Defence Research and Development Canada
Recherche et développement pour la défense Canada

DEFENCE R&D DÉFENSE

CapDEM Exercise Gamma

Results and Discussion

Wayne Robbins, Barbara Waruszynski, Claire Lalancette,
Michel Lizotte and Christophe Nécaille

Defence R&D Canada – Ottawa

Technical Report
DRDC Ottawa TR 2011-044
June 2011

Canada

CapDEM Exercise Gamma

Results and Discussion

CapDEM Evaluation Team

Wayne Robbins
Barbara Waruszynski
DRDC Ottawa

Claire Lalancette
Michel Lizotte
Christophe Nécaille
DRDC Valcartier

Defence R&D Canada – Ottawa

Technical Report
DRDC Ottawa TR 2011-044
June 2011

Principal Author

Original signed by Wayne Robbins

Wayne Robbins

Defence Scientist

Approved by

Original signed by Julie Tremblay-Lutter

Julie Tremblay-Lutter

SH/Capabilities for Asymmetric and Radiological Defence and Simulation Section

Approved for release by

Original signed by Chris McMillan

Chris McMillan

Chair, Document Review Panel

This report documents work conducted between summers 2006 and 2007 under the auspices of the CapDEM TDP.

Abstract

Exercise Gamma was designed to be a complete third-party test and evaluation of the Collaborative Capability Definition, Engineering and Management (CapDEM) approach. The primary goal of this final iteration of the CapDEM Evaluation Strategy was to test and evaluate the CapDEM approach using a 'real problem' based on a departmentally-defined scenario and executed by a team composed of DND/CF members. The intent was to validate the necessary people, process and materiel to address a 'real problem' while still enabling the observation and study of its application within an increasingly operational-like environment. As the third and final exercise, Exercise Gamma was the largest and most ambitious of the evaluation efforts, the result of gradual, controlled growth from one exercise to another, benefiting from the accumulated experience of the evaluation team along with its validated evaluation strategy. The exercise shifted away from incrementally controlled experimentation towards the reality of actual departmental clients applying Capability Engineering and CapDEM's ability to meet those needs. Accordingly, this report summarizes the results of Exercise Gamma which was undertaken to evaluate the three fundamental axes that compose the Capability Engineering (CE) construct (i.e., People, Process and Materiel). Specifically, the report outlines the conduct of Exercise Gamma, the results of observations and focus groups that were conducted throughout the exercise, and provides discussion and recommendations to consider in terms of the potential institutionalization of the CapDEM approach within the department.

Résumé

L'exercice *Gamma* a été conçu pour être une épreuve et une évaluation tout à fait indépendante de l'approche axée sur la définition, l'ingénierie et la gestion collaboratives des capacités (DIGCap). L'objectif principal de ce dernier volet de la Stratégie d'évaluation de l'approche DIGCap consistait à mettre à l'essai et à évaluer cette dernière à l'aide d'un « problème réel » fondé sur un scénario défini par le Ministère, l'approche étant alors mise en œuvre par une équipe composée de membres du MDN et des FC. L'intention était de valider les personnes, le processus et le matériel nécessaires pour s'attaquer à un « problème réel », tout en permettant l'observation et l'étude de l'application du processus dans un contexte à caractère de plus en plus opérationnel. En tant que le troisième et dernier exercice, l'exercice *Gamma* a été le plus vaste et le plus ambitieux de tous les efforts d'évaluation; il résultait de la croissance graduelle et contrôlée s'étant produite d'un exercice à l'autre et il a bénéficié de l'expérience cumulative acquise par l'équipe d'évaluation et de sa stratégie d'évaluation validée. L'Exercice s'est éloigné des expériences progressivement contrôlées pour évoluer vers la réalité de véritables clients ministériels, en appliquant l'ingénierie des capacités et l'outil DIGCap pour répondre aux besoins de ces derniers. Par conséquent, le présent rapport résume les résultats de l'exercice *Gamma*, qui a été entrepris pour évaluer les trois axes fondamentaux du concept structurel de l'ingénierie des capacités (IC) : les personnes, le processus et le matériel. Le rapport décrit l'exécution de l'exercice *Gamma* et les résultats des observations faites pendant l'Exercice et des interventions des groupes témoins; il offre une discussion et des recommandations à étudier relativement à l'institutionnalisation éventuelle de l'approche DIGCap au sein du Ministère.

This page intentionally left blank.

Executive summary

CapDEM Exercise Gamma: Results and Discussion

Wayne Robbins; Barbara Waruszynski; Claire Lalancette; Michel Lizotte; Christophe Nécaille; DRDC Ottawa TR 2011-044; Defence R&D Canada – Ottawa; June 2011.

INTRODUCTION

Exercise Gamma was intended to be a complete third-party test and evaluation of the Collaborative Capability Definition, Engineering and Management (CapDEM) approach. The primary goal of this final iteration of the CapDEM Evaluation Strategy was to test and evaluate the CapDEM approach as applied by a team composed of DND/CF members on their own 'real problem' based on a departmentally-defined scenario. The intent was to validate the necessary people, process and materiel to address a 'real problem' while still enabling the observation and study of its application within an increasingly operational-like environment. Doing so involved capturing the experience of an external group applying the process, as well as assessing its readiness and those issues impacting its application.

Exercise Gamma was the largest and most ambitious of the evaluation efforts, the result of gradual, controlled growth from one exercise to another, benefiting from the accumulated experience of the evaluation team along with its validated evaluation strategy. It shifted away from incrementally controlled experimentation towards the reality of actual departmental clients applying Capability Engineering and CapDEM's ability to meet those needs.

RESULTS

This report summarizes the results of Exercise Gamma, the third and final evaluation exercise undertaken to evaluate the three fundamental axes that compose the Capability Engineering (CE) construct (i.e., People, Process and Materiel). As a complete third-party test and evaluation, it shifted emphasis from an 'internal team' using CapDEM towards the reality of external groups using the CapDEM approach to address their own problem by themselves.

The results of Exercise Gamma were obtained from a combination of various focus groups as well as observations of the Capability Engineering Team (CET) as they applied the Capability Engineering Process (CEP) using the Collaborative Engineering Environment (CEE). In terms of each axis, a synopsis of Exercise Gamma's results and recommendations is as follows:

– PEOPLE AXIS

Mandate use of the team charter. To maintain a cohesive and functional CET with an effective understanding and fulfillment of its roles by the appropriate individuals, there must be a more defined link between the team charter and the day-to-day governance and functioning of the CET. There needs to be less dependency on team volition to use the charter as a practical and authoritative guide, and not just use it as an ancillary reference for the alignment of roles and individuals to specific parts of the process (CEP) as well as the technological environment (CEE).

Utilize appropriately designated and dedicated personnel. The CET must be composed of suitably skilled and interested individuals who are appropriately available and in sufficient number according to the requirements of the CE effort. Participating individuals need to be dedicated to the CET and not divided between multiple jobs as part of ensuring consistent availability and fewer conflicts in terms of time and accessibility. Aptitude, expertise, availability and appropriate role assignments are key elements of a successful CET.

Integrate expertise within the CET. The CET needs to have resident expertise not only on the problem space being addressed, but also in terms of the CE construct. Knowledge of both of the CEP and the CEE would help members see the 'big picture' of the effort, including how the parts fit together and how they aid in the performance of various tasks.

Constructively manage CET roles. The roles on the CET must be managed in a concerted, clear and transparent manner. That is, the CET must not be left to flounder or its structure be changed in an ad hoc fashion. To ensure cohesive CET behaviour, it is important not to create confusing functional overlap (i.e., ensure well-delineated responsibilities) or distract members through interpersonal issues (e.g., 'turf war') that can have adverse effects on collaboration and team dynamics. It is also important to clarify the purpose and alignment of support roles as part of facilitating good working relationships, embedding of expertise and providing appropriate inter-role linkage (including the knowledge of 'who to go to'). The selection and availability of skilled leadership is also fundamental.

