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CapDEM Exercise Beta:

Results and Discussion

CapDEM Evaluation Team

W. Robbins, B. Waruszynski, C. Lalancette, M. Lizotte and C. Nécaille

The exercise described in the document was conducted between summer 2005 and spring 2006.

Defence R&D Canada – Ottawa

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Abstract

Exercise Beta is intended to be a complete functional test and evaluation of the Collaborative Capability Definition, Engineering and Management (CapDEM) approach. The primary goal of this iteration is to test and evaluate the CapDEM approach via an instance based on a realistic problem. The intent is to ensure that the necessary people, process and materiel can address a “real world” problem, while still running the exercise in a semi-controlled environment. This report summarizes the results of Exercise Beta, the second evaluation exercise undertaken to evaluate the three fundamental axes that compose the Capability Engineering (CE) construct (i.e., People, Process and Materiel). This exercise aims to do a complete functional test of the CapDEM axes based on a realistic use case. It shifts emphasis from debugging the evaluation methodology towards the core of the problem and CapDEM’s ability to meet the client’s needs. As a transitional exercise, Exercise Beta allows a gradual, controlled growth from one exercise to another, facilitating increased credibility in the evaluation team and its strategy along with the ability to more definitively examine the issue of scalability in the application of the CapDEM axes. As a result, this report outlines the results of focus groups that were carried out throughout the exercise. Discussions and recommendations for the way ahead are put forward to better understand and prepare the strategic direction of the final exercise, Exercise Gamma.

Résumé

L'Exercice Beta doit constituer un essai complet et une évaluation complète de fonctionnement du projet de Définition, ingénierie et gestion collaboratives de capacités (DIGCap). L'objectif principal de cette itération consiste à essayer et à évaluer le projet de DIGCap au moyen d'un exemple fondé sur un problème réel. Cette façon de faire vise à assurer que les personnes, le processus et le matériel nécessaires peuvent résoudre un problème « du monde réel » tout en continuant d'exécuter l'exercice dans un environnement semi-contrôlé. Le présent rapport résume les résultats de l'Exercice Beta, le deuxième exercice entrepris pour évaluer les trois axes fondamentaux qui composent le concept de l'ingénierie des capacités (c.-à-d. les personnes, le processus et le matériel). Cet exercice vise à effectuer un essai complet de fonctionnement des axes de DIGCap selon un cas d'utilisation réelle. La priorité de l'exercice passe de la mise au point de la méthodologie d'évaluation au cœur du problème et à la capacité de DIGCap de satisfaire aux besoins du client. Comme exercice de transition, l'Exercice Beta favorise une croissance graduelle et contrôlée d'un exercice à un autre et facilite le renforcement de la crédibilité de l'équipe d'évaluation et de sa stratégie, ainsi que la capacité d'examiner de façon absolue la question de la variabilité dimensionnelle dans l'application des axes de la DIGCap. En conséquence, le présent rapport décrit les résultats des groupes de discussion qui ont été mis sur pied pendant l'exercice. Les discussions et les recommandations concernant la voie à suivre sont présentées afin de mieux comprendre et préparer l'orientation stratégique du dernier exercice, l'Exercice Gamma.

Executive summary

CapDEM Exercise Beta: Results and Discussion

Robbins, W., Waruszynski, B., Lalancette, C., Lizotte, M., Nécaille, C.; DRDC Ottawa TM 2009-252; Defence R&D Canada – Ottawa; February 2010.

Introduction or background

Exercise Beta is intended to be a complete functional test and evaluation of the Collaborative Capability Definition, Engineering and Management (CapDEM) approach. The primary goal of this iteration is to test and evaluate the CapDEM approach via an instance based on a realistic problem. The intent is to ensure that the necessary people, process and materiel can address a “real world” problem, while still running the exercise in a semi-controlled environment.

Results

This report summarizes the results of Exercise Beta, the second evaluation exercise undertaken to evaluate the three fundamental axes that compose the Capability Engineering construct (i.e., People, Process and Materiel). This exercise aims to do a complete functional test of the CapDEM axes based on a realistic use case. It shifts emphasis from debugging the evaluation methodology towards the core of the problem and CapDEM’s ability to meet the client’s needs.

The results of Exercise Beta were obtained from three focus groups which were conducted throughout the exercise. In terms of each axis, a synopsis of Exercise Beta’s results follows:

- People:
 - Identified outstanding issues surrounding specified “roles and responsibilities” for the Capability Engineering Team (CET).
 - ♦ Some roles and responsibilities need to be mapped differently than provided within the exercise; in addition, such mappings will likely need to change for future CETs.
 - ♦ Many tasks were learned “on the job”; as a result, it was difficult for members to know exactly what was expected of them.
 - ♦ Size of the main CET should be limited to a small number of people (six to ten people maximum).
 - ♦ Team leadership was an issue for all members, including the Team Leader. In particular, the Team Leader felt that there was too much onus on knowing all aspects of the Capability Engineering Process (CEP).
 - ♦ Members had mixed views on the use of sub-teams. Internally, they were effective, but members felt detached from the Team Leader and the CET as a whole (forming work “silos” that impacted work efficacy).

- ♦ It would be beneficial to use a “cookbook approach” to provide the definitions and instructions for completing the CEP templates, as well as to denote which deliverables were particular to which roles.
 - Missing or misunderstood principles of “teamwork and collaboration”.
 - ♦ Team communication and collaboration were viewed as critical to the overall performance of the CET. Frequent communication (beyond regular team meetings) was effective. However, individual members felt that it was sometimes difficult to organize the work that needed to be completed, and some people tended to work independently. Consequently, collaboration with other members was disjointed. Additionally, the CET focused on co-location as a requirement to collaborate, deeming the distributed collaboration technologies inadequate in comparison.
 - ♦ Member participation in CET activities is impacted when individuals feel disconnected from the team and/or isolated from the current work effort (i.e., are not situationally aware of the team’s activities, despite their particular role/function at the time).
 - ♦ The Team Leader needs to ensure support for the CET and enhance team collaboration, without focusing exclusively on information and project management aspects of the role. This includes facilitating and ensuring sub-team interaction to prevent disjointed awareness and potential confusion over the work being completed.
 - Strengths and weaknesses of the “team building exercises”.
 - ♦ The initial People Axis training/team building exercise was well-received and recommended as a way to structure additional training elements.
 - ♦ The continued application of the team building principles was lacking as evidenced by the non-use of the Team Charter to guide and formulate the CET as it progressed.
- Process:
 - Identified enhancements for templates and task descriptions.
 - ♦ The CET noted the need for additional guidance on CEP execution; specifically, the need for a “cookbook”, to provide further description of activities and better understanding of how the elements worked together. The coordination of CEP deliverables, specifically their flow and timing between the various members, was highlighted.
 - ♦ Various template improvements were noted in terms of topic focus, level of detail and applicability, appropriate separation and alignment to process areas, along with redundancy and miscellaneous clerical errors.
 - Clarification required with respect to the relationship between requirements, Operational and SoS architectures.
 - ♦ There was a lack of comfort in terms of how requirements were related to the architectures documented within the CEP; in particular, how the Requirements (specification) could be separate from the Operational

Architecture. As part of addressing this issue, the CET modified the CEP's "Develop Operational Architecture" process to address and analyze various "strategic factors".

- Identified logistical issues influencing application of the process.
 - ♦ The lack of a formal engagement structure to ensure stakeholder participation affected the CET's ability to obtain stakeholder input to validate their completed work. Additionally, the inability to obtain stakeholder input throughout application of the CEP necessitated additional work on behalf of the CET to address data and content issues. Combined with a lack of prior experience with the process, the CET was not able to complete the effort in a timely manner, thus resulting in recommendations to address the process' "battle rhythm" and resultant cycle time.
- Materiel:
 - Identified various strengths, weaknesses of the Collaborative Engineering Environment (CEE) for being able to more fully support the CEP and facilitate collaboration within the CET.
 - ♦ General commentary was provided on various tools and the collaborative technologies utilized, including missing and hard to utilize functions, tool performance, familiarity issues and general preferences. Each of these facets was of significant importance to the users' desire to utilize the CEE.
 - ♦ Performance and access issues resulting from using disparate IT infrastructures confounded the use of collaboration, information exchange and communication technologies. Necessitated by demographics and the need for flexible software management, multiple networks with multiple access points were required; however, such an architecture conflicted with varying network implementation and security policies. Consequently, functionality, robustness, performance and usability (in terms of speed, access to data, equivalence in functionality and user interface) were severely impacted.
 - Identified perceived flaws and inconsistencies in the utilized workflow.
 - ♦ The CET viewed the CEP as primarily about engineering and analysis of deliverables, and the processing, organization and management of information required to do so. Their desired focus for the CEE was therefore as an information model and an appropriate workflow to facilitate the creation of these CEP products. The provided CEE was viewed as insufficient (the flow between CEE components and their alignment to specific CEP activities) in addressing this need.
 - Gaps and/or inconsistencies in the alignment of roles and responsibilities with respect to knowledge/use of CEE components.
 - ♦ A number of Information Technology (IT) and Knowledge Management (KM) related challenges (e.g., information organization and modelling, system usage and interoperability) were experienced by the CET. The CET members felt that these issues directly impacted their individual roles and responsibilities. Hence, how to provide

appropriate levels of informational and technical expertise to, for or within the CET needs to be better addressed.

- Identified the importance of a number of non-technical issues related to CEE utility (ranging from logistics to demographics).
 - ♦ A number of logistical and technical issues impacted the CET's working behaviours. The lack of awareness regarding existing capabilities (e.g., VTC compatibility) resulted in modifications to work practices inconsistent with intent. Issues related to policy and physical logistics (e.g., security passes) negatively influenced teaming experiences and willingness to try further.
 - ♦ Demographics influenced the acceptance of the CEE and its use for certain types of work. As CET membership changed, team demographics affected work styles, swinging more towards a traditional co-located office style of interaction. Such preferences were mirrored by a decrease in the utilization of enhanced communication and collaboration technologies.

Significance

As a transitional exercise, Exercise Beta allows a gradual, controlled growth from one exercise to another, facilitating increased credibility in the Evaluation Team and its strategy along with the ability to more definitively examine the issue of scalability in the application of the CapDEM axes. The exercise enabled the collection of end user (operator) feedback so as to further refine each axis through application of the Capability Engineering construct, allowing continuous improvement of the construct during its development. Future trials and application of the CapDEM approach within progressively more operational settings will also benefit from the observations and lessons learned.

Future plans

The strategic intent of Exercise Beta was to increasingly understand the application of Capability Engineering in context, thus supporting the evolution of the CE approach and to better situate its application within the final exercise of the CapDEM Evaluation Strategy, Exercise Gamma. This final exercise will involve a real capability goal and a CET composed of participants from across the organization's matrix. Consequently, discussions and recommendations for the way ahead are put forward in this light.

Given that the application of systems engineering at a capability level is new to the department, further improvement through appropriate experimentation and incremental application are recommended. Additionally, to effectively enable institutionalization, the creation of specially trained "CE officers" is proposed to facilitate the practice of CE through the availability of knowledgeable and experienced practitioners. Furthermore, continuous improvement of the CE approach is necessary as CE evolves into its niche within the force development community. Moreover, encompassing all of these aspects is the challenge of institutional resistance to change, combined with the difficulty of obtaining knowledgeable personnel that can be fully dedicated to the effort at hand.

Other issues to address are the complexity and duration of the approach, along with validating the necessity and suitability of its various elements in support of the decision making effort. Additionally, efficient team development, training, and technology provisioning continue to be recognized as warranting on-going improvement.

The level of detail and volume of analytical products required to satisfy capability level decisions will not completely be answered until a use-case has its output transitioned into implementation in the capability production domain. However, Exercise Beta's analytical products were very well received by the operational authorities for exercise's capability area, and will be serving as the departure point for their actual analysis of the same capability domain.

Sommaire

CapDEM Exercise Beta: Results and Discussion

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Introduction ou contexte

L'Exercice Beta doit constituer un essai et une évaluation complète du fonctionnement de l'approche de la Définition, ingénierie et gestion collaboratives de capacités (DIGCap). L'objectif principal de cette itération consiste à mettre à l'essai et à évaluer le projet de DIGCap au moyen d'une situation fondée sur un problème réel. Cette façon de faire vise à assurer que les personnes, le processus et le matériel dont on a besoin sont en mesure de résoudre un problème « du monde réel » tout en poursuivant l'exercice dans un environnement semi-contrôlé.

