in analyzing Exercise Alpha's results. These include: capability gap, focus and approach, deliverables and descriptions, scope and information, as well as workflow and synchronization.

Capability gap. The capability gap must be distinguished from the scenario previously discussed. Different capability gaps can be given with the same scenario. The scenario is the overall context while the capability gap is the problem to be solved and is required to trigger the CEP. The capability gap given to the CET participants was a two-pager description. The CET team complained that this information was really not enough detailed to be workable, as it was reported by the observers several times.

Focus and approach. The CET participants had difficulty to keep a holistic approach. As an observer said: "some members are struggling leaving behind the point of view of system engineering and leaping into capability engineering". This observation was also made by the participants themselves. The participants focused significantly on the deliverable contents, instead of focusing on the process itself as this comment indicated: "We only filled in the templates, we didn't do all the activities for each stage". This mismatch was in spite of the recommendations and explicit instructions of the Evaluation Team not to be concerned with the 'contents' of the output, but rather the means of generating them. The participants put a lot of efforts toward the information they thought was missing to enable them to fulfill their duty, as it was reported by the observers several times.

Deliverables and descriptions. The templates for producing deliverables were well received and appreciated. As one participant quoted: "it contains enough information to do the job". During the exercise, several participants commented the templates or requested minor clerical modifications, such as document page numbering, clarification on some dates, etc. The CET issued some request for term clarification in several documents, such as, the meaning and extent of each of the terms composing the PRICIE acronym. Many members of the CET asked for additional practical examples. Different comments illustrate this point:

- “The examples given ... were too simplistic and not representative enough to be useful.”; and
- “The examples given are too high-level.”

The CET identified the lack in the process of a glossary of all important terms, to avoid “serious communication problems”, despite the fact that one was available. To conclude with the templates, the CET pointed out that they still need validation by the “real users” before Beta and Gamma exercises start.

Scope and information. The scope of the CEP quickly overwhelmed the Subject Team. This can be deduced from several factors:

- The Subject Team constantly expressed the need for more information. The next comment is representative of the CET: “Some more effort on exercise background documents would ease the problem of working on hypothetical talks.”;
- Despite the fact that the Evaluation Team told them not to focus on the content of the deliverable, the Subject Team members constantly felt unsecure and without the sufficient level of knowledge to play their CET roles, as stated one member: “Struggling with filling the CEP doc. I don’t have any real experience with DoDAF. How can I document OA with a sufficient level of detail to assess its achievement to further identify corresponding SoS solutions. I don’t know the tasks/activities nor the information flow...”. This was also observed during the CET meeting;
- The CET identified a major flaw in the information provided as “a lot of background and resources are missing. Stakeholder / operator participation is extremely important but lacking in Alpha”. They also complained about the lack of information required to capture requirements; and
- The CET even identified the need for more information on capability engineering, and asked for a tutorial.

Workflow and synchronization. It was noticed that the Subject Team was using the templates as a guide more than following the process. Nevertheless, the members used the role/responsibility matrix tool which was provided to them, in order to figure out their duties. In the middle of the exercise, it appeared that the Subject Team was able to understand and play their role. Some discussion arose concerning the order of some activities, specifically concerning the requirements and the operational architectures—which gives an opportunity to refine the process’ workflow.

In summary, despite an overwhelming scope and a new process to apply, it appears that the Subject Team members figured out their roles and responsibilities, applied partly the process and followed the workflow of activities that were proposed to them. Despite the fact that they focused a lot on the deliverable content, they identified some possible improvement to the process, which is a positive outcome within the scope of Exercise Alpha.

4.3 Materiel

In terms of the Materiel axis, several themes emerged in analyzing Exercise Alpha's results, ranging from specific functionality and technology issues to logistical concerns (see Figure 1). These results were extracted from the Subject Team's intermediate feedback forms, the Evaluation Team's observation reports and the final questionnaire.



Figure 1: Materiel issue spectrum

Functionality: Issues related to the functional aspects of the CEE were identified along the following lines:

- *Tool availability and characterization:* The Subject Team indicated that the tool suite (as a whole) was easily and readily accessible. Some stress and annoyance were evidenced when network problems (e.g., JSimNet proxy was off-line) and/or equipment failure (e.g., broken projector) caused unforeseen difficulties during work sessions and necessitated alternate, ad hoc solutions to be employed with little warning. Isolated technical issues with respect to tool configuration and performance are detailed under 'Technology' (see below).
- *Tool applicability:* Tools oriented toward communication, collaboration and document handling were applicable and used the most. They were also used across the entire range of CEP stages and were highly rated in terms of usability and user friendliness. Conversely, the system engineering tools were more focused in their usage while their usability was rated significantly lower. In terms of application to specific deliverables, the broadest range of tools was applied toward the generation of the Project Plan and the Operational Architecture.
- *Tool suitability and selection:* The Subject Team decided not to use a variety of tools that were provided as part of the CEE. Additionally, commentary was provided that the Subject Team felt they "did not have the right Architecture tools".
- *Communication tools:* The breadth of communication tools (including teleconference, videoconference, chat/instant (text) messaging, and e-mail) were employed throughout the exercise and appreciated ("Lots of comms means increased flexibility"). Positive reviews were given to the ACCESS Labs, particularly in terms of its utility. It was also rated as the most useful tool in facilitating group collaboration. Feedback suggested that lack of familiarity, usage etiquette, logistics and technical difficulties sometimes influenced usage ("... no time to fumble with many tools...").
- *Importance of audio/visual:* Videoconference was the most common and favoured means for real-time group interaction. While the real-time nature of the text-based chat/instant messaging tool was positively received, it was used less due to the team's greater familiarity with VTC along with its lack of audio/visual support.
- *Portal:* The use of Livelink as a portal for accessing project information was highly utilized. However, additional collaborative functions, such as discussion groups and tasks were not significantly used.