Increase and clarify alignment between CEE and CET. Exercise Gamma illustrated the need for a more effective bridging between the People and Materiel axes. An improved alignment between the CEE and CET is central to achieving increased self-sufficiency and higher productivity, both as a team and as individual members. Specifically, increased self-confidence with the technology would enable the CET to effectively and assuredly use and explore novel application of the CEE. Consequently, they would be able to function more independently, rather than disrupt their workflow by requiring continuous interaction with outside expertise. Further, the performance of individual team members can influence interactions amongst the rest of the CET, thus impacting team dynamics and consequently, the efficacy of their teamwork and collaboration.

– PROCESS AXIS

Formalize identifiable linkages between CEP and CBP. Despite their existence, the linkages between Capability-Based Planning (CBP) and the CEP were not easily identified by the CET members. As a result, the CET was apprehensive in terms of how to proceed in a coordinated manner that respected both processes. Future CEP versions must formalize such linkages and make them more easily identifiable; indeed, when the development and utilization of the process are under the purview of a single organization (i.e., Chief of Force Development (CFD)), such synchronization will become more straightforward.

Clarify CEP lifecycle and progression. Key aspects of the CEP, such as its iterative, incremental and multi-stage design, were difficult for CET to understand; specifically, confusion between the aspects and how they related to each other was encountered. Clarity of the CEP lifecycle, including the relationship and progression between the above aspects of the CEP must

be more clearly communicated. In the broadest sense, the CET needs a clear understanding as how to execute, manage and understand stages in an iterative and incremental manner.

Provide alternative CEP specifications. There was general consensus that the provision of complementary specifications for the CEP, specifically the use of deliverable-centric and task-centric methods, would foster greater understanding and acceptance of the process. A key challenge of such a dual-pronged approach will be to maintain coordination and consistency between them.

Ensure workflow independence. Workflows should be specified suitably orthogonal to (i.e., independently of) the specific problem and technical environment. However, they must be linked in an illustrative (normative) manner to the CEE to better enable CET understanding.

Clarify CEP and CEE linkage relative to information management practices. The linkage and mutual influence amongst information modelling, tool input and output, process input and output (i.e., deliverables) and their relative specification needs considerable attention and forethought. Facilitating productive application of the CEE and the CEP through the effective use of information management requires the use of well-founded information structuring and management principles. Further, such principles will serve as the basis for well-principled and well-informed exploration of said structuring, versus potentially negative side effects resulting from misinformed, ad hoc changes.

Investigate deliverable benchmarking and applicability to decision making. The merit of creating benchmarks for deliverable completion and how to provide guidance in support of such benchmarking remain open questions. The CET was able to illustrate the potential of architectures and capability engineering within the force development process; however, they were not able to make solid conclusions about their applicability within the decision process.

Follow the process and accept its variability. There has been and will always be natural variance in the conduct of the CEP, in part due to its descriptive rather than prescriptive specification. While the amount of variance in Exercise Gamma was regarded as atypical based on issues of process maturity and practitioner experience, going forward it will be important to properly control process evolution during its application (i.e., avoid utilizing multiple versions of the process within a single instance). It will also be important to limit premature workflow customization as part of avoiding unnecessary divergence from recommended practices.

– MATERIEL AXIS

Ensure reliable infrastructure provisioning and management. The use of multiple and independently managed networking and computing infrastructures was an unremitting source of user difficulties and technical challenges, which grew relative to the number of participants and the increased breadth of organizations represented. Typical difficulties included unplanned and/or unannounced network policy changes that adversely affected the remote use of tools outside of the host network. The consolidation of work efforts (i.e., use of the CEE) on the host network would eliminate many of the cross-network issues. While external access remains desirable, the variety and configuration of access points needs to be limited and well-controlled as a matter of pragmatism. Any such changes would also require further consideration in terms of security and classification. Indeed, short of providing cross-infrastructure service level

agreements, the unified existence, application, management and support of the CEE on a single network infrastructure merits thorough consideration.

Investigate requirements and alternatives for secure distributed collaboration using non-homogenous environments. A means to enable and support different internal and external configurations of the classified CEE requires further study, including both technical and security/classification issues. While the value of such functionality is likely to markedly increase as CEE use becomes commonplace, the viability and provision of external access remains a substantive challenge, both technically and in terms of regulatory and policy issues.

Increase focus, expertise and alignment in terms of information management and associated technological capability. There were considerable challenges in providing a clear, flexible, extensible, scalable, comprehensive and understandable means to use, link and describe information that was amenable to CET usage, CEP application and CEE representation. Specifically, issues of conceptual understanding and pragmatics of implementation were problematic. Underlying the situation was a lack of suitable CET expertise, Subject Matter Expert (SME) availability and a variety of technical and operational issues. Ultimately, there was (and will increasingly be) a need to shift towards the use of composable (and conceptually interoperable) information architectures.

Facilitate workflow independence. As part of facilitating learning and providing a baseline for initial use, workflows must be linked in an illustrative (normative) manner to the CEE; however, such linkages must be done so as to avoid unnecessarily restrictive limits or dependencies on the axes as they mature and change over time. That is, the decoupling of logical (process) vs. physical (technological) workflows creates a more adaptable way to repurpose and realign the 'what' from the 'how' in a more granular (and therefore flexible) way. Indeed, the move towards composability and conceptual interoperability necessitates that workflows be specified in a suitably orthogonal manner to (i.e., independently of) a specific problem and technical environment. Facilitating workflow independence from a CEE perspective is also a necessary complement to realize process-centric workflow independence.

Increase support for interfaces to external processes. As part of achieving clearer linkage between the CEP to external processes, there is a need to investigate the technological requirements and implications of linking CEE systems to those used by external processes. That is, this issue speaks to the need for technological support along the CEP interface to other departmental processes. In working towards this capability, clearer identification of relevant organizations, processes and systems will need to be provided, along with the consideration of issues such as representation, compatibility, security and access (e.g., permissions).

Clarify CEE support for information management practices. Appropriate structuring and use of information management principles in terms of the CEE need to be applied at the interface between axes as part of providing a composable interface. Considerable forethought will be required to facilitate productive process application given the confluence of information modelling, tool input and output, process input and output and their use relative to each other. Indeed, to avoid only superficial interaction between information management practices and the technological environment, well-founded information structuring and management principles need to be applied and serve as the basis for well-principled application of the CEE.

Increase and clarify alignment between CEE and other axes. Ensuring appropriate application of the CEE by the CET is a key element of their ability to function independently and with fewer workflow disruptions. Consequently, ensuring appropriate technical propensity along with a balance of technology cohesion and delineation would be part of achieving clear alignment to, and effective usage of, the CEE. Such clarity would reduce the potential of inappropriate technology application, and help focus the CET relative to useful and forward-looking technologies. In as much as the above issues can impact the performance of individual members, it can transitively impact team dynamics, and therefore the efficacy of their teamwork. Consequently, the broader engineering effort could then be significantly affected, either positively or negatively.

Integrate CEE expertise within the CET. The availability of CEE expertise within the CET is useful both as part of addressing tool application and information management issues but also to facilitate awareness of potential application, advocacy of suitable usage and/or which pitfalls to avoid (i.e., to provide mentorship and coaching). Complementary resident expertise in terms of the CE construct would aid in creating a holistic understanding and reduce the potential for technological silos (for example, knowledge of particular software but a lack of awareness in terms of its implications within the broader technological environment and the engineering effort itself).

Promote increased understanding and usability. The themes of understanding and usability underlined many of the issues that affected CEE use. In particular, how particular tools should be used both individually and in conjunction with each other had significant impact on the CET members' work efforts. By addressing the issues of expertise integration and improved clarity/alignment, individual members can be more focused, which will also facilitate the provision of training, mentoring and coaching, along with a stronger ability to target problematic areas in terms of technical support and CEE evolution.

Expand technology and associated capability base. There is an ongoing need to explore alternative and developing technologies as part of providing an innovative and creative collaborative engineering environment. Such a 'technology watch' will prove essential in addressing the advancing technological landscape in conjunction with the changing breadth and depth of tool functionality, the evolving needs of the department and a growing, more capable user base.

SIGNIFICANCE

As the final exercise, Exercise Gamma was the culmination of 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 application of the CapDEM approach outside of the Technology Demonstration Programme (TDP) will be well served by the veracity of Exercise Gamma as well as the comparison across the whole series of evaluation exercises.