Résultats

Le présent rapport résume les résultats de l'Exercice Beta. Cet exercice est le deuxième exercice entrepris pour évaluer les trois axes fondamentaux qui composent le concept de l'ingénierie des capacités (c.-à-d. le personnel, le processus et le matériel). Cet exercice vise à effectuer un essai complet de fonctionnement des axes de DIGCap en fonction d'un cas d'utilisation concret. La priorité de l'exercice n'est plus la mise au point d'une méthodologie d'évaluation; l'accent est plutôt mis sur le cœur du problème ainsi que sur la capacité de la DIGCap à satisfaire aux besoins du client.

Les données recueillies lors de l'Exercice Beta proviennent de trois groupes de discussion qui se sont rencontrés au cours de l'exercice. Voici un sommaire des résultats de l'Exercice Beta pour chaque axe :

- Le personnel :
 - Cerner les problèmes non réglés touchant des « rôles et responsabilités » précis de l'équipe d'ingénierie des capacités (EIC).
 - ♦ Certains rôles et responsabilités doivent être configurés de façon différente à ce qui avait cours durant l'exercice; de plus, de telles configurations devront probablement être changées pour les prochaines EIC.
 - ♦ De nombreuses tâches ont été apprises « sur le tas »; en conséquence, il était difficile pour les membres de l'EIC de savoir exactement ce que l'on attendait d'eux.
 - ♦ Le nombre de personnes au sein de la principale EIC doit être réduit (six à dix personnes au maximum).
 - ♦ Le leadership au sein de l'équipe posait un problème à tous, y compris le chef d'équipe. Notamment, le chef d'équipe estime que l'on s'attend

trop à ce qu'il connaisse tous les aspects du processus d'ingénierie des capacités (PIC).

- ♦ Les avis des membres de l'équipe étaient partagés en ce qui concerne la formation d'équipes secondaires. À l'interne, celles-ci étaient efficaces, mais les membres se sentaient coupés du chef d'équipe et de l'ensemble de l'EIC (« cloisonnements » qui nuisaient à l'efficacité au travail).
- ♦ Il serait avantageux de suivre un « processus détaillé » pour donner les définitions et les instructions nécessaires pour reproduire les modèles du PIC ainsi que pour indiquer quelles réalisations attendues correspondaient à chaque rôle.
- Principes manquants ou mal interprétés de « l'esprit d'équipe et de la collaboration ».
 - ♦ La communication et la collaboration au sein de l'équipe étaient perçues comme essentielles au rendement global de l'EIC. Maintenir une communication fréquente (allant au-delà des réunions d'équipe habituelles) était efficace. Toutefois, certains membres estiment qu'il était parfois difficile d'organiser le travail qui devait être fait et certains avaient tendance à travailler de manière indépendante. En conséquence, on pouvait constater un certain manque de cohérence au niveau de la collaboration avec les autres membres. De plus, pour l'EIC, le critère essentiel à la collaboration était le partage des bureaux. On estimait que les technologies collaboratives décentralisées n'étaient pas adéquates en comparaison.
 - ♦ Il y a un effet négatif sur la participation des membres aux activités de l'EIC lorsque les individus se sentent coupés de l'équipe et/ou isolés des efforts de travail en cours (p. ex., les membres ne sont pas conscients des activités de l'équipe malgré leur rôle particulier ou leur fonction précise à ce moment).
 - ♦ Le chef d'équipe doit s'assurer que l'EIC bénéficie d'un soutien et il doit améliorer la collaboration au sein de l'équipe sans mettre toute l'attention exclusivement sur les aspects de son rôle liés à l'information et à la gestion de projet. À ce titre, il doit établir et faciliter les interactions au sein des équipes secondaires afin de prévenir les décalages dans la connaissance de ce qui se passe et éviter la confusion en ce qui concerne le travail en cours.
- Forces et faiblesses des exercices de « renforcement de l'esprit de corps ».
 - ♦ L'exercice de formation et de renforcement de l'esprit de corps portant sur l'axe du personnel a été bien accueilli et recommandé en tant que moyen permettant de structurer des éléments de formation additionnels.
 - ♦ Il existait une lacune au niveau de l'application continue des principes de renforcement de l'esprit de corps. Cela a été mis en évidence par le non recours à la charte d'équipe pour guider l'EIC à mesure de la progression du travail.

- Processus :

- ♦ L'utilisation d'infrastructure de TI différentes a entraîné des problèmes de rendement et d'accès, ce qui va à l'encontre de la collaboration, de l'échange d'information et de l'utilisation des technologies de communication. Compte tenu de l'effectif et du besoin d'une gestion plus souple des logiciels, il existe un besoin pour de multiples réseaux disposant de nombreux points d'accès; toutefois, une telle architecture n'était pas compatible avec les différentes politiques touchant la sécurité et l'implantation des réseaux. En conséquence, cela a eu des effets négatifs importants sur le fonctionnement, la robustesse, le rendement et la facilité d'emploi (en termes de vitesse, d'accès aux données, d'équivalence de fonctionnalités et d'interfaces utilisateur).
- Cerner les anomalies et les incohérences perçues dans la gestion des processus dont on se servait.
 - ♦ L'EIC percevait essentiellement le PIC comme un outil destiné essentiellement à l'ingénierie et à l'analyse des produits à livrer ainsi qu'au traitement, à l'organisation et à la gestion de l'information nécessaire pour obtenir ces produits. En conséquence, pour les membres de l'EIC, l'environnement d'ingénierie collaboratif devait donc être essentiellement un modèle d'information et un mode de gestion adapté des processus qui faciliterait la création de ces réalisations du PIC. L'environnement d'ingénierie collaboratif fourni fut perçu comme ne pouvant répondre à ce besoin (la gestion des processus entre les composantes de cet environnement et leur harmonisation à certaines activités propres à l'EIC).
- Écarts et/ou incohérences dans la correspondance des rôles et des responsabilités relativement aux connaissances/à l'utilisation des composantes de l'environnement d'ingénierie collaboratif.
 - ♦ L'EIC a fait face à un certain nombre de défis liés à la technologie de l'information (TI) et à la gestion de la connaissance (GC) (par ex., organisation et modélisation de l'information, utilisation et interopérabilité des systèmes). Les membres de l'EIC ont eu l'impression que ces problèmes ont eu un effet direct leurs rôles individuels et leurs responsabilités. Par conséquent, il faut trouver des solutions qui permettront de fournir des niveaux d'expertise informationnelle et technique dont à besoin l'EIC.
- Déterminer l'importance d'un certain nombre de questions non techniques liées à l'utilité de l'environnement d'ingénierie collaboratif (allant de la logistique aux données démographiques).
 - ♦ Un certain nombre de problèmes de natures technique et logistique ont eu des répercussions sur la façon de travailler de l'EIC. L'ignorance des capacités existantes (p. ex., la compatibilité des systèmes de vidéoconférence) a entraîné, au niveau des pratiques de travail, des modifications qui vont à l'encontre des intentions initiales. Les problèmes touchant les politiques et la logistique physique (p. ex., les laissez-passer) ont eu un effet négatif sur les expériences de collaboration et la volonté de poursuivre ces expériences.

- ♦ La constitution de l'effectif de l'équipe a influencé l'acceptation de l'environnement d'ingénierie collaboratif et son utilisation pour certains types de travaux. Les modifications de l'effectif de l'EIC ont un effet sur les méthodes de travail, favorisant davantage les interactions plus traditionnelles, propres aux gens qui partagent des bureaux. De telles préférences ont entraîné une diminution de l'utilisation des technologies améliorées de communication et de collaboration.

Importance

En tant qu'exercice de transition, l'Exercice Beta permet une croissance graduelle et contrôlée d'un exercice à l'autre, permettant d'accroître la crédibilité de l'équipe d'évaluation et de sa stratégie tout en permettant d'examiner de façon plus définitive la question de l'application graduelle des axes de la DIGCap. Cet exercice permettait de recueillir les commentaires des utilisateurs finaux (opérateurs), ce qui permet de définir davantage chaque axe par l'application du concept d'ingénierie des capacités, ce qui entraîne une amélioration constante du concept au cours de sa mise au point. Les observations et les leçons retenues seront utiles lors des prochains essais et serviront également à l'application de l'approche de la DIGCap, à l'intérieur d'un cadre graduellement plus opérationnel.

Plans futurs

L'Exercice Beta avait pour visée stratégique de permettre de graduellement mieux comprendre l'application de l'ingénierie des capacités en situation, ce qui permet d'appuyer l'évolution de l'approche de l'ingénierie des capacités et de mieux situer son application lors du dernier exercice de la stratégie d'évaluation de la DIGCap, l'exercice Gamma. Ce dernier exercice impliquera l'atteinte d'un véritable objectif lié à la capacité ainsi que la participation d'une EIC composée de gens venant de partout à l'intérieur de l'organisation. En conséquence, les discussions et les recommandations concernant la voie à suivre sont présentées sous cet éclairage.

Compte tenu du fait que l'application de l'ingénierie des systèmes au niveau d'une capacité est nouvelle dans ce service, il est recommandé d'y apporter d'autres améliorations par l'intermédiaire d'expérimentations appropriées et de la mettre en application graduellement. De plus, pour permettre une institutionnalisation efficace, on propose la création de postes « d'agents d'ingénierie des capacités » spécialement formés. Par leur présence, ces utilisateurs expérimentés et chevronnés faciliteront l'utilisation de l'ingénierie des capacités. En outre, une amélioration constante de l'approche en matière d'ingénierie des capacités est nécessaire étant donné que cette ingénierie évolue au sein de la communauté du développement des forces. De plus, la résistance des institutions au changement est un autre défi important qui englobe toutes ces aspects. Il faut en outre tenir compte de la difficulté à trouver du personnel qui s'y connaît et qui est prêt à se consacrer entièrement à la tâche à accomplir.

Parmi les autres problèmes à régler, il faut compter la complexité de l'approche, sa durée ainsi que la pertinence des différents éléments venant soutenir les efforts de prise de décisions. En outre, la formation d'une équipe efficace, la formation et l'approvisionnement en technologie sont toujours reconnus comme un gage d'amélioration continue.

Quel que soit leur niveau de précision, on ne disposera pas d'un nombre suffisant de produits analytiques nécessaires pour prendre des décisions touchant les capacités tant que les résultats d'un cas d'utilisation n'auront pas fait la transition vers la mise en application dans le domaine de la production de capacités. Toutefois, les produits analytiques de l'Exercice Beta ont été très bien accueillis par les autorités opérationnelles responsables du secteur des capacités de l'exercice et ces produits serviront de point de départ pour l'analyse concrète du même domaine des capacités.

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1 Introduction

Defence R&D Canada is currently investigating the Capability Engineering (CE) [1] concept through a Technology Demonstration Project called Collaborative Capability Definition, Engineering, and Management (CapDEM). Based on the scope and potential implications of employing CE, it is essential to evaluate the approach and minimize any associated risks prior to any commitment to institutionalize this new construct. A formal evaluation strategy for the CapDEM approach is therefore as fundamental as a testing strategy within classical systems engineering. Consequently, an evaluation strategy [2] has been devised and is organized along CapDEM's three axes – People [3], Process [4] and Materiel [5]:

- **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 enable 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.

The strategy involves three iterations: Exercise Alpha, Exercise Beta and Exercise Gamma. Each exercise applies the CapDEM approach with increasingly larger scale and complexity. This report summarizes the results of Exercise Beta [6], the second evaluation exercise undertaken to evaluate the three fundamental axes that compose the CE construct. This exercise aims to do a complete functional test of the CapDEM axes based on a realistic use case. It shifts emphasis from debugging the evaluation methodology (Exercise Alpha) towards the core of the problem and CapDEM's ability to meet the client's needs. The intent is to ensure that the necessary people, process and materiel can address a "real world" problem level, while still running the exercise in a semi-controlled environment (i.e., the subject group and timeline will still be controlled internally). This transitional exercise allows a gradual, controlled growth from one exercise to another, facilitating increased credibility in the Evaluation Team and its strategy along with the ability to more definitively examine the issue of scalability in the application of the CapDEM axes.

The report is organized as follows: Chapter 1 gives the Introduction to the paper. Chapter 2 briefly describes the goals, purpose and 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 CapDEM approach on a per axis basis. Chapter 5 provides further discussion and analysis of the results while also putting forward recommendations learned from Exercise Beta. Finally, Chapter 6 concludes with a summary of the exercise and how its execution met the intent of the overall evaluation strategy.