- *Repository:* Positive comments were received in terms of Livelink as a document/file repository. The “check in/out” functionality (used to ensure orderly document handling) was useful but sometimes problematic due to technical issues (see below). In terms of information locating, searching and exchanging, finding information and the ability to search for it proved difficult. These issues ranged from finding the source information to understanding and structuring the repository as well as organizing the information within it (“it is also a challenge to build up the discipline to use a consistent filing system”, “...having a hard time to find documents on LL” and “... could it be the job of a technologist to help capture architecture info into db...”). Information exchange through e-mail was also highly used, often in place of the repository (mostly due to familiar and traditional work practices).

Technology: Issues related to the technological aspects of the CEE were identified along the following lines:

- *Account management:* A lack of consistency amongst usernames for the various tools proved confusing and frustrating to the CET members (“...need to stick to one unique convention when creating accounts”). This issue was amplified by the requirement for individual accounts on a per tool basis.
- *Tool configuration and performance:* There were miscellaneous configuration problems with specific tools for some users. A notable issue was the need to properly install and configure a very fragile support module to Livelink to enable the “check in/out” functionality (misconfiguration could bring down the server). This unforeseen technical dependency and the resulting need to involve additional IT staff led to time consuming delays and frustration amongst the Subject Team (“...required modules for Livelink not installed...”). Additional difficulties were encountered with the performance of networked client/server tools (specifically, CORE Enterprise) over wide-area portion of the DRENet. (“...have a CORE account but I couldn’t access it today”, “...slow respond on Enterprise client...”). Miscellaneous technical problems ranging from network outages (“JSimNet not available”) to minor configuration differences between DRDC Ottawa and DRDC Valcartier ACCESS labs created difficulties. Hardware failures (e.g., a broken projector in DRDC Ottawa) also forced changes in work plans.
- *VTC resolution and environmental conditions:* At the time that the exercise was conducted, the ACCESS Lab videoconference system was unable to simultaneously transmit data and camera video at native resolution (due to required hardware that was unavailable at that time). An alternative technological solution (the use of Livelink MeetingZone on-line meeting application) was deemed unsatisfactory (i.e., too confusing to the users given the number of tools already causing concern). Consequently, manual document sharing (i.e., talking to the group through the document editing process) was used. The Subject Team reported frustration with this situation as it did not meet expectations. Additional displeasure was voiced over the difficulty of seeing appropriate video detail due to resolution problems and on inappropriate lighting conditions (“hard to see expressions on people’s faces...”).

Logistics: Issues related to the logistical aspects of using the CEE were identified along the following lines:

- *Availability/scheduling:* Due to the shared nature and increasing popularity of the ACCESS Labs, their availability for extended work sessions proved to be an issue (“Booking access to a VTC is very hard even though we were told that we had priority”). Numerous scheduling conflicts required manual intervention.
- *Room management systems:* The booking of the DRDC Ottawa and DRDC Valcartier ACCESS Labs is done via the DRENet Outlook calendaring system. While well known and understood, issues at the DRENet policy and technical level created difficulty for the Subject Team to independently arrange their VTC-based meetings and work sessions. In particular, individuals at each lab had to manually coordinate, schedule and book their lab on behalf of the Subject Team. Various individuals who did not have the necessary permissions combined with technical limitations on inter-lab resource bookings further exacerbated the situation. This organizational logistic (vs. that of the CEE) caused delays and frustration on behalf of the Subject Team.

5 Discussion and recommendations

The Evaluation Team was able to gather significant insight into issues surrounding preparatory efforts and CET execution support, as well as the kinds of issues encountered by the Subject Team. Feedback on methodologies and the CapDEM approach also proved very useful and will result in improved methodological changes in subsequent evaluation exercises. Without the information received via Exercise Alpha, a number of issues would have “slipped by”. Consequently, the Evaluation Team feels that their objectives for Exercise Alpha, to a large degree, were met.

Based on the results summarized in Chapter 4, an analysis and discussion of the associated issues and various perspectives relating to them will be presented next.

5.1 Approach and methodology

This section discusses the results and recommends some improvements to the methodological approach

5.1.1 Data collection and analysis

Some data collection issues were observed. The main ones requiring further work include: feedback mechanisms and recording of sessions.