FUTURE PLANS

The strategic intent of Exercise Gamma was to understand and assess the issues and implications of utilizing Capability Engineering in an external context, specifically by identifying those outstanding issues that could impact its way forward. This final exercise was intended to serve as the basis for further evolution and application of the CapDEM approach as it becomes transitioned to the larger department through the force development community. 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 evolution and integration of the approach into departmental practices will be well-served by additional and incremental application and experimentation in a variety of circumstances. Notably, to effectively enable institutionalization, the creation of specially trained 'CE officers' is proposed to facilitate the practice of Capability Engineering 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.

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 Gamma's analytical products were well received by the exercise participants as well as its sponsors which represented key organizations related to the eventual institutionalization of the CapDEM approach. Exercise Gamma can therefore be regarded as a positive step in bridging the transition of Capability Engineering from its research and development roots to exploitation by the force development community.

Sommaire

CapDEM Exercise Gamma: Results and Discussion

Wayne Robbins; Barbara Waruszynski; Claire Lalancette; Michel Lizotte; Christophe Nécaille; DRDC Ottawa TR 2011-044; R & D pour la défense Canada – Ottawa; Juin 2011.

INTRODUCTION

L'exercice *Gamma* a été conçu pour être une épreuve et une évaluation tout à fait indépendantes de l'approche axée sur la définition, l'ingénierie et la gestion collaboratives des capacités (DIGCap). L'objectif principal de ce dernier volet de la Stratégie d'évaluation de l'approche DIGCap consistait à mettre à l'essai et à évaluer cette dernière à l'aide d'un « problème réel » fondé sur un scénario défini par le Ministère, l'approche étant alors mise en œuvre par une équipe composée de membres du MDN et des FC. L'intention était de valider les personnes, le processus et le matériel nécessaires pour s'attaquer à un « problème réel », tout en permettant l'observation et l'étude de l'application du processus dans un contexte à caractère de plus en plus opérationnel. Pour ce faire, il a fallu recueillir les expériences d'un groupe de l'extérieur appliquant le processus et évaluer son état de préparation et les questions influant sur son application.

L'exercice *Gamma* a été le plus vaste et le plus ambitieux de tous les efforts d'évaluation; il résultait de la croissance graduelle et contrôlée s'étant produite d'un exercice à l'autre et il a bénéficié de l'expérience cumulative acquise par l'équipe d'évaluation et de sa stratégie d'évaluation validée. L'Exercice s'est éloigné des expériences progressivement contrôlées pour évoluer vers la réalité de véritables clients ministériels, en appliquant l'ingénierie des capacités et l'outil DIGCap pour répondre aux besoins de ces derniers.

RÉSULTATS

Le présent rapport résume les résultats de l'exercice *Gamma*, troisième exercice entrepris pour évaluer les trois axes fondamentaux du concept structurel de l'ingénierie des capacités (IC) : les personnes, le processus et le matériel. En tant qu'épreuve et évaluation tout à fait indépendantes, l'Exercice a moins mis l'accent sur une « équipe interne » utilisant l'approche DIGCap et il a plutôt favorisé la réalité des groupes de l'extérieur recourant à l'approche pour régler eux-mêmes leurs propres problèmes.

Pour obtenir les résultats de l'exercice *Gamma*, nous avons eu recours à des groupes témoins et à des observations faites par l'Équipe d'ingénierie des capacités (EIC) tandis qu'elle appliquait le processus d'ingénierie des capacités (PIC) à l'aide de l'environnement d'ingénierie des capacités (EnvIC). Voici un résumé des résultats de l'Exercice et des recommandations formulées à l'issue de ce dernier, relativement à chacun des axes :

– L'AXE DES PERSONNES

Utilisation obligatoire de la charte d'équipe. Afin de conserver à l'EIC sa cohésion et sa fonctionnalité et d'amener les personnes concernées à comprendre efficacement ses rôles et à bien les remplir, il doit y avoir un lien plus défini entre la charte d'équipe, d'une part, et, d'autre part, la régie et le fonctionnement quotidiens de l'EIC. L'équipe doit être plus encline à utiliser la charte à titre de guide pratique faisant autorité, plutôt que comme un ouvrage de référence auxiliaire, pour ce qui est d'aligner les rôles et les personnes sur des éléments particuliers du processus (PIC) et sur l'environnement technologique (EnvIC).

Employer un personnel dévoué et bien choisi. L'EIC doit se composer de personnes intéressées par le projet et possédant les compétences voulues; elles doivent être suffisamment disponibles et nombreuses, tout dépendant des exigences de l'effort à déployer en matière d'IC. Les participants doivent se consacrer entièrement à l'EIC, au lieu de se diviser entre de multiples tâches, de manière à garantir une disponibilité constante et à réduire le nombre de conflits d'horaire et d'accessibilité. Les aptitudes, les compétences, la disponibilité et l'attribution judicieuse des rôles, voilà autant d'éléments clés dont dépend le succès de l'EIC.

Intégrer les compétences dans l'EIC. L'EIC a besoin de posséder en son sein des connaissances non seulement sur l'espace faisant problème mais aussi sur le concept structurel d'IC. La connaissance du PIC et de l'EnvIC aiderait les membres à voir l'ensemble de la situation, y compris comment les éléments s'agencent entre eux, et elle favoriserait l'exécution des diverses tâches.

Gérer d'une façon constructive les rôles de l'EIC. Les rôles de l'EIC doivent être gérés d'une façon concertée, claire et transparente. En d'autres mots, il ne faut pas laisser l'EIC errer au hasard ou modifier sa structure de façon aléatoire. Afin d'assurer la cohésion de l'EIC dans son comportement, il importe de n'engendrer aucun recoupement fonctionnel prêtant à confusion (veiller à ce que les responsabilités soient bien définies) et de veiller à ce que les membres ne soient pas distraits par des conflits interpersonnels risquant d'avoir des effets nuisibles sur la collaboration et la dynamique collective. Il importe aussi de clarifier le but et l'alignement des rôles de soutien afin de faciliter les bonnes relations de travail, l'intégration des compétences et l'établissement de liens utiles entre les rôles (notamment, connaître les relations hiérarchiques). En outre, il est fondamental de choisir des chefs compétents et accessibles.

Accroître et clarifier l'alignement entre l'EnvIC et l'EIC. L'exercice *Gamma* a montré la nécessité d'établir un lien plus efficace entre les axes « Personnes » et « Matériel ». Un meilleur alignement entre l'EnvIC et l'EIC est essentiel afin de favoriser un accroissement de l'autonomie et de la productivité de l'équipe et de ses membres. Plus précisément, si l'EIC se sentait plus sûre d'elle-même sur le plan technologique, elle pourrait mieux utiliser et explorer des applications novatrices de l'EnvIC. Par conséquent, les membres pourraient fonctionner avec plus d'indépendance, au lieu de bouleverser leur cadence de travail en devant recourir constamment à des experts de l'extérieur. En outre, le rendement de membres individuels de l'équipe peut influer sur les rapports entre les autres, ce qui a des conséquences pour la dynamique collective et, partant, pour l'efficacité du travail d'équipe et de la collaboration.

– L'AXE DU PROCESSUS

Régulariser des liens identifiables entre la PFC et le PIC. Malgré leur existence, les liens entre la planification fondée sur les capacités (PFC) et le PIC n'ont pas été repérés facilement par les membres de l'EIC. Par conséquent, celle-ci ne savait pas trop comment coordonner les choses d'une façon qui respecterait les deux processus. À l'avenir, les versions du PIC devront régulariser ces liens et les rendre plus faciles à repérer; en fait, quand la mise au point et l'utilisation d'un tel processus relèveront d'une seule organisation [p. ex., le Chef – Développement des Forces (CDF)], pareille synchronisation deviendra plus directe.

Clarifier le cycle de vie et la progression du PIC. L'EIC a eu du mal à comprendre certains aspects du PIC, tels que sa conception itérative, progressive et à stades multiples; plus précisément, elle a eu de la difficulté à faire la distinction entre les aspects et la façon dont ils se rapportent l'un à l'autre. Il importe de mieux expliquer le cycle de vie du PIC, y compris la relation entre les aspects susmentionnés et la progression de l'un à l'autre. Au sens le plus large, l'EIC doit comprendre clairement comment exécuter, gérer et franchir les stades d'une façon itérative et progressive.