2 Background

This section sets the context of Exercise Beta and its results, including an overview of CapDEM and Exercise Alpha, the first of three exercises in the CapDEM Evaluation Strategy. The planned structure and intent of Exercise Beta is also provided.

2.1 CapDEM Approach

As a means by which to deliver on the potential of Capability Based Planning [7], CapDEM is organized along three primary axes: People, Process and Materiel. In short, the process defines the rules and methodologies by which people apply their expertise, creativity and engineering knowledge, using the appropriate technology and tools to facilitate the development of the necessary capabilities. This section provides a brief overview of the three axes in more detail.

People Axis. The Capability Engineering Team [3] construct represents a central and fundamental element of organizational design for the CapDEM TD project. The CET construct is defined as a cross-functional, multidisciplinary team (with complementary skills) committed to applying and managing the capability engineering process. The CET is basically composed of a team leader, systems engineers, systems architects and requirements/operational analysts. This core analytical team will be partnered with operational subject matter experts (SMEs) and liaison members from across the PRICIE¹ capability components.

Process Axis. The Capability Engineering Process [4] is a set of processes, roles and responsibilities, products and guidance that use systems engineering rigour to develop Investment Options in order to fill the identified capability gaps. The set of Force Development Options is primarily intended for high-level managers making decisions about defence strategic investments. In addition, the accepted investment option is used by PRICIE personnel responsible for implementing the solution. In order to address their needs, each option involves a two-part architectural solution: an operational architecture and a system-of-systems (SoS) architecture. Figure 1 illustrates the dynamics supporting the incremental production of CEP deliverables. The approach is not purely spiral, iterative or waterfall, which are all, in some sense, sequential. Rather, there is continuous interaction between the processes since changes in one of them may impact the others. The “Manage Engineering Effort” process determines the speed of the components with regard to available resources and constraints (e.g., a delivery date given by the decision makers). The series of decision

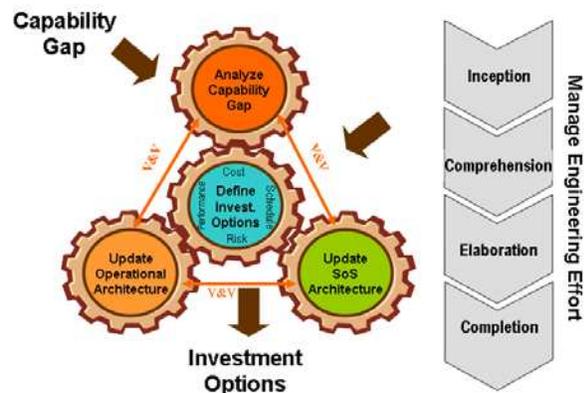


Figure 1: CEP Dynamics

¹ PRICIE = Personnel; Research; Infrastructure & Organization; Concepts, Doctrine & Collective Training; IT Infrastructure; Equipment, Supplies and Services.

gates, which mark passage from one stage (Inception, Comprehension, Elaboration and Completion) to the next, are also controlled by this process.

Material Axis. The Collaborative Engineering Environment [5] is a logical environment consisting of a set of tools and technologies that 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. Primarily based on commercially available tools and applications, the function of such an environment is to enable project stakeholders to have a common location and a common interface by which to access information, utilize specialized applications and communicate with each other. Table 1 highlights the major elements of the CEE used for Exercise Beta.

Table 1: Collaborative Engineering Environment

Tool	Purpose	Focus / Audience
DOORS	Requirements analysis	Managerial stakeholders
CORE	Functional analysis	Systems engineering/architecture SMEs
OpNet	Network analysis	Communications/network SMEs
IPME	Human systems integration	Human factors SMEs
InterchangeSE	Central (model) repository, data integration and management	Integrators, managers, systems engineers/architects
Livelihood	Central (document) repository & collaborative portal	Enhanced file sharing, information exchange, hub for participant interaction
ACCESS Labs	Audio conferencing / VTC and collaborative tools	Collaborative labs/workspace
DRENet	Email & host network for tools	Host network for IEE & ICE tools

2.2 Exercise Alpha

Exercise Alpha [8] was conducted in the Spring 2005, and was designed to be a “proof-of-concept” trial in how to integrate and evaluate the interdependencies of the three main CapDEM axes. The primary goal was to “debug” the evaluation methodology. The exercise’s key issues transitioning from Exercise Alpha [9] [10] into Exercise Beta include:

- Scenario specification is crucial; key criteria include a clear definition of the problem (for all team members), sufficient contact with Subject Matter Experts (SMEs) in the problem area, and ease of access to appropriate and existing data on the problem.
- CET members should have the right experience for their assigned role and be available to accommodate a given schedule of collaborative work sessions. It is absolutely critical that the appropriate level of priority be applied by line managers to support proper dedication to the exercise.
- The Evaluation Team must either incorporate a mentoring and coaching role to their responsibilities, or arrange for a separate resource to provide same.

- Questionnaires should be replaced by other means of data collection that are not so dependent on sample size to generate meaningful results.
- A practical “hands-on” training syllabus is required, particularly for the CEP and CEE areas.

2.3 Exercise Beta

Table 2 presents a description of Exercise Beta (as planned) [6], summarizing its overall goal and scope as well those for each axis. It also presents the output expected for each axis.

Table 2: Exercise Beta

Exercise		Beta
Aspect		
Goals	Overall	<ul style="list-style-type: none"> • Test and evaluate the CapDEM approach via an instance based on a realistic problem. • Ensure that the necessary people, process and materiel can address a “real world” problem.
	People	<ul style="list-style-type: none"> • Test and evaluate the effectiveness and appropriateness of the roles and responsibilities. • Test, evaluate and validate the principles of teamwork and collaboration.
	Process	<ul style="list-style-type: none"> • Test and evaluate CEP activities, gates, inputs and outputs.
	Materiel	<ul style="list-style-type: none"> • Test and evaluate the current CEE as to which tools, technologies and facilities are considered essential, insufficient or missing in terms of supporting the CET and CEP.
Scope	Overall	<ul style="list-style-type: none"> • Four month duration. • Realistic scenario.
	People	<ul style="list-style-type: none"> • Complete team size. • CapDEM-related DND employees and contactors. • Distributed work sites.
	Process	<ul style="list-style-type: none"> • Complete each CEP v2 deliverables. • Complete at least 3 iterations in the Elaboration Stage.
	Materiel	<ul style="list-style-type: none"> • Fully exploit CEE functionalities.
Outputs	People	<ul style="list-style-type: none"> • Outstanding issues surrounding the specified roles and responsibilities of the CET. • Missing or misunderstood principles of teamwork and collaboration. • Strengths and weaknesses of the teambuilding exercises.
	Process	<ul style="list-style-type: none"> • Structural problems within the process specification so as to eventually correct the process in subsequent versions. • Description, terminology and cosmetic weaknesses within the process specification. • Process elements that will require particular attention during training (i.e., highlight any anticipated issues or items that seem difficult to understand).
	Materiel	<ul style="list-style-type: none"> • Successful, missing and/or weak CEE components/functionalities in order to more fully support the CEP and facilitate collaboration within the CET. • Perceived flaws or inconsistencies in the existing workflow between the various tools. • Gaps and/or inconsistencies in the alignment of roles and responsibilities with respect to knowledge/use of CEE components. • A database of materiel issues and problems encountered by the CET and/or the Evaluation Team, as well as any identified solutions.

3 Approach and Methodology

The approach and methodology for the exercise implemented most lessons learned from Exercise Alpha: the main data gathering mechanism was changed, and careful attention was taken in scenario and participant selection as well as the construction of the work plan. Training was also extended and the Evaluation Team tried to be more proactive. This section examines the main components of the approach and methodology for Exercise Beta.

3.1 Data Gathering and Analysis

The approach to data analysis for this exercise primarily focused on common themes and issues. Summarized in Table 3, many of the data collection means served more than one purpose. For example, attendance at weekly CET meetings allowed the Evaluation Team to observe team progress, give advice and also help in the design of the focus groups. The focus group (see Annex A) became the principal and best source of data, as most of the information gathered through other means were validated with all CET members during the session. The themes and issues that are presented in the following sections primarily stem from the focus group analysis.

Table 3: Summary of Data Collection Means and Mechanisms

Means	Purpose	Comments
CET Progress Meeting Attendance	<ul style="list-style-type: none"> Observe the CET Suggest approaches with issues Answer questions 	At least one Evaluation Team member attended weekly meetings
Meeting with CET Leader	<ul style="list-style-type: none"> Obtain feedback on the CET performance Give advice to the CET leader 	Happened on an ad hoc basis, mainly between the leaders of the CET and Evaluation Team
Gate Review Meeting	<ul style="list-style-type: none"> Evaluate the content of the work produced at each stage 	Performed at the end of Comprehension, Elaboration and Completion stages
Focus Group	<ul style="list-style-type: none"> Extract common themes and issues related to each axis as well as the methodology and approach relative to each stage 	Performed at the end of Comprehension, Elaboration and Completion stages
Ad hoc Interview	<ul style="list-style-type: none"> Allow feedback from the CET to the Evaluation Team Obtain clarification on select topics/issues from particular CET members 	Not required during this exercise
Lessons Learned Collection	<ul style="list-style-type: none"> Document lessons learned Obtain material to improve focus groups 	Usage decreased over the exercise
Help Desk	<ul style="list-style-type: none"> Offer a “single point of entry” for the CET members to request help Build a list of problems encountered 	Mainly used after kick-off for questions related to CEE

3.2 Work Plan

The work plan [6] used to organize the exercise, including both CEP stages and other significant events, was structured in three main phases:

- Preparation: This “pre-CET” phase contains activities which address participant readiness, scenario, training, evaluation and technical environment issues.
- Experimentation: This “active CET” phase corresponds to the core of the exercise.
- Analysis: This “post-CET” phase examines and organizes the feedback collected.

The Experimentation phase started with a reduced CET on 12 September 2005 (as planned) and ended on 17 February 2006 (one month later than initially planned). The CET attended the kick-off meeting (Annex B) held on 1 November 2005 as well as the training sessions that followed. The only major adjustment to the schedule was the addition of a month in order to complete the Inception Stage. This change was necessary in order to account for the delay in recruiting individuals to fill CET positions. The duration for the other CEP stages remained approximately as planned. However, the time allocated for the Elaboration Stage did prove insufficient to conduct the planned three iterations. Figure 2 presents the final plan, including the exercise phases, the CEP stages and significant exercise events.

Preparation Phase		25 Jul 05 to 21 Oct 05
Experimentation Phase		12 Sept 05 to 17 Feb 06
CEP Inception Stage		12 Sept 05 to 11 Nov 05
Kick-Off Meeting		1 Nov 05 am
Training		1 Nov pm, 2 - 3 Nov 05
Dry run gate review		8 Dec 05
CEP Comprehension Stage		14 Nov 05 to 16 Dec05
Gate review and focus group		22 Dec 05
CEP Elaboration Stage		19 Dec 05 to 7 Feb 06
Gate review and focus group		7 Feb 06
CEP Completion Stage		8 Feb 06 - 17 Feb 06
Gate review and focus group		1 March 06
Analysis Phase		23 Jan 06 - 31 March 06

Figure 2: Beta Experimentation Cycle Summary

3.3 Core and Stakeholder CET Members

Core CET. The core CET consisted of DRDC personnel and contractors geographically distributed between DRDC Ottawa and DRDC Valcartier as shown in Figure 3. Recruitment was based on the different individual’s experience/ability to fulfil a specific role, their availability and location. In addition to their main roles, the core CET members assisted and provided feedback to the Evaluation Team.

Stakeholder Members. The initial planning of Exercise Beta included the recruitment of stakeholder members for the CET. Such members were expected to contribute by bringing their

expertise, experience and competencies to augment the core team in terms of the specific capability gap being addressed. However, no stakeholders were officially linked to the core CET.