Feedback mechanisms. Based on the methods for capturing the Subject Team’s feedback, it was realized that a long questionnaire with a limited number of people would not elicit any meaningful results, especially since some of the questions could not be understood or answered correctly. By having more frequent discussions with the PM, the use of questionnaires may have been reduced substantially, thereby limiting the Subject Team’s frustration with constantly answering questionnaires. The main focus should have been on increasing the validity and utility of the most pertinent questions, and thereby limiting the number of questionnaires to a minimum. Instead of employing various questionnaires in the future, the Evaluation Team realized that a focus group session would be most beneficial in attaining any meaningful results from the Subject Team members. In addition, a 360 degree evaluation methodology could also help to capture some of the fundamental aspects of the interrelationships between Subject Team members. Such an evaluation methodology could enable the team members as well as the Evaluation Team to determine team performance, and elements of team performance that could be improved upon for future CapDEM exercises. The methodology could also be explored with the PM and the rest of the Subject Team to determine how best to understand the dynamics between the team leader and team members. The proposed feedback methodology could be employed at the end of Exercise Beta to determine if this type of performance tool would be beneficial in further understanding the principles of teamwork and team communication for capability engineering teams.

Recording of the sessions. The Evaluation Team felt that it may have been more beneficial to have had the sessions within Exercise Alpha recorded for further observation. Although members of the Evaluation Team reported meticulously their observation after each session, a recorded

version would have allowed verifications and given the possibility to the other members to listen to a session.

5.1.2 Work plan

Although criticized by the CET, the actual schedule and effort planned met the purpose of the Exercise.

Project constraints. The Evaluation Team still believes that the planned schedule and level of effort was sufficient with respect to the exercise and its constraints. One such constraint was the need to prepare for the follow-on exercise (Exercise Beta). This reality influenced the pace of Exercise Alpha and there was almost no room for flexibility (e.g., a longer period of execution or more than two days a week per person). The need for additional working time stemmed from the failure to easily work without worrying about the actual content. This aspect about the scenario is discussed later.

Relevant results. The purpose of getting timely and relevant information for Exercise Beta was successfully attained. The Evaluation Team was able to obtain significant insight into issues surrounding preparatory efforts and execution support as well as the kinds of issues encountered by the CET. Feedback on data collection methodologies also proved to be very useful.

5.1.3 Subject Team

The lessons learned concerning Subject Team participation within Exercise Alpha belong to three main topics: the importance of commitment, team member selection, and the importance of key personnel (e.g., the project manager and senior engineer).

Importance of commitment. As previously stated, the lack of availability represents one of the difficulties encountered throughout the exercise. It prevents a full commitment from some members. To avoid this problem in the future, the priority of the exercise needs to be acknowledged by their managers, ensuring a proper dedication to the exercise itself. Managers and key organizational members should also reinforce the importance of the Exercise, which in turn, will assist in reducing any uncertainty in the mind of potential participants. In addition, the team itself should be aware of the importance of their commitment toward the exercise, as well as their activities outside of the exercise effort. As done in Alpha, clear statements of the expectation in terms of time and effort should be made prior to participant selection. Time availability should be checked prior to member selection and at the time of recruitment.

Team member selection. The Alpha Subject Team was a mix of experienced and non-experienced personnel for their roles. It was thought that since the experimental focus was more to “debug” the methodology than to solve a real problem, the players’ experience was not necessarily a significant issue. However, the results demonstrated the contrary. Specifically, non-experienced members felt uncomfortable in their roles. They lacked confidence in themselves, and thus they needed to stay very close to the problem and relied on the process’ description of tasks to enhance their level of self-confidence. Unfortunately, since the process had to be refined, doing so contributed to their level of discomfort in the Exercise. The need for

personnel with prior experience, ability to deal with fuzziness and a good level of self-confidence, in order to refine the process, is one of the findings of this experiment.

Key personnel. The last lesson learned concerning this aspect is the key importance of the project manager and senior engineer personalities. As they are, by the very definition of the roles the most experienced players in this Exercise, their influence on the rest of the Subject Team was a key to counterbalance the feelings of uncertainty and doubt that were experienced by the rest of their team. The leadership and broad experience of the project manager and senior engineer are key assets for the success of such an experiment.

5.1.4 Evaluation Team

The main regret in this exercise for the Evaluation Team is the apparent less positive experience garnered by the Subject Team. The presumed reasons for the Subject Team's disappointing experience were varied, but all seem rooted in different expectations, both in terms of the exercise and the Evaluation Team itself. In order to better meet the Subject Team's expectations, the Evaluation Team would have to propose newer responsibilities in the next exercise, including:

Coaching and mentoring. A key lesson learned is that the Subject Team needed more formal, proactive coaching and mentoring throughout the exercise. This would ensure that the Subject Team members would follow the steps within the exercise without too much difficulty, while increasing their confidence and reducing uncertainties. As a result, the Evaluation Team would have to organize the subsequent exercise to incorporate these functions. The difficulty with the coaching and mentoring would consist in enabling the CET to be autonomous without leaving it to feel abandoned and unsupported. The CET must also take responsibility on its own and realize that it is supposed to be a self-contained functioning unit, as if the Evaluation Team did not exist and the exercise was not based on an experiment.

Communication. The Evaluation Team realized the importance of maintaining constant interaction with the Subject Team members. More frequent debriefings with the Evaluation Team may have prevented many issues from transpiring throughout the exercise (e.g., better time management, more thorough understanding of roles and responsibilities, and better training and coaching in the use of tools). In addition, more regular debriefings with the PM could have resolved some of the issues experienced by the Subject Team members, especially when there were disagreements over the process of the exercise.