Fournir des spécifications de rechange pour le PIC. Tous s'entendaient pour dire que des spécifications complémentaires pour le PIC, en particulier l'utilisation de méthodes axées sur les résultats attendus et sur les tâches, accroîtrait la compréhension et l'acceptation du processus. Le défi principal d'une telle démarche à deux axes consistera à conserver la coordination et l'uniformité entre les deux.

Assurer l'indépendance des flux de travail. Il faut définir les flux de travail d'une façon qui se rapporte directement au problème particulier et à l'environnement technique. Cependant, ils doivent être liés d'une façon indicative (normative) à l'EnvIC afin de favoriser davantage la compréhension des choses par l'EIC.

Clarifier les liens entre le PIC et l'EnvIC par rapport aux pratiques de gestion. Les rapports et l'influence mutuelle observés entre les modèles d'information, les outils fournis et produits, les intrants et les extrants des processus (ex. : résultats escomptés) et leurs spécifications relatives nécessitent une attention considérable et une réflexion approfondie. Afin de faciliter l'application productive de l'EnvIC et du PIC par le biais de l'utilisation efficace de la gestion de l'information, il faut employer des principes solides de gestion et de structuration de l'information. En outre, ces principes serviront de base à l'exploration réfléchie et judicieuse des structures en question, ce qui évitera les effets secondaires éventuels que produiraient des changements ponctuels axés sur des renseignements erronés.

Mener des recherches sur les critères d'évaluation des résultats escomptés et sur leur applicabilité au processus décisionnel. Le mérite qu'il y a à créer des points de référence quant à l'obtention des résultats escomptés et la question de savoir comment fournir des paramètres guides pour appuyer l'adoption de ces points de référence demeurent des thèmes que l'on continue de débattre. L'EIC a pu faire voir le potentiel des architectures et de l'ingénierie des capacités au sein du processus de développement des forces, mais elle n'a pas réussi à formuler des conclusions solides sur leur applicabilité dans le processus décisionnel.

Suivre le processus et accepter sa variabilité. L'application du PIC a toujours comporté et comportera toujours une variance naturelle, notamment à cause de la spécification descriptive plutôt que normative du processus. L'ampleur de la variance dans l'exercice *Gamma* a été considérée comme étant atypique, compte tenu de la maturité du processus et de l'expérience des praticiens, mais à l'avenir, il importera de contrôler convenablement l'évolution du processus pendant son application (ex. : éviter d'employer de multiples versions du processus dans un seul et même cas). Il importera aussi de limiter l'adaptation prématurée des flux de travail pour éviter ainsi la divergence inutile par rapport aux pratiques recommandées.

– L'AXE DU MATERIEL

Assurer la gestion et la prestation de services d'infrastructure fiables. L'utilisation d'infrastructures de réseautage et de calcul multiples et gérées indépendamment a été une source constante de difficultés et de défis techniques pour les utilisateurs, difficultés et défis qui augmentaient en fonction du nombre de participants et de la taille des organisations représentées. Parmi les difficultés typiques, il y avait la suivante : des changements non planifiés et/ou non annoncés dans les politiques des réseaux, changements qui nuisaient à l'utilisation des outils en dehors du réseau hôte. Le regroupement des efforts (c'est-à-dire le recours à l'EnvIC) dans le réseau hôte éliminerait bon nombre des problèmes dus à la structure interréseaux. L'accès depuis l'extérieur demeure souhaitable, mais il faut limiter et contrôler judicieusement la variété et la configuration des points d'accès, pour des raisons pragmatiques. Afin d'opérer n'importe quel changement du genre, il faudrait aussi prendre en considération la sécurité et la classification. En effet, à moins d'établir des accords sur les niveaux de service applicables entre les diverses infrastructures, l'existence, l'application, la gestion et le soutien de l'EnvIC au sein d'une seule infrastructure de réseau méritent un examen approfondi.

Mener des recherches sur les besoins dans le domaine de la collaboration décentralisée et sécurisée avec des environnements non homogènes et sur les solutions de rechange à cet égard. Il faut étudier davantage un moyen de dynamiser et de soutenir des configurations internes et externes différentes de l'EnvIC classifié, y compris les questions techniques ou relatives à la sécurité/classification. Certes, la valeur d'une telle fonctionnalité augmentera sans doute à mesure que l'emploi de l'EnvIC deviendra plus courant, mais la viabilité et l'offre d'un accès de l'extérieur continuent de représenter un défi de taille sur le plan technique et du point de vue de la réglementation et des politiques.

Accroître le ciblage, l'expertise et l'alignement de la gestion de l'information et des capacités technologiques connexes. Fournir un moyen clair, souple, extensible, évolutif, complet et compréhensible pour utiliser, intégrer et décrire l'information se prêtant à l'utilisation par l'EIC, à l'application du PIC et à la représentation de l'EnvIC a comporté des défis de taille. Plus précisément, la compréhension des concepts et les aspects pragmatiques de la mise en œuvre ont fait problème. Il y avait aussi divers éléments sous-jacents : un manque d'expertise suffisante dans l'EIC, la disponibilité d'experts des questions abordées et toute une gamme de problèmes techniques et opérationnels. En fin de compte, on avait besoin (et ce besoin ira en augmentant) de passer à l'utilisation d'architectures de l'information composables (et interopérables sur le plan conceptuel).

Faciliter l'indépendance des flux de travail. Afin de faciliter l'apprentissage et d'établir un point de référence pour l'utilisation initiale des flux de travail, il faut créer des liens indicatifs

(normatifs) entre eux et l'EnvIC; cependant, il faut le faire d'une manière qui évitera les limites inutilement contraignantes ou les dépendances par rapport aux axes à mesure qu'ils prendront de la maturité et qu'ils évolueront avec le temps. En d'autres mots, le découplage des flux logiques (processus) et physiques (technologiques) favorise avec plus d'adaptabilité l'isolement du « quoi » par rapport au « comment » et permet de lui donner un nouveau but au sein de petits groupes (et, partant, accroître la souplesse du processus). En effet, pour passer à une composition intéressante et à l'interopérabilité conceptuelle, il faut que les flux de travail soient définis directement et indépendamment par rapport à un problème particulier et à un environnement technique. Il faut également faciliter l'indépendance des flux de travail par rapport à l'EnvIC, afin de faire complément à l'indépendance des flux de travail axés sur les processus.

Soutenir davantage les interfaces avec les processus extérieurs. Afin de clarifier davantage les liens entre le PIC et les processus extérieurs, il importe d'analyser les exigences technologiques et les conséquences de l'établissement de liens entre les systèmes de l'EnvIC et ceux employés par les processus extérieurs. Autrement dit, nous parlons ici de la nécessité d'un soutien technologique au profit de l'interface entre le PIC et d'autres processus ministériels. En travaillant vers la création de cette capacité, on devra désigner plus clairement les organisations, les processus et les systèmes concernés, tout en prenant en considération les questions de représentation, de compatibilité, de sécurité et d'accès (ex. : permissions).

Clarifier le soutien accordé par l'EnvIC aux pratiques de gestion de l'information. Il faut structurer et utiliser convenablement, à l'interface entre les axes, les principes de gestion de l'information relativement à l'EnvIC si l'on veut fournir une interface composable. Beaucoup de prévoyance s'imposera pour faciliter l'application productive des processus, étant donné la confluence des modèles d'information, des outils et des processus utilisés et produits et de leur emploi les uns par rapport aux autres. En effet, afin d'éviter une interaction superficielle entre les pratiques de gestion de l'information et l'environnement technologique, nous devrons appliquer de solides principes de structuration et de gestion de l'information et nous en servir comme d'un fondement pour l'application judicieuse de l'EnvIC.