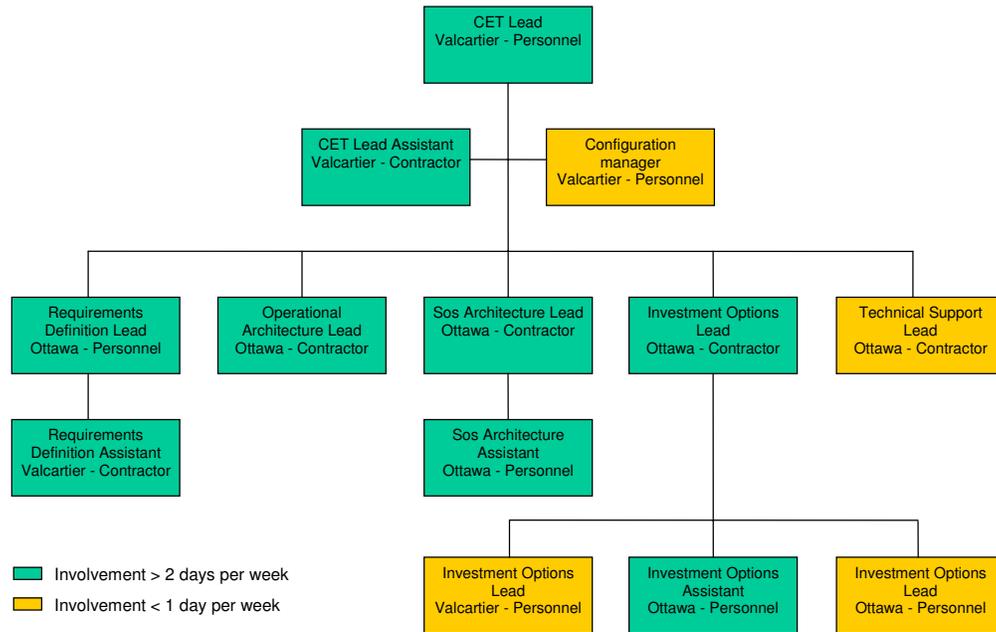


Figure 3: Organizational Chart of the Core CET

3.4 Evaluation Team

Figure 4 illustrates the Evaluation Team, with basic role, geographic distribution and involvement of each team member. The main responsibilities of the Evaluation Team were as follows:

- Recruit participants for the CET
- Oversee exercise progress
- Organize CET training
- Develop tools and mechanisms to gather data for each axis
- Provide coaching to the CET regarding issues related to each axis
- Implement and follow-up on evaluation activities
- Report results

3.5 Scenario

The scenario proposed for Exercise Beta (related to the Northwest Passage and described in [6]) was based on a realistic capability gap which included domain fields mastered by the CET Lead. Its selection was ultimately based on its concreteness, along with the ease by which it could be understood by the CET. The potential for future DND interest on such a topic also contributed to its selection.

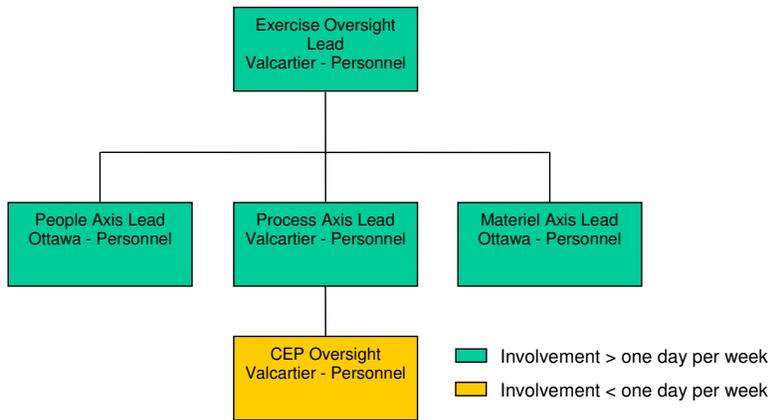


Figure 4: Evaluation Team Organizational Chart

3.6 Training

Following the initial kick-off meeting, approximately two days of training were provided (starting 1 November 2005). Table 4 lists the training provided to all CET members. Individualized binders containing all training materials were distributed to each team member.

Table 4: Training Summary

Axis	Training	Description	Duration
People	CET Overview	Presentation introducing the CET to team work principles	30 minutes
	Team Dynamics Exercise	CET participated in an exercise that demonstrate the value of team collaboration and communication	75 minutes
Process	CEP Overview	Presentation introducing newcomers to the process	30 minutes
	CEP Training Session	Detailed training on CEP (with examples)	6 hours
Materiel	Livelink Training	Introduction of the Livelink knowledge management tool	3 hours
	CORE Familiarization	Web seminar presenting the main capabilities of CORE	2.5 hours

4 Results

This section presents the results from Exercise Beta, organized relative to the three axes as well as the approach and methodology taken within the exercise. Results from applying the CapDEM approach in terms of the CET's output are also provided. Observations and lessons learned relative to these results then follow in the upcoming section.

4.1 CET Output

Starting from a scenario related to the Northwest Passage (NWP), the CET's objective was to apply the CEP and use the CEE to produce investment options to help decision makers to make well-informed decisions. The options had to provide the ability for the DND/CF to conduct surveillance and reconnaissance of maritime traffic transiting through the NWP. As the scenario was realistic (but not real) and the work had to stay unclassified, the CET made many assumptions and used mostly fictitious data.

During the course of the exercise, the CET produced the complete set of the CEP deliverables, along with a newly defined document deemed useful by the CET. These were:

- Engineering Management Plan
- Operational Architecture
- System-of-Systems Architecture
- Requirements
- Investment Options
- Integrated Dictionary
- Strategic Context Analysis (the new CET-proposed deliverable)

Within the exercise, three operational solutions were devised for the NWP scenario, each being scored by judgemental assessments. Table 5 shows that Option 1 and Option 3 had really close scores while Option 2 was judged not operationally acceptable by its low score (exact values are not important in terms of this document; rather, the highest (least negative) measures are best).

Table 5: Operational Options Assessment Scores

Comparison Technique	Option 1: Full Coverage	Option 2: Coverage of the Approaches	Option 3: Sub Surface and Approaches	Best Option
Risk Assessment	-88	-104	-88	1 and 3
Advantage / Disadvantage	52	-33	44	1
Response to Factors	19	-46	18	1 and 3
Overall Scores	-17	-183	-26	1

Table 6: SoS Options Comparison Table

Option Name	Ranking	Cost	Performance	Risk	Schedule
Option 1a: Current Systems	2	\$900M	100%	Very high	2
Option 1b: Enhanced UAVs	1	\$100M	100%	Medium	1

Time constraints for the exercise only allowed the development of SoS and investment options for Option 1. Within that option, two solutions were proposed with cost, performance, risk and schedule being detailed for each (see Table 6). The resulting recommendation was to select Option 1b (enhanced UAVs), which had a better ranking due to being less expensive, less risky and slightly faster to implement while yielding the same performance as Option 1a (current systems).

4.2 Overview

Exercise Beta utilized a significantly different data collection methodology than the one employed in Exercise Alpha. Specifically, Exercise Beta moved away from quantitative-based individual survey and questionnaire-based techniques, towards more interactive and team-oriented qualitative techniques through the use of focus groups. Focus groups allowed participants to put forward their ideas and issues within a forum setting. The focus groups were scheduled to coincide with the CEP gate reviews to maximize attendance and participation by the CET as well as to align the data collection points with well-established “sync points” in the process. Consequently, the focus groups obtained substantial levels of participation from the CET with most members attending or sending their feedback in advance if they could not be present. As a result, the focus group was identified as the preferred method to obtain feedback. Furthermore, the focus groups were so popular that the CET recommended that they be made a standard part of the CEP definition. Additionally, another benefit of the focus group is that it served as an opportunity to co-locate the entire CET on a regular basis, therefore facilitating a minimal schedule for team building exercises.

Participants. All of the Exercise Beta’s participants took part in a series of three focus groups which were held throughout the exercise between December 2005 and March 2006 (see Table 7). These focus groups were conducted at the end of each stage during its associated gate review meeting in order to elicit discussion around the relevant activities and deliverables. For the Inception Stage, a one-on-one interview was held with the team leader and deputy team leader to obtain initial feedback on how the effort was progressing. After the Comprehension Stage was completed, a focus group was held that would incorporate both general observations on the Inception Stage with a detailed examination of issues around the Comprehension Stage.

Questions. A semi-structured interview guide was employed throughout all of the focus groups (see Annex A). Approximately 15 to 18 questions were asked per focus group, concentrating mainly on the people, process and materiel axes, training and the support provided by the Evaluation Team. The focus groups ran for approximately four hours, ensuring that the key questions were well-addressed by the CET. The questions were intended to start conversations

about general areas/themes that were familiar to the participants. The questions were generally easy to understand and predominantly open-ended, based on feedback received from Exercise Alpha. Prior to running the focus groups, the Evaluation Team vetted the questions to determine if they were appropriate to use with the CET. A trained facilitator moderated the focus group sessions, and used additional probing questions to obtain a better understanding of the responses to the key questions.

Table 7: Focus Group Details

Description	Date	Location	Attendees		
			CET	Evaluation Team	Other
End of Comprehension	22 Dec 05	DRDC Valcartier	7	4	1 – Capability Manager role player
End of Elaboration	7 Feb 06	CGI Office Ottawa	9	5	2 – Capability Manager role player & Evaluation Team replacement
End of Completion (and exercise)	1 Mar 06	CGI Office Ottawa	6	4	2 – Capability Manager role player & Evaluation Team replacement

Analysis Using Common Themes. The results for Exercise Beta are based on an analysis of the common themes which emerged throughout the various stages of the exercise. After each CEP stage (i.e., Inception, Comprehension, Elaboration and Completion), a gate review meeting was conducted involving the Capability Manager, the CET Leader (Project Manager), the CET Sub-team Leaders and the Evaluation Team. The data collection methods for conducting the gate review meetings were contingent on the required data and information. For example, the one-on-one interviews were employed for discussions with the Project Manager (PM) vs. focus groups, which were used to obtain the CET’s feelings, attitudes and perceptions of Exercise Beta. Participants provided feedback on their experiences in the exercise to help the Evaluation Team assess and validate each axis, including the actual work along with the experimental methodology and approach. The focus groups were conducted face-to-face within a controlled setting using a list of semi-structured, open-ended questions to help guide its conduct. This methodology was also used to evaluate and validate the efficacy of the CET’s training (e.g., mid-Elaboration). Table 8 outlines the methodology employed at each stage.

Table 8: Mechanisms for Data Collection

CEP Stage	Data Collection Method
Inception	One-on-one interview(s) with the PM
Comprehension	Focus group
Elaboration (including training)	Focus group
Completion	Focus group

The results of the focus groups were analyzed after reviewing all four stages in Exercise Beta. Unless there was an issue specific to a particular stage, the results are presented as a roll-up of the critical areas identified for each axis. Based on these results, recommendations are put forward

within the subsequent section for further consideration as best practices and lessons learned to assist in Exercise Gamma, the final CapDEM evaluation exercise.

4.3 CapDEM Axes

This section presents the results obtained from the focus groups in terms of each axis. A number of common themes have been put forward to better explain the critical issues that evolved from the focus group discussions.

4.3.1 People

A number of themes emerged within the People Axis and are examined under the following headings: team collaboration, team communication, team charter, as well as roles and responsibilities.

Team Collaboration. Overall, team collaboration was important to the CET; however, individual members felt that it was sometimes difficult to organize the work that needed to be completed (i.e., it was a challenge to do that work together). Within the CET, some people tended to work independently, thus posing an additional challenge in terms of collaboration with various other members. Another issue was the importance of face-to-face meetings. Team collaboration was enhanced more through frequent co-location as opposed to distributed teams. That is, more frequent face-to-face meetings were far more beneficial for the CET and helped to foster the “Norming Phase”. The CET felt that they were more productive when they met face-to-face, and as a result, such meetings became the preferred method for collaborating between team members. For this particular CET, distributed collaboration technologies (such as ACCESS) did not seem to provide the “feeling” of team collaboration and were considered less personal because of their virtual setting. Specifically, the level of communication achieved by the distributed CET did not meet their expectations. Another issue focused on team participation. The ability for each individual to feel part of the team was very important to the CET members (as part of enabling strong team collaboration across the CET). Feedback focused on the need to feel that one is part of a team, and that individuals are not working in isolation from the rest of the team. For instance, once a member’s role is completed, it is still important to keep that member “in the loop” to ensure that the team member knows how objectives are being completed throughout the project. Within Exercise Beta, more collaboration was deemed necessary between architecture teams in order to better understand each other’s requirements. Therefore, teamwork was critical even though some members had felt that they were working in isolation from the CET and its sub-teams. Unwittingly, the Team Leader didn’t always provide support and enhance team collaboration, but was more preoccupied with ensuring the CET had the required information and a good understanding of the effort’s objectives and deliverables.