Support. The Subject Team required support for on-going daily issues and problems, including various axis-specific issues. The Evaluation Team will need to ensure this need is met, either by itself or through an external support mechanism.

5.1.5 Scenario

The negative comments from the CET on the scenario have revealed to the Evaluation Team a fundamental orientation of Exercise Alpha that failed: the transposition of software-intensive "unit testing" to the CapDEM approach.

Unexpected importance. The importance given to the scenario by the CET was very surprising to the Evaluation Team. The primary focus of Exercise Alpha was on the development of an efficient evaluation environment: “debugging” the methodology. The Evaluation Team was simply expecting the CET to use the process and the tools provided to create any output fitting the format required. Within the overall CapDEM Evaluation Strategy, the purpose of Exercise Alpha was to mimic the notion of “unit testing” in software-intensive systems. In such testing, input data is not important as long as the software does what it has been designed for and does not crash. Therefore, the Evaluation Team considered the scenario as a secondary element for Exercise Alpha. This transposition did not work and is most likely at the origin of numerous difficulties encountered by the CET. For instance, it has affected the CET’s motivation; and as a result, the morale of the team suffered throughout the exercise.

Richer set-up. Following these results, the Evaluation Team has to re-examine if its scenario approach for the next iteration, Exercise Beta, is adequate. As indicated in the evaluation strategy [2], the intent of Exercise Beta is to ensure that the CapDEM approach can address a “real world” problem. Exercise Beta is a transposition of software functional testing into which realistic data are essential to ensure a coherent workflow. Therefore, the quality of the scenario is critical. Exercise Alpha has provided some key hints to reach the appropriate quality level.

The CET needs a very rich problem area that can be investigated through an easy access to data and subject matter experts (SMEs). In addition to making their own search for relevant data, they need to interview and validate their information and findings with knowledgeable people. More specifically, it suggests looking at specific “criteria” that will help to choose a scenario:

- SMEs: Knowledgeable people in the problem area must be available throughout the exercise;
- Data access: The CET needs open access to a lot of existing data enabling them to analyze information; and
- Problem scope: The problem to solve must be clear to all participants, including SMEs, to prevent undesirable effort.

5.1.6 Training

As mentioned previously, proactive coaching and mentoring is required throughout the exercise. Nevertheless, improvements to the training content, approach and logistics are also suggested.

Practical training. The Subject Team expressed the desire for more practical training, especially for the Materiel (tools) and Process axes. Nevertheless, some theoretical training is needed in order to provide a basis for integrating the various concepts of capability engineering. Therefore, one possible solution is to augment the existing training approach by combining practical tool and process training together within a simulated CEP instantiation. Doing so would provide a mirror of the training exercise utilized by the People axis.

Incremental training. To address issues of personalized and variable-scoped training, the use of staged training sessions is proposed. This technique would enable CET members to join in progressively at the appropriate level to take advantage of their existing background in terms of capability engineering and tools. The result is a “multiple on-ramp” or “spiral” approach to

training which would facilitate graduated access to a topic's training. The challenge will be to plan such sessions in terms of time and budget, as the availability of stakeholders and resources are key concerns. Multiple half-day training sessions may be the answer.

Logistics. Along with improvement to training, a number of logistic issues should be addressed:

- Training should be given offsite to ensure complete participation by the team and avoid any temptation to answer the telephone and attend to other pressing items (especially when a Subject Team member's office and training occur in the same location);
- There needs to be a clearer differentiation between the training and the kick-off portions of the exercise; and
- The concept of the training binder given to each participant with all relevant documentation was much appreciated and should be kept for the following exercises. By doing so, the following issues must be addressed:
 - ♦ It is important that the content is ready before hand. For Exercise Alpha, it was finished at "the last minute" just before the training started. This timeline gave no room for error and/or Subject Team to review it in advance;
 - ♦ External logistical assistance needs to be provided to address all the paper handling issues (printing, collating documents into the binders, etc.); and
 - ♦ Additional requests for the content were:
 - It should start with a short "where to find" page, containing the references and a summary of the fundamental documents for the participants; and
 - A tutorial on capability engineering should also be provided, in order to facilitate the shift from "system thinking" to "capability thinking".

5.2 CapDEM axes

From the CapDEM perspective, the following presents an analysis of the results and experiences from Exercise Alpha in terms of each individual axis.

5.2.1 People

By examining the role of human dynamics within Exercise Alpha, the Evaluation Team realized that there are fundamental rules of engagement that need to be adhered to for better team performance. Based on the Evaluation Team's observations, certain elements need to be considered before enabling a team to go through the stages of group development (i.e., forming, storming, norming and performing).

Balance and understanding of roles and responsibilities. The Evaluation Team observed that there was an imbalance of roles and responsibilities among the Subject Team members. A few members felt that they should have been told where to look for all the information, as opposed to obtain information from relevant sources to start developing their thought processes. A few members did not complete their portion of the work; and as a result, other team members carried out additional roles and responsibilities to fulfill the tasks at hand. It was realized that the roles

and responsibilities of individual team members should have been better understood to ensure that each team member would have fulfilled their roles and responsibilities to the fullest. The Team Charter had outlined the roles and responsibilities. However, limited attention was paid to the Team Charter. The Evaluation Team realized the need to better integrate the Team Charter into the exercises to ensure that each member is aware of its roles and responsibilities and understands its participation in the team construct.