Renforcer et clarifier l'alignement entre l'EnvIC et les autres axes. Il est essentiel de garantir l'application appropriée de l'EnvIC par les membres de l'EIC, pour que ceux-ci puissent fonctionner indépendamment et pour réduire le nombre de perturbations dans les flux de travail. Par conséquent, afin de réaliser un alignement clair sur l'EnvIC et l'utilisation efficace de ce dernier, il importerait de garantir la propension technique des participants ainsi qu'un équilibre entre la cohésion et le groupement des technologies. Pareille clarté réduirait l'éventualité d'une application impropre de la technologie et aiderait à orienter l'EIC vers les technologies utiles et tournées vers l'avenir. Dans la mesure où les questions susmentionnées peuvent influer sur le rendement des divers membres de l'Équipe, elles risquent aussi d'influer transitivement sur la dynamique de cette dernière et, partant, sur la qualité de son travail collectif. L'effort d'ingénierie global pourrait donc être touché lui aussi, soit positivement, soit négativement.

Intégrer l'expertise sur l'EnvIC dans l'EIC. La présence d'une expertise sur l'EnvIC dans l'EIC est utile pour s'attaquer aux questions relatives à l'application des outils et à la gestion de l'information et aussi pour faciliter la prise de conscience d'applications possibles, la mise en exergue d'utilisations appropriées et/ou la mise en garde contre les écueils à éviter (en d'autres mots, pour fournir un mentorat et un encadrement). Une expertise complémentaire présente sur place relativement au concept structurel de l'IC aiderait à créer une compréhension holistique et à

réduire l'apparition éventuelle d'un cloisonnement technologique (par exemple, la connaissance d'un logiciel donné, mais l'ignorance de ses implications dans l'environnement technologique global et au sein de l'effort d'ingénierie même).

Promouvoir la compréhension et l'utilité. Les thèmes de la compréhension et de l'utilité ont fait partie intégrante de bon nombre de questions relatives à l'application de l'EnvIC. En particulier, la façon dont des outils donnés devraient être employés individuellement et les uns avec les autres a eu un effet considérable sur les efforts des membres de l'EIC. En se penchant sur l'intégration de l'expertise et sur l'amélioration de la clarté et de l'alignement, on favorisera une meilleure concentration des efforts des membres de l'équipe, ce qui facilitera aussi la formation, le mentorat et l'encadrement ainsi qu'une capacité accrue de s'attaquer aux secteurs problématiques, quant au soutien technique et à l'évolution de l'EnvIC.

Élargir la base technologique et la gamme des capacités connexes. Il faut constamment explorer les technologies de rechange et celles qui sont en devenir afin de susciter un contexte de l'ingénierie novateur et créatif axé sur la collaboration. Une telle « veille technologique » s'avérera essentielle face à l'évolution du paysage technologique et de la fonctionnalité des outils, toujours plus large et profonde, aux besoins en devenir du Ministère et à l'accroissement du bassin d'utilisateurs et de leurs capacités.

IMPORTANCE

Comme l'exercice *Gamma* correspondait au dernier stade du projet, il a été le point culminant d'une croissance graduelle et contrôlée d'un stade à l'autre, ce qui a accru la crédibilité des membres de l'équipe d'évaluation et de sa stratégie ainsi que sa capacité d'examiner d'une façon plus définitive la question de l'extensibilité dans l'application des axes DIGCap. L'Exercice a permis de recueillir les opinions des utilisateurs (opérateurs) finaux et de parfaire ainsi chacun des axes grâce à l'application du concept structurel de l'ingénierie des capacités (IC), ce qui a favorisé l'amélioration continue du concept pendant sa mise au point. À l'avenir, l'application de la démarche DIGCap, en dehors du Programme de démonstration de technologies (PDT), profitera de la véracité de l'exercice *Gamma* et de la comparaison faite à tous les stades de la série des exercices d'évaluation.

PERSPECTIVES

Le but stratégique de l'exercice *Gamma* était de comprendre et d'évaluer les aspects et les conséquences de l'utilisation de l'ingénierie des capacités dans un contexte extérieur, plus précisément en cernant les problèmes non résolus qui risquaient d'influer sur sa progression. Cet exercice final visait à servir de fondement pour l'évolution et l'application futures de la démarche DIGCap, alors qu'elle fera une transition à l'ensemble du Ministère, par l'intermédiaire des milieux s'occupant du développement des Forces. Par conséquent, les discussions et les recommandations relatives à l'avenir se situent dans ce contexte.

Comme l'application de la systémique au niveau des capacités est nouvelle dans le Ministère, on aura avantage à faire d'autres applications et expériences graduelles dans des circonstances diverses pour faire évoluer la démarche et l'intégrer dans les pratiques du Ministère. En particulier, afin de favoriser efficacement l'institutionnalisation de la démarche, nous recommandons de créer des postes d'agents de l'IC et de leur fournir une formation spéciale;

ainsi, grâce à leurs connaissances et à leur expérience, ils faciliteront l'application de l'ingénierie des capacités. En outre, il faudra continuer d'améliorer la démarche axée sur l'IC, à mesure que celle-ci évoluera dans son créneau, dans les milieux du développement des Forces. Par ailleurs, chapeautant tous ces aspects, il y a le défi de la résistance des institutions au changement conjuguée à la difficulté d'obtenir un personnel compétent pouvant se consacrer à fond au travail à accomplir.

On ne saura pas au juste quels produits analytiques seront nécessaires pour la prise des décisions relatives aux capacités tant que les résultats d'une utilisation concrète n'auront pas été transposés dans le contexte de la mise en œuvre des capacités produites. Cependant, les produits analytiques de l'exercice *Gamma* ont été bien reçus par les participants et par les commanditaires qui représentaient des organismes clés ayant quelque chose à voir avec l'éventuelle institutionnalisation de l'approche DIGCap. On peut donc considérer que l'exercice *Gamma* a marqué le franchissement d'une étape dans la progression entre le stade de la recherche-développement en ingénierie des capacités et celui de l'exploitation de celle-ci par les milieux du développement des Forces.

This page intentionally left blank.

Table of contents

List of figures

List of tables

Acknowledgements

The Evaluation Team would like to thank the members of the CET for participating in Exercise Gamma. Their participation was fundamental to the test and evaluation of the CapDEM approach as applied to a 'real problem' in an actual operational context.

The Evaluation Team would also like to thank Jack Pagotto, Project Manager of the CapDEM TDP, for his assistance and support throughout the formulation and execution of the overall CapDEM Evaluation Strategy. We would specifically like to acknowledge Jack's pivotal role in the formulation of the Project Level Agreement and detailed work plan under which Exercise Gamma was conducted.

1 Introduction

Defence R&D Canada (DRDC) recently originated and investigated the Capability Engineering (CE) concept through a technology demonstration project called Collaborative Capability Definition, Engineering and Management (CapDEM). As part of this effort, a formal evaluation strategy for the approach was undertaken [1]. The strategy involved three exercises (Exercise Alpha, Exercise Beta and Exercise Gamma), each one applying the CapDEM approach with increasingly larger scale and complexity (see Section 2.1). The lessons learned were then used to improve and/or clarify the elements of the CapDEM approach, as well as to improve the evaluation methodology.

The scope of the three exercises can be described as follows:

- **Exercise Alpha** [2][3][4] was the initial effort to evaluate the interaction within the CapDEM approach. Based on a quasi-experimental approach and using a semi-controlled environment[1], this exercise was designed to be a 'proof-of-concept' trial in how to integrate and evaluate the interdependencies within the CapDEM approach. The primary goal was to 'debug' the evaluation methodology before proceeding with larger experimental subject groups in subsequent exercises.
- **Exercise Beta** [5][6][7] was intended to be a complete functional test and evaluation of CapDEM approach. Based on a realistic problem definition, Exercise Beta shifted emphasis from debugging the evaluation methodology towards the core of the problem and CapDEM's ability to meet client needs.
- **Exercise Gamma** [8][9] was intended to be a complete third-party functional test and evaluation of CapDEM approach. Based on a realistic problem definition, Exercise Gamma shifted emphasis towards external groups being able to address their own problem using the proposed approach.

This report presents the results of Exercise Gamma, which was conducted between October 2006 and May 2007. In contrast to previous exercises, Exercise Gamma was conducted under a Project Level Agreement (PLA) signed by three DND organizations, the purpose of which was to formally engage departmental clients (see [10] for additional perspective).