Team Communication. It was noted that team communication was vital to the overall performance of the CET. In particular, there was a requirement for team members to interact more frequently beyond that in their regular team meetings. Again, face-to-face meetings were considered to be more effective in communicating throughout the exercise (both within the sub-teams and across the whole CET). Tools, such as Meeting Zone (an on-line meeting tool), weekly meetings and conference calls, discussion forums on Livelink, telephone and chat sessions, were used successfully; the ACCESS labs tended to be used when people would get

together for a particular meeting. At times, there was a lack of communication between the Team Leader and the remaining CET members (i.e., there wasn't enough information exchanged between the Team Leader and other CET members). It was also noted that sub-teams did not communicate as well as the main CET did as a whole. Specifically, each sub-team worked independently of the others, and as a consequence, individual sub-teams were not apprised of the results that were emerging from other groups. This disjointed awareness created a great deal of confusion over the work that was being completed.

Team Charter. The team charter was not implemented as a useful tool. Although training had been given to the CET on how to use the charter and revise it to suit their needs, the charter itself was not a priority. The CET did realize that they needed to incorporate the team charter into their overall strategy and discussions as a means to avoid “parachuting” people into roles, to help outline the time allocated to the CEP deliverables in terms of each stage, and to address time management and provide for better planning in terms of timelines and overall effort (especially at the beginning of team development). However, while the CET felt that the team charter was important, it did not come to mind as a priority in terms of maintaining successful team cohesion and fulfilling project deliverables.

Roles and Responsibilities. As Exercise Beta progressed, the CET realized that the team roles and responsibilities were not very well “mapped out” and would likely need to change for future CET structures (particularly for Exercise Gamma). Many tasks were learned “on the job”, and it became more difficult for sub-team members to know exactly what was expected of them. A “cookbook approach” was highlighted as potentially beneficial for the CET by providing definitions and instructions on completing the templates, as well as denoting which deliverables were particular to specific roles and responsibilities.

Team leadership was a particular issue for the CET members, including the Team Leader. The Team Leader felt that there was too much onus on knowing everything about the CEP and the expectations for completing the CEP. On the other hand, some team members felt that they worked well within their own sub-team, but hardly liaised with the CET Team Leader. Sub-teams could have worked out well within the CET structure; however, the CET felt that sub-team leaders disconnected the sub-teams from the main CET. As such, the CET felt that the sub-teams did not work as effectively as initially thought due to the perception that the sub-teams created their own “silos”. According to the CET, there is a need to have only a small number of people for the main CET (six to ten people maximum).

4.3.2 Process

A number of themes emerged under the Process Axis, namely focusing on issues of quality assurance, availability, traceability and artefact-orientation. These themes are explained under the following categories: work plan, activity workflow, iterative and spiral approach, requirements, templates, data collection and content production.

Work Plan. Many comments about the need for a work plan were collected during the first focus group at the end of the Comprehension Stage. Some CET members explicitly mentioned that the plan was missing or not established on time. Another indicated that more time was needed upfront to customize the process. They also indicated they were never quite sure who was working for whom and that “a better schedule for resources coming in” was required. It was also

mentioned that there was difficulty to plan the work as it took two to three weeks to get comfortable with the process. During the second focus group, there were fewer comments regarding the work plan. A minor comment focused on the fact that the plan was good at the sub-team level but was not shared with the rest of the team.

Activity Workflow. Exercise Beta was the first opportunity to test the entire process in a realistic situation. The CET experienced many difficulties in the production of CEP deliverables (as was stated “The work to be done is not easy at first sight”). During each focus group, the CET generally noted the need for additional guidance on CEP execution; specifically, the CET mentioned the need for a “cookbook”, to provide further description of activities and better understanding of how the elements worked together. The coordination of CEP deliverables, specifically their flow and timing between the various members, was also highlighted as an issue. In particular, some members indicated that they did not find where their inputs would come from, when they would come and in what form. The CET also pointed out that the work breakdown structure was task-oriented and did not show the production and flow of deliverables. They asked to align tasks with the flow of deliverables. In addition, it was observed that some participants were unintentionally left with “nothing to do” for parts of the CEP. For instance, it was unclear that the SoS architecture lead should work on the “As-Is” architecture during the Inception Stage instead of waiting until the Comprehension Stage.

Iterative and Spiral Approach. The timeline of Exercise Beta did not allow for any iterations to be conducted during the Elaboration Stage. The team pointed out in two focus groups that this stage will benefit from conducting a number of iterations, as more iterations with fewer details would have helped to develop the options. The team also identified that the spiral approach should have been used in the Comprehension Stage, and that the “battle rhythm” of early stages would need to be accelerated in order to be able to perform iterations earlier in the process. That is, shorter cycles would have provided better results.

Requirements. The relationship between the “Analyze Capability Gap” and the “Develop Operational Architecture” processes (along with their corresponding deliverables) was questioned during the exercise. Some CET members mentioned they were never comfortable with having two templates (“Requirements Definition” and “Operational Architecture”). They stated that “one cannot divorce requirements from operational architecture”. In order to get the high-level needs documented in the “Requirements Definition” deliverable, the CET conducted a “strategic factor analysis” as part of the “Develop Operational Architecture” process. Thus, this activity required some duplication of effort but was considered to be beneficial by the CET.

Templates. Each focus group commented on the CEP templates. At the end of the Comprehension Stage, many comments focused on the Engineering Management Plan (EMP). It was commented that this template was not suitable and that it focused too much on the content rather than the management of the effort. The CET also indicated that there was redundancy between templates. They questioned the level of detail for some templates as well as the soundness of having separate “Requirements Definition” and “Operational Architecture” templates. They also suggested that the “Volume 2” template, as produced by the “Assess Force Development Option” process, be incorporated into the “SoS Architecture” template. The examples presented in the templates were criticized as the CET did not think they fit the level of application (i.e., capability engineering). Finally, some clerical formatting problems (like consistent colour usage and hidden document elements) were reported.

Data Collection. Some CET members encountered difficulties with data collection. In particular, one member reported that he needed help to collect the data: it was time consuming, and some information was not available due to classification. The CET did suggest that work should be done to ensure availability and accessibility to all relevant data.

Content Production. While the CET was dealing with a realistic problem it was not a real one per se. Thus, the content of their deliverables needed to make sense but not be necessarily valid. As was stated, “[we] were more preoccupied with the process than the content” and doing so made them feel that rigour was not carried out to the extent that it should have been. They thought that validation and verification of the content would have provided greater value. They also believed that better results would have been achieved by going through multiple iterations within the Elaboration Stage, and that at least one additional iteration could have been useful within the Comprehension Stage.

4.3.3 Materiel

A number of themes emerged under the Materiel Axis, including disparate Information Technology (IT) infrastructures, information model and workflow, informational and technical liaison, logistical and technical awareness, as well as demographic influences and challenges.

Disparate IT Infrastructures. The CET relied on networked collaboration, information exchange and communication technologies to address geographic distribution and sharing of information between the team members. While mobile, the CET members were generally located at three distinct locations, utilizing two different DND/DRDC networks as well as the Internet (for off-site contractors, home-based access). Multiple networks were required due to team demographics/location and the logistics of placing “experimental” software on an operational network in a timely and flexible manner. Differing implementation and security policies for the various networks resulted in certain tools not being fully functional and/or requiring different user interfaces at different access points. Robustness and usability (in terms of speed, access to data, user interface functionality and other issues) were also severely impacted by the use of the multiple IT infrastructures.

Information Model and Workflow. From a CET perspective, the application of the CEP was significantly about the engineering and analysis of deliverables, resulting from the processing, organization and management of diverse and voluminous information. Therefore, as a set of tools, the CEE was not particularly interesting to the CET. The desired focus for the CEE was as an information model and an appropriate workflow to facilitate the creation of CEP products; that is, as a means by which information could be processed, organized and managed. The CET did not feel the CEE (as provided) met this need to the required level.

Informational and Technical Liaison. A difficulty experienced with using the CEE was the need to have appropriate levels of informational and technical expertise linked/integrated with the CET. Within Exercise Beta, there were a number of challenges in dealing with IT and KM issues, such as information organization and modelling within the CEE (such as in Livelink), as well as difficulties with respect to system usage and interoperability.

Logistical and Technical Awareness. CET members remarked that a number of logistical and technical issues impacted their working behaviours within Exercise Beta. Specifically, awareness

of a number of issues related to the collaborative facilities (such as VTC bridging outside of the ACCESS labs) resulted in the team modifying their meeting structures in a manner inconsistent with the intent to utilize the distributed teams. Additional issues related to policy and physical logistics (such as security passes and facility lighting) also influenced CET behaviour (negatively influenced teaming experiences and willingness to try further).

Demographic Influences and Challenges. Beyond the issue of CET awareness, team demographics also influenced the acceptance of the CEE and its impact on certain working behaviours. In particular, the change in CET membership changed the team demographics (i.e., work background and average age). Correspondingly, the work styles preferred by many of the CET members swung more towards traditional co-located office styles. Members preferred to stay at their desk and interact with other CET members in co-located, face-to-face environments. Such preferences were mirrored by a decrease in the utilization of enhanced communication and collaboration technologies (i.e., they did not like to utilize CEE components that required adapting to different facilities, such as the ACCESS lab or the use of VTC capability). Thus, distributed work sessions were not the norm, nor did they benefit from the “richness” of the CEE’s collaborative facilities.

5 Discussion

Based on the execution of Exercise Beta, this section highlights a number of observations and lessons learned. These discussions are organized relative to the three axes as well as the approach and methodology taken within the exercise. Observations are based on the application of the CapDEM approach via the CET's output.

5.1 CET Output

As an exercise, Exercise Beta was based on fictitious data and a realistic (but not real) scenario. However, despite this constrained and artificial nature, Exercise Beta was still able to provide deliverables that demonstrated the utility and value of the CapDEM approach. That is, it illustrated that a CET can provide rigorously analyzed information that would be relevant to decision makers through the application of the capability engineering construct.

Specifically, despite concerns over the actual usability of the deliverable contents, exercise results have been requested by a sibling DND organization. Such interest offers an indicator that the CET created interesting contents and realistic options through the application of the CapDEM approach.

5.2 CapDEM Axes

This section presents discussion on the observations and lessons learned from the focus groups in terms of each axis. A number of common themes have been put forward to better explain the critical issues that evolved from the focus group discussions.

5.2.1 People

A number of themes emerged under the People Axis, including: team collaboration and communication, team charter, as well as roles and responsibilities.

Team Collaboration. Collaboration among CET members was considered to be important to ensure that the objectives were met at the end of the exercise. A few of the team members recommended that there needs to be greater collaboration between team members, especially when CET members need to better understand each other's requirements. Successful team collaboration involves a shared environment, where team members share their ideas, skills and knowledge to complete their team objectives. By providing enhanced team leadership and support, teams are able to collaborate in a more constructive manner and are able to resolve team issues more effectively. In addition, virtual environments may not always be the most suitable solution for teams when promoting team collaboration. Within this CET, team members felt that by engaging more frequently in face-to-face discussions and meetings, the CET would have been able to function more effectively by maintaining greater visibility throughout the exercise. The CET realized that it would be more important to meet one-on-one with team members to brainstorm issues and to strategize on the following requirements. This inevitably has helped the CET in further developing the "Norming Phase" and in building more trusting relationships. Co-

location also helped to avoid unnecessary risks. Distributed teaming approaches, including those using the ACCESS facilities, did not generate greater team collaboration. Therefore, it would be worthwhile to further investigate the issues associated with ACCESS facilities and what elements need to be modified to improve this method of team collaboration. Establishing team principles for maintaining successful virtual teams was also recommended by a few of the team members (e.g., need to set up protocols for virtual team, how to work as a team, and so forth). Maintaining activities outside of the CET with team members was also considered to be important in maintaining collaboration.

Team Communication. Team communication was important to the overall performance of the CET. In fact, more frequent interactions between team members were considered to be important for instilling better communication practices. This frequent interaction, however, was contingent on having face-to-face meetings as opposed to virtual meetings. Face-to-face meetings were considered to be far more beneficial for team members as it enabled people to carry out their tasks more effectively throughout the exercise. Some tools, such as Meeting Zone (an on-line meeting tool) and conference calls, were also used to help supplement face-to-face meetings; however, the ACCESS facilities were not as successful as getting together physically to discuss and brainstorm issues. It would be important to better understand why facilities, such as the ACCESS labs, were not considered to be as effective for communicating as face-to-face communications. It would be important to determine what aspects of the virtual environment deter people from using such facilities (e.g., lighting, noise, technical set-up, integrity of system, etc.). Moreover, the communication between sub-teams did not yield very effective results. Sub-teams worked independently of one another throughout this exercise. Team leadership may have played a significant role in helping the sub-teams communicate more effectively. Therefore, it would be worthwhile to further understand how team leadership plays a critical role in bridging the gap between sub-teams and their ability to communicate more effectively with each other.