Enhance commitment and motivation. The Evaluation Team recognized that there was a perceived lack of commitment and motivation stemming from the Subject Team at the onset of the exercise. Balancing priorities and work schedules were difficult for the Subject Team, as well as obtaining adequate information on the scenario/capability gap. To attain stronger commitment and motivation from the Subject Team, the Evaluation Team realized that it is important to provide a proactive coaching role to help support the CET.

Work closely with Project Manager and Senior Engineer. The Project Manager and the Senior Engineer both play important roles in the success of the Subject Team meeting its objectives. As they are the most experienced players in this experiment, their influence on the Subject Team would have helped to mitigate feelings of fear, uncertainty and doubt during the exercise. The leadership and broad experience of the Project Manager and Senior Engineer are key assets for the success of such an experiment, especially in providing guidance to the Subject Team.

Liaise with SMEs. The Evaluation Team observed that there was no direct link to the Subject Matter Experts (SMEs) during this exercise. Although it was not expected for the Subject Team members to liaise with the SMEs, the team members felt that the SMEs could have provided better validation of their steps in fulfilling certain deliverables. As a result, connecting to the SMEs would have proved to be fundamental to the success of the exercise.

Avoid disruptions during meetings. A few team members had their cell phones on during meetings; and as a result, other team members were annoyed about the disruptions. Some Subject Team members also reviewed their e-mail messages while the meeting was being carried out. Therefore, the Evaluation Team has realized that there needs to be rules of engagement which prohibit team members from using technology such as cell phones or viewing and responding to e-mail messages. As a result, all cell phones and laptops should be turned off during meetings (unless the laptops are used for meeting purposes).

5.2.2 Process

Capability gap description. The CET wanted to receive a more complete description with more background information. From their point of view, a two-pager description is not enough to trigger the CEP. The Evaluation team still believes this short description could trigger a CEP. In real life, time would be planned around the necessary information to better understand the problem to be solved. In Exercise Alpha, no time was allocated for this activity, as the content was not that important for this exercise. However, the Evaluation Team recognized that an assessment on the relevance on the actual form of the capability gap description is required. Exercise Beta could shed some light on this issue, seeing that this exercise will incorporate a more realistic schedule.

Workflow. The scenario ended up being too simple to make it possible to validate the workflow. Therefore, many “can’t say” responses were received on the evaluation forms with respect to this particular point. Combined with the excessive flexibility in tool use, this situation led to a lack of constructive feedback in terms of the proposed workflow as well as commentary on its importance.

Documentation and deliverables. Numerous issues in terms of the process documentation and deliverables arose in a number of areas. They included:

- The deliverables and templates were not validated with real users nor existing DND templates. This ‘newness’ left the Subject Team feeling like they were experimental and not sufficiently linked to the standard practices of the Department.
- Various clerical improvements for the CEP presentations were also identified, including page numbering of the documents, and references to CEP materials. This point has some importance due to the number of documents available. It would also contribute to a better mastering of the process by the CET and enable smoother working sessions.
- The size of the “starter kit” should be reduced by providing overviews of the whole process activities, roles and responsibilities.
- The Subject Team also pointed out the need to check and verify the linkages between the deliverables. Specifically, while some optional parts were “greyed out”, they were referenced elsewhere within the document. This inconsistency introduced confusion and created a degree of incoherence in the process. Consequently, this kind of issue highlighted the need for special care to be taken in cross-referencing process specifications and documentation, especially when considering optional and multi-branch workflows.
- The Subject Team also emphasized the need for a glossary, even though it was made available. Consequently, all documentation must be available and clearly identified to the participants prior to starting an exercise.

Useful constructs. The Subject Team highlighted a couple of very useful constructs within the application of the process. These include the deliverable templates and the roles and responsibilities matrix. The templates were much appreciated. A possible improvement would be to provide samples of each section’s contents to ease the understanding of the process. Comments, such as “what do you want?”, “when do you want it?” and “who do I contact to get this information”, were frequent during this exercise. The roles and responsibilities matrix was also very much appreciated. The use of the checklist and matrix helped the participants figure out where and when they are involved in the process and what they have to produce. An improved description of roles and responsibilities is underway for the next version of the process, and will be accompanied by a CEP handbook (e.g., cookbook) with a real example of a CEP initiative.

5.2.3 Materiel

General discussion about the CEE can be identified along the following lines: functionality and configuration, logistics and awareness, training and learning. These areas correspond (to a large degree) to those identified in Materiel results section; the reader is referred there for specific results which this section complements through additional analysis and commentary. This section

adds additional critique as to larger issues that need to be addressed in terms of axis-specific lessons learned.