The remainder of this report is organized as follows: Chapter 2 briefly describes the CapDEM approach, the previous exercises as well as the goals, purpose and expected outcomes of Exercise Gamma. Chapter 3 then outlines the exercise results in terms of the general methodology, while Chapter 4 presents the results on a per axis basis. Chapter 5 provides discussion and analysis of the results while also putting forward recommendations in support of eventual institutionalization. Finally, Chapter 6 concludes with a summary of the exercise and how it fulfilled the intent of the overall evaluation strategy.

[1] The 'quasi-experimental approach' refers to the use of a number of proven experimental procedures, but not to the extent of strictly applying the scientific method, in terms of a separate control group and so forth. Similarly, the 'semi-controlled environment' refers to the use of pre-defined experimental environment, but one that was allowed to evolve to best support the effort going forward. Note that all exercises within the evaluation strategy were addressed in this way.

2 Background

This section provides a brief overview of the CapDEM approach, summarizing the previous exercises while illustrating the intent of Exercise Gamma.

2.1 The CapDEM Approach

In terms of structure, CapDEM was organized along three primary axes: People, Process and Materiel. Such organization provided a natural division for issues to be dealt with in terms of capabilities; accordingly, its principle output, Capability Engineering, is similarly structured. In short, the process defines the rules and methodologies by which the people apply their expertise, creativity and engineering knowledge, using the appropriate technology and tools to facilitate the development of the necessary capabilities. Each axis can be defined as follows:

- **People**: The Capability Engineering Team (CET) construct represents a central and fundamental element of organizational design for CapDEM (and Capability Engineering). The CET construct [11] 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 is then partnered with operational subject matter experts (SMEs) and liaison members from across the PRICIE[2] capability components.
- **Process:** The Capability Engineering Process (CEP) aims at providing decision makers with better information on strategic investment and divestment [12]. The CEP consists of a set of processes, roles and responsibilities, products and guidance that use systems engineering rigour to develop potential solutions to identified capability gaps. These potential solutions (i.e., Force Development Options) are developed using the five inter-linked processes shown as a system of gears in Figure 1. This figure also represents the incremental production of deliverables as through the continuous and dynamic interaction between the processes. As changes in one process may impact another, such an approach enables pruning of the solution space as soon as possible while focusing effort on worthwhile options as early as possible. The 'Manage Engineering Effort' process determines the speed of the gears with regard to available resources and constraint (e.g., a delivery date given by the decision makers). This process also controls the decision gates, the passage from one stage to the next (i.e., Inception, Comprehension, Elaboration and Completion) and the eventual termination of the whole effort.
- **Materiel**: The Collaborative Engineering Environment (CEE) [13] is a logical environment consisting of a set of tools and facilities that 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. Primarily based on commercially available tools and applications (i.e., COTS), the function of such an environment is to enable project stakeholders to have a common location and a

[2] PRICIE = Personnel; Research and Development; Infrastructure and Organization; Concepts, Doctrine and Collective Training; Information Management; Equipment, Supplies and Services.

common interface by which to access information, utilize specialized applications and communicate/collaborate with each other.

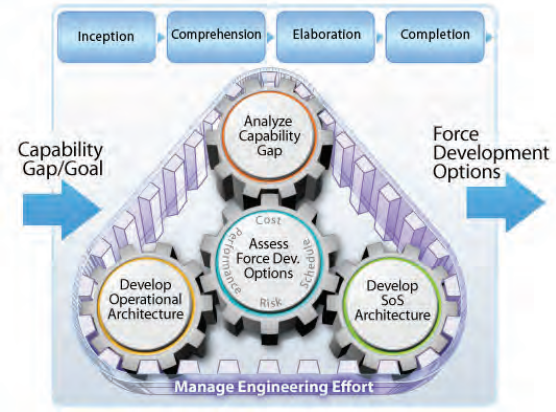


Figure 1: CEP v4 Dynamics

2.2 Exercise Alpha

Exercise Alpha [2][3][4] was conducted in spring 2005 with an abridged CET of five people. This exercise was designed to be a 'proof-of-concept' trial in how to integrate and evaluate the interdependencies of the three CapDEM axes. The primary goal was to 'debug' the evaluation methodology. The main lessons learned related to the areas of approach and methodology, (specifically relating to scenario selection), CET recruitment, role of the Evaluation Team, suitability of data collection techniques and training.

2.3 Exercise Beta

Exercise Beta [5][6][7] was conducted between September 2005 and February 2006. This exercise was conducted by a full CET consisting of DRDC personnel and contractors that were geographically distributed between DRDC Ottawa and DRDC Valcartier. The intent was to achieve a complete functional test and evaluation of the three CapDEM axes. Based on a realistic problem definition, Exercise Beta shifted emphasis from debugging the methodology towards addressing the reality of the problem space and CapDEM's ability to meet client needs. The main lessons learned from this exercise were in terms of the following themes: CET organization, interaction and dedication; assignment of operational and PRICIE representatives; CEP deliverable orientation and tools; CEE awareness and IT support; Evaluation Team role (coaching and advisory); and training.

2.4 Exercise Gamma

Exercise Gamma [8][9] was conducted between October 2006 and May 2007. The intent of the exercise was to execute a complete third-party functional test and evaluation of CapDEM approach. Based on a realistic problem definition, Exercise Gamma shifted emphasis towards external groups being able to address their problem using the proposed approach. As part of

addressing a client-based problem definition, Exercise Gamma was conducted under a Project Level Agreement (PLA) between three organizations: Chief Force Development (CFD), Chief of Staff Information Management (COS(IM) / ADM(IM)) and Defence R&D Canada (DRDC) [10]. This approach provided for the formal engagement of departmental clients and access to department staff for purposes of forming the CET. While such an approach was different from the initial design of Exercise Gamma [1], the objectives between the PLA and the original evaluation strategy were compatible. Table 2 presents a description of Exercise Gamma, summarizing goals, scope and expected outputs for each axis and the overall exercise.

Table 1: Exercise Gamma – Design Summary

Aspect		Description
Goals	**Overall**	• Test and evaluate the CET, CEP and CEE as applied to a realistic problem provided by an external client. • Ensure the necessary people, process and materiel can address a 'real world' problem when being executed by an appropriate real-world client group.
	People	• Test and evaluate the final iteration of the CET. • Put forward best practices and lessons learned for a comprehensive Team Charter, including the proper identification of roles and responsibilities, dynamic teamwork and collaboration practices, as well as effective team communication practices and mechanisms.
	Process	• Test and evaluate version 4 of the CEP, including its complete set of activities and deliverables.
	Materiel	• Test and evaluate the revised CEE. • Investigate and determine a reasonable list of functionalities (required, preferred and optional) for CEE institutionalization.
Scope	**Overall**	• Seven month duration. • 'Real world' scenario.
	People	• Complete team size. • DND clients from more than one organization.
	Process	• Complete each CEP v4 deliverable. • Complete each CEP v4 task and iterate as mandated by the process.
	Materiel	• Fully exploit CEE functionalities in performance of their tasks.

Outputs and Outcomes	**People**	• Complete the Team Charter, incorporating roles and responsibilities, as well as teamwork and collaboration principles for the CET. • Put forward recommended best practices for initiating a successful CET. • Link successful team dynamics with CEE (e.g., ACCESS Labs and Livelink) for enhanced communication practices.
	Process	• Ensure the CET clearly understands CEP processes. • Ensure the CET clearly understands CEP deliverables. • Identify documentation weaknesses (process and deliverable templates) to facilitate application during institutionalization within the DND/CF. • Identify training weaknesses to be addressed when providing future training to DND/CF personnel. • Identify metrics to measure and facilitate continuous improvement of the CEP. • Identify critical factors for successful implementation of the CEP.
	Materiel	• Provide a user-validated list of mandatory/preferred functionalities to fully enable the CEP and facilitate collaboration inside the CET. • Refine and validate the existing workflow between the various tools. • Provide an updated and expanded database of 'Frequently Asked Questions' (FAQ), 'Tips & Tricks' and lessons learned.