Team Charter. Overall, the team charter was not implemented as a useful tool. Initially, the CET felt that they needed to incorporate the team charter into their overall strategy and discussions; however, this charter was quickly forgotten and not considered to be an integral tool for the CET. Throughout the focus groups, the CET realized that there was a need to review and use the team charter to avoid “parachuting” people into roles. The CET also realized that the team charter could have been employed to help people commit better to project deliverables. A team coordinator could have possibly referred the CET members to the team charter and could have better explained the viability of the tool for the remainder of the exercise. The team charter could have also clearly allocated the time required to complete the deliverables based on the four stages. This would have contributed to better planned timelines and overall effort to complete the project deliverables. Even though the CET felt that the team charter could have been a useful tool by the end of the exercise, it would be prudent to further examine why it wasn’t employed properly, and how the team charter could be better structured to reflect the team’s values and commitment to fulfilling the objectives of the exercise.

Roles and Responsibilities. Team roles and responsibilities were not very well delineated, and it was soon realized that changes to the existing organizational chart would have to be implemented to better suit the needs of the future CET structure. The CET members recommended that there is a requirement to have team members with the right set of skills and knowledge to take on particular roles and responsibilities. Recruitment and selection should be based on finding the right people with the right set of competencies, personality traits and knowledge.

The implementation of sub-teams created silos, where members felt isolated from each other and didn't truly understand how deliverables were being completed throughout the exercise. According to the CET, the ideal team would have six to ten people as a maximum. This team would also need a coordinator to help establish better linkages between CET members, the Capability Manager, PRICIE representatives and stakeholders. By incorporating a team coordinator role, the CET would have a better understanding of how they would engage with Subject Matter Experts (SMEs) and PRICIE representatives throughout the process (e.g., "... the coordinator will have the role of PRICIE expert to redirect question to the appropriate PRICIE reps").

To ensure that members do not feel isolated and that sub-teams would not get a limited understanding of the entire work effort (i.e., "the big picture"), it is required that team members know how work is being completed, even though they may have completed their portion of the deliverables. In addition, avoiding part-time participation is preferred to limit disruptions, promoting both availability and continuity of effort. Limited resources and participation can lead to an incomplete understanding of the CEP, CET and CEE. Therefore, there is a need for a full-time dedicated team to complete the objectives within a realistic timeframe.

Initial exercise planning included the recruitment of stakeholder members; however, such recruitment was never achieved. At each focus group, elements regarding stakeholders were pointed out. As in Exercise Alpha, participants in Exercise Beta indicated that they required SMEs. They noted that there were no SMEs dedicated to the initiative. They mentioned that in a real case (i.e., not an exercise), they would have spent more time in communicating with stakeholders and sponsor(s). They also suggested that the work should be carried out in areas related to the SMEs (to promote availability). The CET also felt that there was limited coordination in helping the CET members understand what needed to be accomplished in line with the Capability Manager, PRICIE representatives and stakeholders. By incorporating the team coordinator role, the CET would have a better understanding of how they would be engaged with SMEs and PRICIE representatives throughout the process.

The suitable selection of personnel, particularly in terms of individual characteristics, is especially important. Individual personality traits need to fit the position and team dynamics. It is also important to recruit and select the "right people with the right competencies." Therefore, selection needs to be tied into career development and career progression. This would enable greater commitment from the team members and also help facilitate team cohesion.

Finally, there is a need to better understand the relationship between the Team Leader and the team members with respect to their roles and responsibilities. What are the expectations of the CET with respect to team leadership? What are the competencies that are required in fulfilling the role of a team leader? What interactions should be maintained between the Team Leader and the CET? These are key questions that require further investigation to facilitate improved efficacy of the CET.

5.2.2 Process

A number of themes emerged under the Process Axis, including: quality assurance, availability, traceability and artefact-orientation. These themes are discussed in terms of: work plan,

stakeholder availability, process composition/relationships, workflow, templates, data collection and information access, as well as use of the iterative approach.

Work Plan. Ensuring the creation of a quality work plan was a significant issue. Even though the CET Lead had produced such a plan, the CET found it to be insufficient. Factors which could have contributed to the problem include:

- The CET Lead did not have knowledge of the CEP prior to appointment.
- The CET Lead built the plan mainly in isolation without the involvement of the CET sub-team leaders.
- Despite a lack of clarity by the CET Lead in terms of the tasks and deliverables, the plan had to be ready before the Comprehension Stage started.

Consequently, a lesson learned is that CET sub-team leaders should participate in the development of the work plan, as each of them can better estimate the time and resources available within their own area of responsibility. It is also believed that a formal review of the Engineering Management Plan (EMP) is required midway through the Inception Stage. It is also important that such a quality assurance review should be performed by people knowledgeable with the CEP and with the key issues in conducting such a capability engineering initiative (e.g. allowing enough time for the Inception Stage to ensure team “Forming and Storming”). In addition to this initial review, additional ones should be performed (as needed) prior to the start of any subsequent iteration.

Stakeholder Availability. As part of enabling the application of Capability Engineering, the availability of Subject Matter Experts and suitable stakeholders needs to be ensured. Since Capability Engineering is primarily concerned with facilitating strategic decision-making, it relies heavily on the input from those with operational experience and domain expertise. Due to such individuals being in high-demand, it can be difficult to obtain their participation, particularly in the case of an exercise. Nevertheless, it is recommended that the sponsors of future initiatives take on the responsibility to ensure participation from these key contributors.

Relationship Between (Sub-)Processes. The relationship between various sub-processes within the CEP needs further examination. Further analysis and experimentation are required to clarify the relationship between the sub-processes dealing with requirements, the operational architecture and the SoS architecture. For example, based on experience to date, consideration has been given to merging “Analyze Capability Gap” under “Develop Operational Architecture”. Although the overall issue has not yet been resolved, the concept of “strategic factor analysis” is recognized as being very relevant to discover high-level needs. In particular, it was seen as a very efficient and systematic way to identify high-level needs using strategic documents as input while also enabling traceability between them. As such, it will be integrated in the next version of the CEP as part of the “Analyze Capability Gap” process within the Inception Stage. Two redefined deliverables from the “Analyze Capability Gap” process within the upcoming CEP version will be the “Requirements Definition” and “Strategic Context Analysis” documents. These will result from the portion of the Requirements Definition deliverable that covers high-level needs being removed and packaged as a separate document along with the aforementioned strategic factor analysis, from which those high-level needs are drawn. In addition, the requirements document will be used to formalize those needs discovered while developing the operational and SoS architectures (i.e., translated into need statements). It is not obvious yet if this translation is

worthwhile, but it will enable better traceability and facilitate better communications with the stakeholders.

Workflow Guidance. Commentary from the CET indicated that the CEP would benefit from increased guidance in terms of workflow. Specifically, CET feedback stated that a workflow based on artefacts would be preferred. Originally, the intent was to limit the “how” in CEP documentation and put emphasis on the resulting products at each stage. This approach was based on the premise that existing engineering and architecting standards could be reused, and that participants would know how to do the work (given enough precision on what to produce). The rationale was not to impose too many constraints on the CET and to enable maximum parallelism in activities. Exercise Beta, however, has shown that engineering at a capability level is quite different from doing so at a systems level (the biggest difference being requirements elicitation). In addition, because of personnel challenges, there must be suitable support for enabling and facilitating CEP execution when experienced people are not available for/assigned to the project. Therefore, a major improvement for the next version of the CEP will be two-fold: (1) the “conceptual” subdivision of the deliverables into a set of artefacts; and (2) a detailed description of the workflow to produce them. In other words, a deliverable can be seen as being constructed from a set of artefacts, with each artefact corresponding to a specific section of a deliverable.

Templates. The templates provided to assist in the creation of the CEP deliverables need improvement. For each deliverable, a template was provided to guide its completion. However, Exercise Beta was the first attempt to produce all CEP deliverables; consequently, various flaws with the templates and their application were discovered. Therefore, the next version of CEP will include various improvements and changes, such as an improved and less onerous EMP template (better adapted and reduced in size). Additionally, a signatory section will also be added to formalize a mid-point review during the Inception Stage (introduced to address the previously mentioned work plan issue). Other changes include integrating the “Volume 2” template of the “Assess Force Development Option” into the “SoS Architecture” template, and a template will be built for the newly proposed “Strategic Factor Analysis”. Modifications to various other templates will be required to reflect the new delineation between processes, as well as to address the numerous (but relatively minor) complaints reported (e.g. formatting, spelling, ordering, duplication, data entry problems, etc.) to avoid further user annoyance and distraction from the effort’s main purpose. Despite these intentions, it would still be possible for some problems to remain. Therefore, one possible solution could be to use automatic report generation in conjunction with the various CEE components. Such functionality would require additional investment in terms of time and money in order to customize the reports so that they align with the CEP templates. However, added benefits would include less duplication and increased consistency in terms of report content, along with being complementary towards any potential artefact orientation.

Data Collection and Information Access. Data collection and access to information needs to be better facilitated. Various reasons impacted on the difficulty experienced in obtaining the information necessary to conduct the exercise; these include: numerous sources (where to find and how to verify); availability of knowledgeable people (many were unavailable); conflicting priorities (exercise requests are a lower priority than real operational requests); and information classification. Classification is a significant issue in that CET members need to have the right clearances and the right environments to be able to manipulate and exploit classified

data/information. Such issues are believed to be an on-going concern for future applications of Capability Engineering, and consequently, some solution(s) will need to be addressed through personnel selection and provisioning of the working environment(s).

Iterative Approach. The iterative approach seems to work well in terms of producing CEP deliverables. Even though CET did not have enough time to perform the desired number of iterations, their comments suggest that such an approach is the right one. Efforts for the next exercise (Exercise Gamma) will attempt to ensure sufficient time is allowed for CET to iterate in both the Comprehension and Elaboration stages.

5.2.3 Materiel

A variety of themes emerged under the Materiel Axis, including disparate Information Technology (IT) infrastructures, information model and workflow, informational and technical liaison, logistical and technical awareness, as well as demographic influences and challenges.

Disparate IT Infrastructures. The use of multiple IT infrastructures was required in order to support a CET that spanned multiple government (DND/DRDC) facilities, contractor offices and CET members' home offices (both within and across multiple cities). Due to this distribution, the CET relied on networked collaboration, information exchange and communication technologies to interact and share information between each other. Additionally, because the CET was mobile (as part of utilizing co-located and distributed work sessions), specific individuals used more than one access point to the CEE. Therefore, infrastructure access was not statically defined per person/location, but highly dynamic. Multiple networks were also required due to the logistics of placing "experimental" software on an operational network in a timely and flexible manner (that is, being able to control the timeline of software installation, as well as its management and configuration). Robustness and usability (in terms of speed, access to data, user interface functionality and other issues) were severely impacted by this use of multiple IT infrastructures. Specifically, differing implementation and security policies resulted in certain tools not being fully functional and/or requiring different user interfaces at different access points (e.g., the Livelink knowledge portal). The use of different access points also proved confusing to the CET members and compounded issues of support. Therefore, from the user perspective there is a need to ensure transparent, location-independent tool access, without affecting functionality, performance and support. Consequently, there is a need to address infrastructure-specific technical and policy limitations in advance of tool selection, deployment and use. This would include more involved IT support that is aware and capable of addressing all the infrastructures to be involved (e.g., the various corporate networks and access points).

Additionally, the coordination of support for the different IT infrastructures needs to be a high priority and addressed in a formal way as to ensure knowledgeable and responsive behaviour when issues arise. Distributed IT support that can appropriately interface and respond to the needs of project-level IT is necessary. The key challenge is to do so in support of an 'ad hoc' non-permanent organizational construct, in which the governing authorities of the various infrastructures would likely want to consider the persistence/permanence of participant connectivity. That is, the resources required for such multiple partner infrastructures would need to be of convincingly sufficient value and importance to justify the effort. This issue was, and will likely continue to be, a problem in terms of shorter-term efforts (such as an exercise or short term projects). As such, Materiel Axis considerations are very difficult to assess on a per case

basis, but rather need to be considered across multiple instances to observe developing themes and their variations.