Functionality and configuration: In terms of functionality and configuration of the CEE, the following points need to be addressed:

- *Functional selectivity:* Specific functionalities (i.e., tools) were requested outside those provided for the exercise. Conversely, a number of provided functionalities were not used. This situation was partly due to familiarity with specific tools which provided similar functionality, combined with the size and distribution of the Subject Team not substantially benefiting from their use (i.e., alternate methods were easier). Additionally, personal bias for and against certain tools also impacted this issue.
- *Functional appropriateness:* Particular kinds of functionality that were not technologically available with the current CEE (such as group vs. individual chat with the Livelink Pandion module) were often requested. This mismatch proved frustrating for both Subject and Evaluation Teams as it led to a reduction in enthusiasm to use a particular kind of tool because the exact “type” of functionality was not available when desired. Despite the possibility of using Livelink MeetingZone module as a replacement, its complexity combined with adding another tool for the Subject Team to use was viewed as problematic. Additionally, it did not provide ad hoc capability (e.g., it required the use of scheduled “on-line meetings” as opposed to offering a light-weight instant messaging mechanism). While such a tool would have also been able to assist in the VTC resolution problem, the complexity of emulating the problematic functionality was again a significant concern. Such examples illustrate how specific implementation issues can influence efforts to introduce “new ways of working” through their impact on social and work practices. There is a need to provide timely redress to perceived functional deficiencies in order not to discourage adoption of the general functionality.
- *Configuration:* Issues in terms of user comfort and lessening potential user confusion in terms of tool access (not tool usage, per se) need to be addressed in terms of seemingly simple things such as consistent tool user names and a single place from which to launch them. In particular:
 - ♦ *Single unified login:* While common accounts for the various tools would help alleviate this issue, they were not possible within Exercise Alpha’s timeline. This issue was further complicated by tool-specific requirements as well as the CEE evolution, resulting in various account irregularities.
 - ♦ *Single unified launch point:* The evolution of the CEE along with various outside policies and technical issues also led to a multitude of tool locations (e.g., different servers, networks, access points). Thus, a single place (i.e., Web page) from which to launch the various tools was not possible.
 - ♦ *Client tool footprint and access point testing:* Issues arose in terms of individual Subject Team members having the right software installed and configured properly on their machines. This issue also related to which of the various access points (DRENet, DWAN and Internet) the members utilized. There is the need to prepare a standard approach to ensuring this baseline setup is achieved. For example, a check

list and set of standard readiness tests may be appropriate to ensure proper functioning of the various tools, and any specific functionality required by the specific users.

Logistics and awareness: In terms of logistics and awareness of the CEE, the following points need to be addressed:

- *Consistent application:* The Subject Team did not consistently use the provided CEE. This situation resulted in various difficulties in performing certain tasks because the tools intended to support them were not used. However, this reality was in part due to a lack of familiarity/awareness of the tools, their functionality and how to work with them in an appropriate workflow.
- *Iterative introduction:* Despite a limited number of tools and functionalities to be used within the exercise, the introduction of the whole set at once proved overwhelming to the Subject Team. It is envisioned that a gradual introduction of the various tools over the application of the process would likely lessen the impact of this issue. The difficulty in such an approach, however, is deciding which tools to introduce when, how to introduce them without interfering/disturbing the work effort, and ensuring that all the appropriate people are available at a variety of different times (for training purposes).
- *Flexibility vs. enforcement:* The model for tool usage within the exercise was to be as flexible as possible. Specifically, the Evaluation Team introduced a restricted set of tools from the larger CapDEM CEE for the Subject Team to utilize. The intent was to minimize the training, knowledge and time/effort required by the CET while still being able to evaluate the tools and their functionalities. Unfortunately, because specific tools were not mandated, the Subject Team re-organized (i.e., self-selected) to omit certain tools while adding others. While these changes were allowed to encourage the CET, they did not fully meet the needs of the Evaluation Team. Consequently, the resulting question is whether to enforce the use of certain tools. This issue is further complicated, given the notion of interoperability between tools (e.g., data formats). Because tool selection, functionality and user experience are not mutually independent, the principle of “tool agnosticism” can be a significant issue when applied to real situations. Therefore, evaluating a specific functionality vs. a specific tool and how they meet the needs of the CET and the CEP must consider these pragmatic issues.
- *Awareness and depth of knowledge:* The level of knowledge and experience by CET members with many of the more complex tools resulted in an immediate preference for simpler, more familiar ones (e.g., Visio vs. CORE). To prevent such tendencies in the future, it will be fundamental to have active, knowledgeable tool users as a part of the group. Having tool SMEs to reference and call upon may not be sufficient to enable smooth flowing daily work practices. An issue in terms of user awareness and potential bias was noticed in that some participants were occasionally providing ratings and commentary for certain tools despite not actually applying them to their part of the exercise. The intent and reasoning behind such behaviour was unclear to the Evaluation Team, but could have been related to focusing on specific aspects of a particular tool as opposed to assessing its functionality and utility within the exercise.

- *Site-specific technical support:* More site-specific technical support is required for the various tools as well as for addressing issues of shared facilities (such as the ACCESS labs and other conference/meeting rooms). The management and coordination of these facilities proved a challenge for Exercise Alpha. However, significant effort and consideration will need to be placed on such logistical kinds of concerns for larger efforts, especially those including multiple, external organizations.