3 Approach and Methodology

Given the introduction to the CapDEM evaluation strategy, this section now overviews the approach and methodology applied during Exercise Gamma. As planned, a large number of the lessons learned from previous exercises (in particular, Exercise Beta) were applied towards the realization of Exercise Gamma; these include: modifying CET organization, adjusting and extending the training programme; employing an improved version of the CEP, and having the Evaluation Team attempt to be more proactive.

3.1 Data Gathering and Analysis

The approach to data analysis within Exercise Gamma remained almost identical to that employed in Beta Exercise, primarily focusing on common themes and issues. Table 2 summarizes the means and mechanisms used for data collection. Each of the means/mechanisms used had specific purposes while also contributing to the development of the focus group questionnaires. Observations, CET deliverables, issues and concerns as well as requests for help and coaching provided good sources of information from which to build more focused questions. As with Exercise Beta, the focus group became the principle and best source of data, as most of the information gathered through other means were validated with all the CET members during the focus group sessions. Hence, the themes and issues that are presented in the following sections of this report primarily stem from the focus group analysis.

Table 2: Data Collection Means and Mechanisms

Means	Purpose	Comment
CET Meeting Attendance	• Observe and collect information on the team's progress. • Suggest approaches to issues. • Answer questions.	One or more members of the Evaluation Team attended most meetings.
Individual Meetings	• Discuss a participant's concerns on an individual basis. • Provide advice to a participant on an individual basis.	On an ad hoc basis, as requested by a CET or an Evaluation Team member.
Gate Review Meeting	• Evaluate the content of the work produced at each stage.	Performed at the end of Inception and Comprehension stages.
Examine CET Deliverables	• Evaluate the content of the work produced at each stage.	Performed at the end of Inception, Comprehension and Completion stages.

Focus Group	• 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 Inception, Comprehension and Completion stages; also performed midway through the Comprehension stage.
Coaching and Help Requests	• Support to ensure the exercise would run smoothly. • Help identify any weaknesses in the CapDEM approach.	Adaptation of the 'Help Desk' concept from Exercise Beta; the coaching practices evolved over the duration of the exercise.

3.2 Work Plan

The exercise work plan [8] organized the entire effort into three main phases:

- **Preparation**: This phase consisted of 'pre-CET' activities to ensure participant readiness as well as to address any issues related to the scenario, training, evaluation or technical environment.
- **Experimentation**: This phase corresponded to the period in which the CET applied the CEP using the CEE. Thus, this phase aligned to the actual execution of the CapDEM approach.
- **Analysis**: This phase corresponded to the organization, examination and analysis of the feedback collected (i.e., the 'post-CET' phase).

Unlike previous exercises, the Evaluation Team did not strictly control the schedule for Exercise Gamma. Rather, the Evaluation Team proposed a timeline for CEP execution (i.e., dates for the various stages and iterations) in order to help meet the schedule (i.e., phases and deadlines) outlined in the PLA. The exercise's final timeline (i.e., that actually realized) is presented in Figure 2, illustrating both exercise phases and CEP stages. The dark bars correspond to Evaluation Team involvement while the light grey bars correspond to CET involvement.

As planned, the Experimentation Phase of Exercise Gamma started on 25 September 2006 and ended mid-May 2007, approximately 2-3 weeks later than anticipated. The main differences from the proposed timeline were:

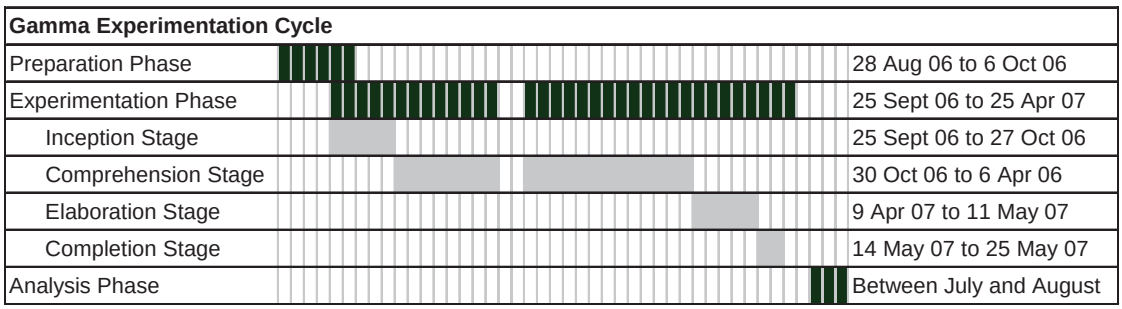


Figure 2: Gamma Experimentation Cycle

- The Comprehension Stage was much longer than expected. This stage lasted 21 weeks with only one iteration while the Evaluation Team had suggested 8 weeks with 2 iterations.
- The Elaboration Stage was much shorter than expected. This stage lasted 5 weeks with only one iteration while the Evaluation Team had suggested 13 weeks with 3 iterations.

Since the PLA governing the exercise specified a firm schedule, there was no ability to significantly extend the end date; hence, the extra time consumed during the Comprehension Stage came at the expense of the Elaboration Stage.

3.3 Capability Engineering Team

Exercise Gamma's initial organizational chart, as presented in the work plan and PLA, was never completely realized for the exercise. In spite of significant effort to obtain sufficient staffing, the roles of CET Coordinator, PRICIE and ECS Operational SMEs, as well as Industry Interface were not filled (Figure 3). A contractor did partially assume some of the tasks intended for the CET Coordinator, but only for a three month period. Additionally, the composition of the CET changed over the course of the exercise due to the retirement of the initial CET Lead. Subsequent changes included selecting the original Chief Operational Architect as the new CET Lead along with the use of a contractor to backfill the subsequently empty Chief Operational Architecture role. The final resulting CET organizational chart is shown in Figure 4.