Information Model and Workflow. From the CET perspective, the CEE was a means to an end, with the desired focus being an information model and an appropriate workflow to facilitate the creation of CEP products. Thus, interest in the CEE was less as a set of tools that could enable Capability Engineering, but rather in how it would enable the CET (and in particular, this CET) to apply the CEP (e.g., the engineering and analysis of deliverables). To this end, the CET did not feel the CEE met their needs, as evidenced by their commentary and the desire to use additional tools not part of the original CEE definition.

In general, the overriding issue would seem concerned with the balance of technical vs. team focus. Specifically, many of the challenges in utilizing the CEE were related to the level of knowledge required (in terms of tool, process and domain) vs. the awareness of how to apply them in the problem context (the intersection of tool, process and domain). While knowledge issues can be addressed through training combined with knowledgeable CET members leading specific activities, facilitating a team-wide information/knowledge management perspective and ensuring the use of particular workflow(s) can be difficult (as people naturally default to previous behaviours). These difficulties are further intensified when compounded by IT infrastructure issues, conflicting tool/work-practice preference (individual vs. group) and limited availability (be it technical or procurement related).

Informational and Technical Liaison. The linkage/integration of informational and technical expertise with the CET proved a significant issue for Exercise Beta. Specifically, there were a number of challenges in dealing with IT and KM issues, such as information organization and modelling within the CEE, as well as difficulties with respect to system usage and interoperability. It was concluded that at least one or more members of the CET, as well as some members on the support team, need to be experienced in data modelling, including modelling experience with the information repository being used (in this case, Livelink). This level of expertise is necessary to meet the preferred information/knowledge focus (see above) and to facilitate proper and useful application of the tools. A lack of knowledge about modelling and how to implement an appropriate model within the given tools can result in unforeseen problems. Specifically, users can misuse, misapply or abandon the technologies put in place for them to use and invent their own way of doing things (whether appropriate or not). Consequently, the importance of dealing with “technological impatience” cannot be underestimated.

Logistical and Technical Awareness. While often dismissed as inconsequential, Exercise Beta illustrated that logistical and technical awareness issues can have unanticipated and significant impact on team working practices. Specifically, awareness related to the collaborative facilities resulted in the team modifying their meeting structures in a manner inconsistent with the intent to utilize the distributed teams. Examples of such misconceptions include not using contractor VTC systems in conjunction with the ACCESS labs because the CET did not know it was possible to do so. Correspondingly, due to the routine nature of VTC as a standard business practice, the need to highlight and ensure the CET could take advantage of such connectivity was not realized by the Evaluation Team until the need had past. Additional issues related to policy and physical logistics (such as site security passes and facility lighting) also influenced CET behaviour. Specifically, these logistical difficulties negatively influenced teaming experiences and their willingness to collaborate because doing so often involved extra effort that was inconvenient,

tedious and annoying. While only some of these issues were addressable within the bounds of the exercise, the key observation is that the change in CET personnel between Exercise Alpha and Exercise Beta inadvertently changed the awareness in many of these areas of concern. Consequently, strong “environmental awareness” needs to be provided and reinforced in terms of tool and facility considerations relative to CET experience and composition.

Demographic Influences and Challenges. Team demographics also proved to be a significant influencing factor in terms of CEE acceptance and related CET work practices. In particular, the change in CET membership (from Exercise Alpha to Exercise Beta) changed the team demographics (e.g., work background and average age). The CET for Exercise Beta utilized work practices more typical of a traditional, “established” workforce; members (predominantly military, ex-military and industrial contractors) preferred to stay at their desk and interact with other CET members in co-located, face-to-face environments (i.e., “across the hall” and “over the partition” type of collaboration). Such preferences were mirrored by a decrease in the utilization of enhanced communication and collaboration technologies. In general, issues of comfort, familiarity and the expectation to accomplish more by utilizing established means of doing business were the predominant influences in how the CET chose to conduct itself with respect to the CEE. Specifically, CET members did generally not like to utilize CEE components that required adapting to (or “experimenting with”) different facilities, such as the ACCESS lab or the use of VTC capability. This difference was in stark contrast to the initial exercise in which a different demographic (younger, more R&D-oriented individuals) had a more successful, productive and enjoyable application of the CEE in a distributed team context. Thus, distributed work sessions were not the norm for Exercise Beta, and the CET did not benefit from the “richness” of the CEE’s collaborative facilities. The key observation is that the CEE must not only meet the functional needs of the CET but also be adaptable to the “softer” aspects related to the social makeup of its user community.

5.3 Approach and Methodology

In terms of the approach and methodology, key observations and lessons learned include: exercise organization, evaluation method and training.

5.3.1 Exercise Organization

The exercise itself was conducted according to a workplan which would guide the CET in its execution of the CEP. The workplan also outlined the role the Evaluation Team would play in terms of interaction with and support for the CET. As with all of the evaluation exercises, the execution of the CEP was driven by a scenario and because of the “ad hoc” nature of this activity, participation in the CET was typically an additional duty for its members. Thus, the issues of workplan and scheduling, scenario specification, and personnel recruitment were significant elements in this area.

Workplan and Scheduling. As expected, based on the first cycle of the evaluation strategy, the Preparation Phase was very important for the smooth execution of Exercise Beta. In particular, it proved very useful to overlap the Preparation and Evaluation phases so as to enable the exercise’s new project manager (PM) to adapt to his new role. The practice also facilitated better “initialization” of the effort between the PM (representing the CET) and the Evaluation Team,

based on its knowledge of the CapDEM approach, the various axes and the intent of the evaluation effort.

In terms of CEP execution, the proposed schedule imposed significant constraints on the CET. Specifically, due to the time desired to conduct the Elaboration Stage, accommodating the desired three iterations within the required timeline of the exercise was not feasible. Therefore, the CET and Evaluation Team leaders agreed it was more important to complete the exercise on time rather than having three iterations. The rationale was that while the three iterations would have increased confidence in the proposed solutions, the purpose of the exercise was not to provide a real (ready-to-implement) solution but rather, to address how the CET would work using a realistic gap. The schedule was deemed to be reasonable (allowing one month for the Inception Stage if all the roles were to be filled at the start). One month, however, was definitely not enough to perform three iterations of the Elaboration Stage. Additionally, the two weeks allowed for the Completion Stage was also reasonable in the given context. In general, the timelines can be seen as highly dependent on initial readiness/availability of personnel, information and the work environment. Specifically, the preparatory period is key to facilitating more flexibility in timing for the middle stages (Comprehension and Elaboration) which occupy significant portions of the CEP timeline. Additionally, it is notable that “perfectionist tendencies” tend to skew execution within the stages and disciplined process execution is required.

Scenario Specification. The specification (i.e., selection) of the scenario driving the exercise is a significant factor in the confidence and perceived readiness of the CET to execute the CEP. Clarity, level of concreteness and availability of relevant information with respect to the scenario are necessary to counteract any lack of confidence the CET may have had with respect to executing a novel process with new team members using tools that may not be well known to them. Malformed, unrealistic, uninformed or otherwise problematic scenario issues can “make or break” the whole exercise with little opportunity to fix initial misconceptions by the CET.

Personnel Recruitment. Recruitment of members to participate on the CET (either as core or stakeholder members) proved a challenge mainly due to personnel availability (as with Exercise Alpha). Effort was made to engage potential client groups (including participation at the kick-off); however, by lacking a formal engagement structure for participation, there was a lack of continued client interaction with the effort. While not the focus of the exercise, external client support was an important aspect in moving forward towards the final evaluation exercise.

5.3.2 Evaluation Method

The evaluative aspects of Exercise Beta provided lessons that were critical in moving from the initial experimental design of the initial evaluation cycle (Exercise Alpha) towards the final client-based Exercise Gamma. Two key areas were identified: (1) data gathering and analysis; and (2) the Evaluation Team.

Data Gathering and Analysis. Exercise Beta utilized a different data collection methodology than its predecessor effort, Exercise Alpha. Specifically, Exercise Beta moved away from individual survey and questionnaire-based techniques (quantitatively based) towards more interactive and team-oriented qualitative techniques based on focus groups. This shift was done in response to commentary from Exercise Alpha’s CET, to encourage increased levels of feedback without the burden of excessive data gathering sessions, and to address the realization

that the CET was too small to viably perform statistical analysis from any quantitative data achieved through questionnaires (i.e, the sample size was too small to draw statistically significant and meaningful results). To meet the desire for increased participation in the data gathering process, the focus groups were scheduled to coincide with the CEP gate reviews, thus maximizing attendance and participation by the CET as well as aligning the data collection points with well-established “sync points” in the CEP. Accordingly, the focus groups obtained substantial levels of participation from the CET with most members attending (or sending their feedback in advance if they could not be present). In fact, the use of focus groups was identified as the preferred method to provide/obtain feedback; and moreover, the focus groups were so popular that the CET recommended their inclusion within the CEP definition. One final benefit was that the focus groups also provided an opportunity to co-locate the entire CET on a regular basis, thus facilitating a minimal schedule for team building exercises.

Evaluation Team. Even though the Evaluation Team did address their roles in terms of observation, coaching and support, commentary from the CET stated that the Evaluation Team needed to be more proactive, and give more input and feedback to the participants throughout the exercise. From the perspective of the Evaluation Team, the challenge was to provide assistance without interfering with the execution or the judgement of the CET, thus impacting the value of the experimental effort. Ultimately, a more advice-oriented and less evaluation-oriented focus was requested by the CET, such that they felt awkward asking questions and being advised by a group of people who were also called “the Evaluation Team”. Despite the fact that the evaluation was focused on the people, process and materiel axes (rather than how well CET members did their jobs), the CET had a difficult time isolating the Evaluation Team’s role. Consequently, the role of and activities related to the Evaluation Team need to be more clearly articulated and routinely reinforced by appropriate interaction with the CET.

5.3.3 Training

While the training offered to the CET in Exercise Beta was more substantial to that of its predecessor, a variety of classical training issues again resurfaced: content and applicability, and scheduling and delivery.

Content and Applicability. Participants felt the training should be practically oriented, rather than mostly consisting of lecture-style presentations. A training scenario, with role playing through a simple exercise, was favoured. This style was, in fact, utilized for the People Axis training session, and proved to be the most well-received amongst all three axes.

Scheduling and Delivery. Due to the complexity, breadth and length of training related to both the Process and Materiel axes, the CEP and CEE training required more attention in terms of scheduling and delivery. Both needed to be delivered in phases, scheduled relative to the CEP stages being executed. For example, process training should be composed of a general overview (to give a global perspective) followed by a training session before the beginning of each stage in a more focused, stage-specific manner. Tool training needs to be done in a similar manner, with a general overview of the entire CEE at the start of the effort. This overview should be accompanied by an integrated process and tool training exercise to increase understanding of how the CEE fits relative to the CEP, its activities and deliverables. Akin to the phased approach to CEP training, on-going, refresher-style tutorials on specific aspects of specific tools would be targeted to the most relevant users at the time. This approach would help address technology

isolation and overload while increasing relevance and addressing the issue of excessive and misdirected training.

Ironically, the Evaluation Team's proposed training and on-going coaching plan was nearly identical in design and intent to the feedback provided by the CET; however, the actual training that was delivered to the CET had to be adjusted due to a number of timeline and personnel constraints.

6 Conclusion

Even though the duration of Exercise Beta was extended by a month and did not allow for the CET to iterate within the CEP as planned, the Evaluation Team still considers Exercise Beta a success.

6.1 Summary

The ability of the CET to apply the CapDEM approach on a realistic scenario enabled the Evaluation Team to obtain a significant amount of useful data on the CapDEM approach, both in general, per axis and in terms of its application in a more realistic setting.

Table 9 provides a synopsis of Exercise Beta’s intended goals and scope as compared to how they were realized within the actual exercise. Brief per axis summaries are also provided.

People. In terms of the People Axis, the scope of the exercise imposed some restrictions on the team composition. Moreover, several themes emerged in analyzing Exercise Beta’s results; these include: team communications (to avoid working in silos); concrete delineation in roles (so members do not feel that others are assuming their role); and that CET leadership is a critical success factor.

Process. In terms of the Process Axis, this exercise permitted the Evaluation Team to identify different enhancements for the templates and process flow, as well as to confirm that further analysis is required to clarify the relationship between requirements, Operational and SoS architectures. The validation part of the process could not be assessed due to the lack of stakeholders.

Materiel. In terms of the Material Axis, this exercise confirmed the difficulty inherent to distributed configuration management and support across organizations with different networks which are not fully interoperable. Moreover, various components of the CEE were either not used, or used in unforeseen ways. Additionally, tools that were not part of the original CEE definition were also employed. The influence of logistics, liaison and demographics, as well as their linkage to roles and responsibilities, were also highlighted.