Training and learning: In terms of training and learning of the CEE, the following points need to be addressed (these augment the general training commentary provided earlier):

- *Increased training and context:* A general requirement exists for increased levels of training beyond the provided introduction. Insufficient training contributed to the Subject Team having a lack of confidence in their ability to do the work with the tools provided. This issue then also affected a range of other people and materiel issues, as outlined elsewhere in this memorandum. Furthermore, there was a lack of application context for the Subject Team members to associate the tool, its user interface, functionality and combined workflow with the needs of the exercise. Consequently, demonstrations with hands-on experience in example sessions would prove useful. Such an approach would be particularly valuable if it could be done in conjunction with the other axes as means of providing input and context.
- *Continuous learning:* To help provide on-going means of knowledge building with the tools, two techniques could be considered. First, a short “1 page guide” to the basic use of the tools needs to be available. While not sufficient for training, this would serve as a reminder and reference mechanism. Such an approach could also link in other axes (in particular the CEP) as to how the various tools could be helpful in the execution of particular stages. Second, the Subject Team needs active assistance throughout the use of the tools. This issue requires the knowledge and “spirit” of the team to be adequately judged so as not to interfere, frustrate, or otherwise cause problems with the normal daily work rhythm of the Subject Team. Possible ways to provide such support include:
 - ♦ Associate Subject Team members together using a “buddy system” in which knowledgeable users are able to assist other team members in the use of the tools. This technique promotes self-regulation of tool exploration but puts additional burden on the CET participants. Ultimately, it relies on the appropriately knowledgeable users being willing and able to assist in this capability.
 - ♦ Provide the Subject Team with active but externally supplied coaching. This technique effectively introduces the notion of CEE SMEs and their availability to assist the CET during their daily work. The main challenges for this approach are obtaining the appropriate coaches, ensuring their availability as required and facilitating robust interaction between the SMEs and the CET. The introduction of coaching is intended to provide assistance and must not result in yet an additional layer of complexity by requiring even more personnel coordination.

6 Conclusion

Exercise Alpha represents the first iteration of the Evaluation Strategy. Its aim is to debug the evaluation methodology before moving into Exercise Beta. The intent is to ensure internal, self-consistency within the CapDEM axes and the evaluation constructs before proceeding to a larger experimental subject group.

As a result, this memorandum presented the results of the first iteration, focusing on the three CapDEM Axes: People, Process and Materiel. This document focused on two related but different perspectives: (1) the evaluation approach and methodology; and (2) the CapDEM approach. From an evaluation perspective, the main findings of Exercise Alpha were divided into five categories: Subject Team, Evaluation Team, scenario, methods and training. Each of these areas was examined in detail, along with discussions, lessons learned and recommendations. Their inclusion is to help realize the best practices required for future exercises (e.g., Exercise Beta and Exercise Gamma).

The following represent the main recommendations to improve the approach and methodology in the next exercise (in order of importance), including:

1. The scenario choice is crucial. For the next exercise, scenario selection should be based on the following criteria:
 - a. Knowledgeable people in the problem area must be available throughout the exercise;
 - b. The CET needs open access to sufficient existing data, enabling them to analyze information; and
 - c. The problem to solve must be clear to all participants (including SMEs).
2. CET members should have the right experience for their role. The priority of the exercise and the availability of participants need to be acknowledged by their managers, ensuring proper dedication to and availability for the exercise;
3. The Evaluation Team needs to incorporate a mentoring and coaching role into their responsibilities;
4. Focus group sessions would be more beneficial in attaining any meaningful results from the Subject Team members instead of employing various questionnaires; and
5. The training component should be more practical in nature, specifically for CEP and CET.

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- [1] Pagotto, J. and Walker, R., “Capability Engineering - Transforming Defence Acquisition in Canada”, in *Proc. of SPIE Defense & Security Symposium*, Orlando, FL, USA, April 2004.
- [2] Robbins, W., Waruszynski, B., Lalancette, C., Lizotte, M., Nécaille, C. 2006. CapDEM evaluation strategy: Integrating people, process and materiel. DRDC Valcartier TM 2005-164.
- [3] CapDEM Evaluation Team, Lalancette, C., Lizotte, M., Nécaille C., Robbins, W., Waruszynski, B. 2005. CapDEM Exercise Alpha : Detailed work plan. DRDC Valcartier TN 2005-258.

Annex A Agenda Kick-off Meeting

Agenda
Exercise Alpha - Kick-off Meeting
11 May 2005, ACCESS Lab Ottawa, Bldg 5

VTC with Valcartier

8:30 – 8:45	Introduction
8:45 – 9:15	Exercise Alpha Overview
9:15 – 9:45	Evaluation methodology
Closing VTC	

9:45 – 10:00	Break
10:00 – 11:00	CET Training
11:00- 12:00	CEP Training, part 1

12:00 -13:00 Lunch

13:00 – 13:45	CEP Training, part 2
13:45 – 14:00	Break
14:00 – 15:30	CEE Training
15:30 – 16:00	Wrap-up

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Annex B Compilation of kick-off meeting questionnaires

Alpha Kick-Off Meeting Evaluation Questionnaire Compilation

Scale used
1 = Strongly agree; 2 = Agree; 3 Neither Agree or disagree;
4 Disagree; 5 = strongly disagree

Objectives of the Kick-Off Meeting	Average
The kick-off meeting allows me to understand the intend of Alpha exercise	1.6
I have a good understanding of the exercise schedule	3
I was given sufficient information about the evaluation methodology	3
I understand the role and responsibilities of each team (subject and experimentation teams)	2.2

CET Training

The materials and presentation for human dynamics were:

Clear	1.2
Useful/helpful	1.2
Sufficient	1.8
The team building exercise was:	
Clear	1.2
Useful/helpful	1.4
Enjoyable	1.6

Please write any other comments you may have about the CET training.