Table 9: Summary of Overall Goals and Scope

Overall	
Goals	<ul style="list-style-type: none"> • Test and evaluate the CapDEM approach via an instance based on a realistic problem. • Ensure that the necessary people, process and materiel can address a “real world” problem.
Scope	<ul style="list-style-type: none"> • Four month duration. • Realistic scenario.
Results	<ul style="list-style-type: none"> • Goals and scope reached. • Significant amount of useful data gathered for each axis.
People	
Goals	<ul style="list-style-type: none"> • Test and evaluate the effectiveness and appropriateness of the roles and responsibilities. • Test, evaluate and validate the principles of teamwork and collaboration.

Scope	<ul style="list-style-type: none"> • Complete team size. • CapDEM-related DND employees and contactors. • Distributed work sites.
Results	<ul style="list-style-type: none"> • Identified outstanding issues surrounding specified roles and responsibilities for the CET. • Missing or misunderstood principles of teamwork and collaboration. • Strengths and weaknesses of the team building exercises.
<i>Process</i>	
Goals	<ul style="list-style-type: none"> • Test and evaluate CEP activities, gates, inputs and outputs.
Scope	<ul style="list-style-type: none"> • Complete each CEP v2 deliverable. • Complete at least 3 iterations of the Elaboration Stage.
Results	<ul style="list-style-type: none"> • Identified enhancements for templates and task descriptions. • Clarification required with respect to the relationship between requirements, Operational and SoS architectures. • Validation part of the process not assessed due to the lack of stakeholders.
<i>Materiel</i>	
Goals	<ul style="list-style-type: none"> • Test and evaluate the current CEE as to which tools, technologies and facilities are considered essential, insufficient or missing in terms of supporting the CET and CEP.
Scope	<ul style="list-style-type: none"> • Fully exploit CEE functionalities.
Results	<ul style="list-style-type: none"> • Identified various strengths, weaknesses of the CEE for being able to more fully support the CEP and facilitate collaboration within the CET. • Identified perceived flaws and inconsistencies in the utilized workflow. • Gaps and/or inconsistencies in the alignment of roles and responsibilities with respect to knowledge/use of CEE components. • Identified the importance of a number of non-technical issues related to CEE utility (ranging from logistics to demographics).

6.2 The Way Ahead

Exercise Beta provided several valuable lessons learned, the results of which are already being incorporated into modifications that will be made in the next version of the capability engineering construct. Applying a systems engineering approach at a capability level is new to the organization and will require further improvement through experimentation and application. This second trial of the construct has reinforced the view that this domain will need the creation of specially trained “CE officers” to effectively enable institutionalization. In addition to becoming knowledgeable in the practice of CE, it is anticipated that this construct will require continuous improvement as it evolves into its niche within the force development community. Challenges include institutional resistance to change (legacy of environmentally-aligned stovepipes, “not-invented-here” issues), and the availability of knowledgeable personnel that can be fully dedicated to applying the approach.

Inevitably, as would be expected for any new process, concerns arise over its complexity, duration and whether each of its elements is truly essential to supporting the needs of decision makers. Ramping up a team efficiently with the basic training and tools continues to be recognized as an ingredient for success that warrants further improvement. In terms of the analysis itself, the level of detail and volume of analytical products required to satisfy capability level decisions remains an on-going question that will not completely be answered until we experience a use-case where output is transitioned into implementation in the capability production domain. However, while Exercise Beta was constrained in various ways across all

three axes, it is interesting to note that the analytical products that were generated have been very well received by the capability's operational authorities, and that they are being used as a departure point for an actual analysis of that capability area.

The CapDEM Evaluation Strategy will continue to build from lessons learned in Exercise Beta to make improvements in the construct prior to implementing its third trial (Exercise Gamma). This final exercise will involve a real capability goal and a team composed of participants from across the organization's matrix. It is important to note that all of these efforts to advance this approach are occurring at a time when the overlying capability planning, management and production domains are still being defined for the first time. As with the concept of capability roadmaps, continuous, iterative and incremental improvement of the capability engineering construct itself will also be required, thus the need to couple its evolution to a rigorous evaluation strategy.

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Annex A Example of Focus Group Guide

Focus Group Discussion Guide

Exercise Beta: Solving a Real Problem

Exercise Beta is intended to be a complete functional test and evaluation of CapDEM's CEP, CET and CEE axes. Based on a realistic problem definition, Exercise Beta shifts emphasis from debugging the evaluation methodology towards the "core" of the problem and CapDEM's ability to meet its needs. This exercise has involved a complete cycle of the CEP using the complete CEE by the CET. The primary goal of this iteration was to test and evaluate the CEP via an instance based on a realistic problem (Northwest Passage Surveillance and Reconnaissance Capability).

To help understand how Exercise Beta stands after finishing the Completion Stage, and indeed the entire Exercise, you are being asked to participate in this focus group session. This focus group will be asked approximately 20 questions (as well as additional probing questions) to help the Evaluation Team assess the effectiveness of the three CapDEM axes.

At this point, I would like to reiterate the background of the Completion Stage, including the objectives, essential activities, deliverables and milestones.

CEP Completion Stage

Objectives

The main goal of the Completion Stage is to finalize the Investment Options documents and recommend an optimal solution. Underlying objectives are:

- To finalize Operational Architecture options
- To finalize SoS Architecture options
- To finalize Requirements Baseline
- To finalize Investment Options definition

Essential Activities

The major activities to be realized during the Completion Stage are:

- The preparation and approval of the final Requirements Baseline release
- The preparation and approval of the final set of Operational Architecture Options
- The preparation and approval of the final set of SoS Architecture Options

- The packaging and approval of the final Investment Options documents (Volumes I and II)
- The ongoing enforcement of the CEP instance Assessment and Control activities
- The execution of the final CEP instance closing activities

Deliverables

The major deliverables to be realized during the Completion Stage are:

- Requirements Baseline - Release 5 (Final Review)
- Investment Options - Release 5 (Final Review)
- Operational Architecture - Release 4 (Final Review)
- SoS Architecture – Release 3 (Final Review)

Milestone

The Completion Stage milestone is to have all the CEP deliverables approved, including the final release of Investment Options. This completes the CEP instance.

Focus Group Questions

Completion Stage

1. In general, how would you assess your overall participation within the Completion Stage compared to the previous Stages (e.g., the Comprehension and Elaboration Stages)?

People Axis

2. Please identify the main issues that you may have encountered within the CET.
 - a. Team collaboration
 - b. Team communication
 - c. Team Charter
 - d. Roles and responsibilities
3. Please describe the elements you would incorporate in the creation of the future “ideal” CET.
4. Please describe what actions you would take to achieve (i.e., move towards) the realization of this “ideal” CET.

Process Axis

5. Please identify the main issues that you may have encountered within the CEP.
 - a. Processes & sub-processes

- b. Stages
 - c. Activities
 - d. Deliverables
6. Please describe the elements you would incorporate in the creation of the future “ideal” CEP.
 7. Please describe what actions you would take to achieve (i.e., move towards) the realization of this “ideal” CEP.

Material Axis

8. Please identify the main issues that you may have encountered within the CEE.
 - a. Functionalities
 - b. Workflow
 - c. Tools
 - d. Facilities
 - e. Connectivity and access
9. Please describe the elements you would incorporate in the creation of the future “ideal” CEE.
10. Please describe what actions you would take to achieve (i.e., move towards) the realization of this “ideal” CEE.

Training

11. Please describe the level of training in understanding the basics of team collaboration, team communication, Team Charter as well as roles and responsibilities.
12. What kind of training methodology would you favour for future CET training?
 - a. What sources of training do you feel would be appropriate and sufficient?
 - b. What length of training is likely sufficient?
 - c. What else could be done to ease the learning process?
 - d. Do you feel that your deliverables (i.e., the Team Charter) could serve as useful example training materials?
13. Please describe the level of training in understanding the basics of CEP, including processes, sub-processes, stages, activities and deliverables.
14. What kind of training methodology would you favour for future CEP training?
 - a. What sources of training do you feel would be appropriate and sufficient?
 - b. What length of training is likely sufficient?
 - c. What else could be done to ease the learning process?
 - d. Do you feel that your deliverables could serve as useful example training materials?
15. Please describe the level of training in understanding the basics of CEE, including the appropriateness of the functionalities provided (both by the tools and facilities), as well as the particular tools utilized.

16. What kind of training methodology would you favour for future CEE training?
 - a. What sources of training do you feel would be appropriate and sufficient?
 - b. What length of training is likely sufficient?
 - c. What else could be done to ease the learning process?
 - d. Do you feel that the current CEE could serve as a useful basis for future training?

Evaluation Team and General Support

17. Please describe the level of support received from the Evaluation Team.
 - a. What went well? What did not go as well?
 - b. Describe your experiences in terms of the “coaching” provided.
 - c. Describe your experiences with the “Help Desk” system, both as an information resource and in terms of any other issues (including technical).
 - d. What improvements, if any, would you recommend?

18. What were your experiences with the Evaluation Team in terms of the evaluation’s data gathering and feedback processes?
 - a. What is your opinion of the use of focus groups?
 - b. What is your opinion of the FAQ (Frequently Asked Questions) mechanism?
 - c. What is your opinion of the Lessons Learned mechanism?
 - d. What improvements, if any, would you recommend?

Annex B Agenda of Kick-off Meeting and Training

AGENDA 01 NOV 05		
ITEM	TIME	SUBJECT
I	0830 - 0945	Set-up
II	0945 - 1000	COFFEE BREAK
III		Intro by Sponsor
IV		CapDEM TD
V		BETA Evaluation Plan
VI		BETA Kick-Off
		a. Team Presentation
		b. Capability Goal
		c. BETA Objectives
		d. CEP Instance Objectives
		e. WBS
		f. Schedule
		g. Next Steps
		h. Pitch to "soft" Stakeholders
VII		Q&A
VIII	1130 - 1200	Sub-Team Meeting
IX	1200 - 1315	LUNCH
X	1315 - 1345	CEP Overview
XI	1345 - 1415	CET Overview
XII	1415 - 1430	COFFEE BREAK
XIII	1430 - 1615	Team Dynamics
XIV	1615 - 1630	Wrap-up; Setting the Scene for Days 2/3
AGENDA 02 NOV 05		
XV	0900 - 1200	CEP Training Session I
		LUNCH
XVI	1330 - 1600	CEP Training Session II
AGENDA 03 NOV 05		
XVII	0900 - 1200	Livelihood Training
XVIII	1200 - 1300	LUNCH
XIX	1300 - 1600	CORE Familiarization
XX	1600 - 1700	Wrap-up

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
EMP	Engineering Management Plan
NWP	Northwest Passage
IT	Information Technology
PM	Project Manager
PRICIE	Personnel, Research, Infrastructure & Organization; Concepts, Doctrine and Collective Training; IT Infrastructure; Equipment, Supplies and Services
SME	Subject Matter Expert
SoS	System of Systems
TD	Technology Demonstrator
VTC	Video Teleconference

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Exercise Beta is intended to be a complete functional test and evaluation of the Collaborative Capability Definition, Engineering and Management (CapDEM) approach. The primary goal of this iteration is to test and evaluate the CapDEM approach via an instance based on a realistic problem. The intent is to ensure that the necessary people, process and materiel can address a “real world” problem, while still running the exercise in a semi-controlled environment. This report summarizes the results of Exercise Beta, the second evaluation exercise undertaken to evaluate the three fundamental axes that compose the Capability Engineering (CE) construct (i.e., People, Process and Materiel). This exercise aims to do a complete functional test of the CapDEM axes based on a realistic use case. It shifts emphasis from debugging the evaluation methodology towards the core of the problem and CapDEM’s ability to meet the client’s needs. As a transitional exercise, Exercise Beta allows a gradual, controlled growth from one exercise to another, facilitating increased credibility in the evaluation team and its strategy along with the ability to more definitively examine the issue of scalability in the application of the CapDEM axes. As a result, this report outlines the results of focus groups that were carried out throughout the exercise. Discussions and recommendations for the way ahead are put forward to better understand and prepare the strategic direction of the final exercise, Exercise Gamma.

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CapDEM, Capability Engineering, Capability-Based Planning, CBP, Evaluation Strategy, Exercise Beta, Capability Engineering Team, CET, Capability Engineering Process, CEP, Collaborative Engineering Environment, CEE

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