CEP Training

The materials and presentation of the CEP overview were:

Clear	1.8
Useful/helpful	2
Sufficient	2.6

The materials and presentation of the CEP deliverables were:

Clear	2
Useful/helpful	2
Enjoyable	2.4

CEP Training (Continued)

Please write any other comments you may have about the CEP training.

Need more time to absorb it

The materials & presentation of the CEP were generic, too generic may be.

CEE Training

The CEE Engineering Tools (DOORS, CORE, Interchange) were adequately explained to start using them.	2.75 , only 4 answers,
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The materials and demonstration for the Engineering Tools were:

Clear	2
Useful/helpful	1,8
Sufficient	2,6

The CEE Collaborative Tools (Livelink, ACCESS Labs, DRENet) were adequately explained to start using them.	1,8
--	-----

The materials and demonstration for the Collaborative Tools were:

Clear	1.8
Useful/helpful	1.8
Sufficient	2.4

Please write any other comments you may have about the CEE training.

Was already familiar with the tools, so my understanding/gains from this briefing was not typical.

Trainers

The trainers were sufficiently knowledgeable.	1.6
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The trainers communicated well.	1.6
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The trainers were sufficiently prepared.	1.4
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Please write any other comments you may have about the trainers (either individually or as a group).

No real problem.

The trainers seem to know their materials. CEP trainer would've been clearer if he used some examples.

Atmosphere and Facilities

The general atmosphere during the meeting/training enhanced the participation.	1.4
--	-----

The room was well suited for this type of event.	1.6
Time Management	
Meeting length was adequate.	1.8
Enough time was devoted to each axis (CET, CEP, CEE).	1.6
Room not well designed for small group ?? best for presentation or VTC	
Your Opinion	
<p>Which part of the kick-off did you enjoy most? Why? <i>CET (Human): complete, logic, strong bases.</i> <i>Overview! Place things in context.</i> <i>I think all part were equally interesting.</i> <i>All well presented, knowledgeable presenters.</i> <i>CET, the proof of concept was demonstrated through the little exercise.</i></p>	
<p>Which part of the kick-off did you enjoy least? Why? <i>CEE eng tool.</i> <i>Tool demo because I was already familiar with it.</i> <i>None of them.</i> <i>NIL.</i> <i>CEP, too much information with not much things to retain. There was no mechanism presented to prove the validity of the concepts.</i></p>	
<p>Please write any suggestions, comments or recommendations for improvements or additions to the kick-off meeting. <i>Not enough time to realize such an exercise and to produce useful enough results. Planners must take into account the fact that people don't know tools for example. Alpha is much more than 4hr/week/1month.</i> <i>Given short time frame, facilities/resources should be ready from kick-off.</i> <i>Make meeting off-site to ensure everybody is available for whole meeting (No need for it to cost anything, just book a room at 101 or Constitution Building).</i> <i>I have the impression that the Alpha exercise will require much more than 4 hours of work per week for each participant if we want to do a good job (a job which will allow you to get valuable feedback for the following and more important exercises).</i> <i>Need some goodies ☺</i></p>	

List of symbols/abbreviations/acronyms/initialisms

ACCESS	Advanced Collaborative Capability Engineering Support System
CapDEM	Collaborative Capability Definition, Engineering and Management
CE	Capability Engineering
CEE	Collaborative Engineering Environment
CEP	Capability Engineering Process
CET	Capability Engineering Team
CF	Canadian Forces
DND	Department of National Defence
DRDC	Defence Research and Development Canada
DRENet	Defence Research Establishment Network
PRICIE	Personnel, Research, Infrastructure & Organization; Concepts, Doctrine & Collective Training; IT Infrastructure; Equipment, Supplies and Services
SME	Subject Matter Expert
VTC	Video Tele-Conference
DND	Department of National Defence
DRDC	Defence Research & Development Canada
DRDKIM	Director Research and Development Knowledge and Information Management
R&D	Research & Development

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The Collaborative Capability Definition Engineering and Management Technology Demonstration (CapDEM TD) project is investigating Capability Engineering (CE) in order to support the Capability-Based Planning (CBP) decision-making process. Prior to any commitment to institutionalization, a formal evaluation strategy has been devised to test and improve the Capability Engineering approach, a methodology based on the systems engineering paradigm and articulated around three axes: People, Process and Materiel. This memorandum presents the results and the main findings of Exercise Alpha, the first exercise of the three validation exercises. It focuses on two related but different perspectives: (1) the evaluation approach and methodology; and (2) the CE approach. Each of these areas is examined in detail, along with discussions, lessons learned and recommendations in order to help realize the best practices required for future exercises (e.g., Exercise Beta and Gamma).

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CapDEM, Collaborative Capability Definition Engineering and Management; Capability Engineering; Capability Engineering Team; Capability Engineering Process; Collaborative Engineering Environment; Evaluation Strategy; Testing; Evaluation; Results; Exercise Alpha

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