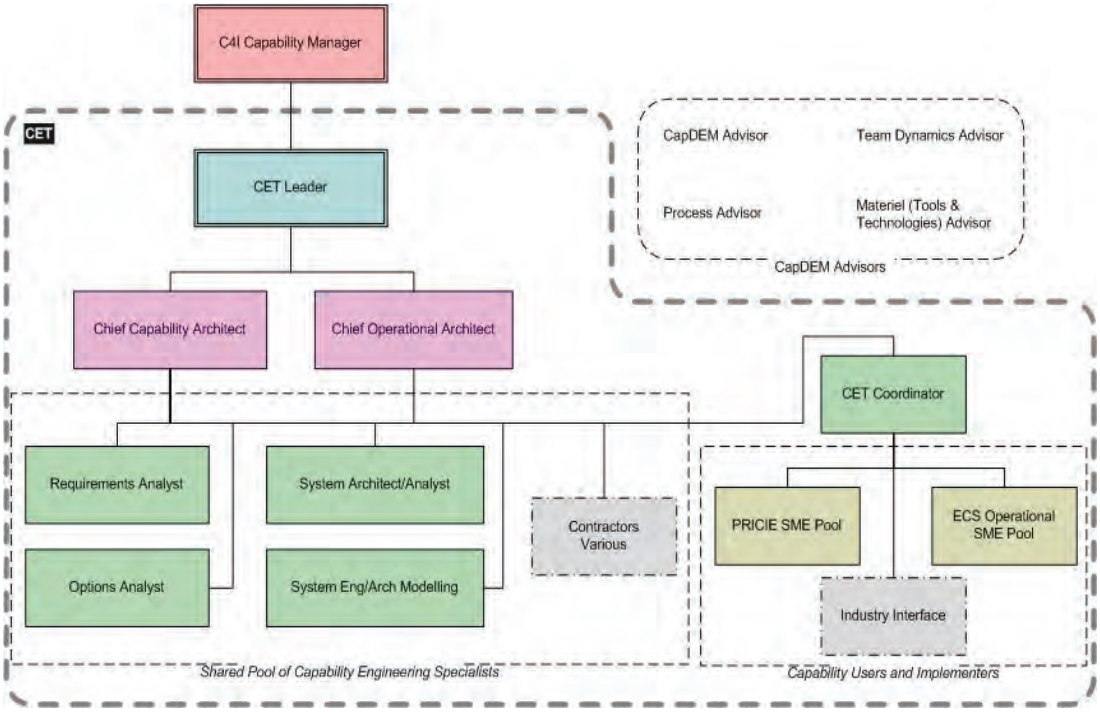


Figure 3: Intended Gamma Structure

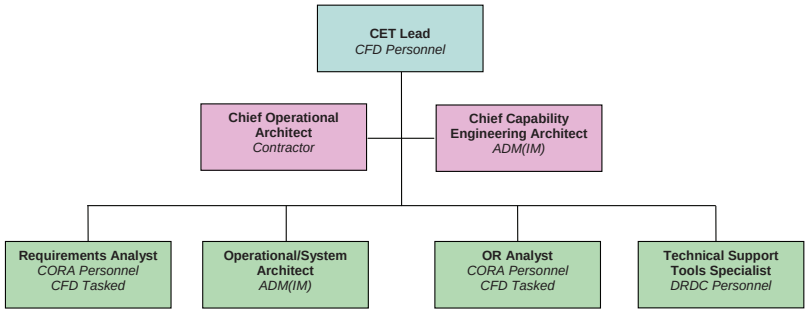


Figure 4: Final Gamma CET

3.4 Evaluation Team

The Evaluation Team was initially composed of five DRDC scientific and technical staff geographically distributed between Ottawa and Valcartier, each with a particular expertise relative to the CapDEM approach. Unlike most members of the CET, the majority of the Evaluation Team had experience with the previous CapDEM evaluation exercises, Exercise Alpha and Exercise Beta.

For Exercise Gamma, the main responsibilities for the Evaluation Team were as follows:

- 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
- Provide guidance to organize and plan CET activities
- Implement and follow-up on evaluation activities
- Report results

Unfortunately, due to a variety of circumstances, the Evaluation Team had to work with only four members for the majority of the exercise. Further, at some points there were only three Evaluation Team members available, thus leaving some axes without an advisor.

3.5 Scenario

For Exercise Gamma, scenario selection was performed by the exercise sponsor(s) as opposed to the Evaluation Team, as in previous CapDEM evaluation exercises. As such, it was chosen to meet a specific objective of the PLA: "to define C4+I[3] capability gaps and recommend Force Development options".

[3] The 'I' in C4+I represents 'Information' (versus C4I, in which 'I' stands for 'Intelligence').

The chosen capability domain of Command, Control, Communication, Computers and Information (i.e., C4+I) is a sub-element of the broader C4ISR domain. As the C4+I capability is applicable across many scenarios, the problem had to be further scoped. Hence, it was decided that the CET would develop C4+I options to contribute to a domestic humanitarian disaster response and relief effort as led by Public Safety and Emergency Preparedness Canada (PSEPC) in a 2015 timeframe.

3.6 Training

The initial Exercise Gamma work plan proposed a number of mandatory and optional training sessions to help the CET in their application of the CapDEM approach. A list of the mandatory training components given is listed in Table 3. However, three courses had to be cancelled:

- **CEE Overview and System Engineering Tool Synopsis**: The one-day training session which was to focus on Materiel axis considerations had to be cancelled due to the difficulty

Table 3: Training Summary

Date	Training	Description	Duration
14-15 September 2006	Architecture Framework Orientation	Familiarization on architectures and their application (including some hands-on practice)	2 days
18-20 September 2006	Livelink User Training	Introduction covering the various capabilities and day-to-day use of Livelink from the end-user perspective	2½ days
27-28 September 2006	CEP v4 Parts 1-2	Overview of the CEP and details on the Inception Stage	2 days
2 October 2006	Use Case Overview; Team Dynamics	Overview of use case, project charter and human dynamics (including an exercise to illustrate the value of team collaboration and communication)	½ day
30 October 2006	CEP v4 Part 3	Details on the Comprehension Stage	1 day
15-16 February 2007	CEP v4 Part 4	Details on the Elaboration Stage (including hands-on component)	2 days

in defining the specific CEE for Exercise Gamma, since the CORA ACCESS Lab and the associated system engineering tools were in the process of obtaining secret certification.

- **Overview/Tutorial on Phoenix Integration's Model Center**: The half-day course to overview this specific tool used for model analysis and optimization purposes was not held, due to a combination of logistical and resource issues. A familiarization briefing was substituted later in the exercise to help set the context for its use.
- **CEP v4 (Part 5)**: This portion of the CEP training (Completion Stage) was omitted due to time constraints and the relative importance of this stage vs. others in meeting the required objectives.

4 Results

This section presents the results from Exercise Gamma, 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 CET output are also provided. Analysis, observations and lessons learned relative to these results then follow in Section 5. Note that all quotations within this document come from the CET, unless otherwise stated.

4.1 Approach and Methodology

The following section provides an overview of results relative to the whole of Exercise Gamma and its methodology. These include the areas of data gathering, participation, questioning structure and thematic analysis. Training and Evaluation Team-related issues are also highlighted.

4.1.1 Data Gathering

Exercise Gamma employed a data collection methodology based on the use of focus groups, similar to that used in Exercise Beta. This approach allowed participants to put forward their ideas and issues within a forum setting. The focus groups were scheduled to coincide with CEP gate reviews in order to maximize attendance and participation by the CET, while also aligning the data collection points to well established 'synchronization points' in the process. However, due to unplanned irregularities in exercise execution, changes were required to take into account the departure of the initial CET Lead as well as schedule delays encountered by CET (see Section 3.2).

4.1.2 Participation

The Evaluation Team conducted four focus groups between November 2006 and May 2007 as shown in Table 4. The focus groups obtained substantial levels of participation and the number of attendees for each focus group was almost constant; however, the specific participants were not always the same. For example, only three CET members attended all focus groups, while three members each missed one focus group and two others only attended two focus groups (as a result of changing CET membership). Further, one Evaluation Team member was missing from each session (not the same each time) while the observers also changed over time. CET members who were unable to attend were allowed to submit their commentary (in advance).

4.1.3 Question Structure

A semi-structured interview guide was employed throughout all of the focus groups (see Annex A through Annex D). Approximately 14 to 17 questions were asked per focus group, concentrating mainly on the people, process and materiel axes, training and Evaluation Team support. The duration of each focus group was limited to no more than three hours to ensure enough time for the questions to be properly addressed while still keeping CET attention. The questions were

Table 4: Focus Group Summary

Corresponding Event	Date	Location	Attendees		
			CET	Evaluation Team	Other
End of Inception Stage	1 November 2006	CORA ACCESS Lab	7	4	2
Change of CET Lead	20 December 2006	CORA ACCESS Lab	6	4	2
End of Comprehension Stage	11 April 2007	NDHQ Conference Room	6	4	2
End of Exercise (After both Elaboration and Completion Stages)	25 May 2007	NDHQ Conference Room	6	4	2

intended to start conversations about general areas and themes that were familiar to the participants. The questions were generally easy to understand and were predominantly open-ended. 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. Prior to running the focus groups, the Evaluation Team vetted the questions in order to ensure suitability for use with the CET. Informed by previous experience in Exercise Beta, question development was based on the work the CET had to perform during the specific period, the observations made by the Evaluation Team during CET work sessions, plus any feedback or questions received from the CET during the same period.

4.1.4 Thematic Analysis

The results for Exercise Gamma have been organized based on an analysis of common themes which emerged throughout the various stages of the exercise. Unless there was something specific to a period, the results are presented as a roll-up of the critical areas that were identified for each axis. Prior to the analysis proper, the notes taken by the Evaluation Team members were integrated together, reinforced by audio recordings of the focus group sessions should clarification be required. Subsequently, mind mapping software was used to assist in the analysis of the consolidated notes and in drawing a spatial representation of the main themes and their relationships that emerged from each focus group (see Annex A through Annex D).

4.1.5 Training

The general feedback regarding training identified the need for more highly focused training, to the degree of being context specific and directly applicable to the specific tasks the individuals had to perform. The degree of participatory (i.e., 'hands-on') training was deemed insufficient at the beginning, but reported as more satisfactory later in the exercise. Furthermore, it was noted that training needed to be conducted by those who best know how to train (i.e., genuine instructors), rather than rely on ad hoc personnel. The issues of consistency across different trainers and timeliness in terms of delivery were also highlighted. Other concerns raised were: (1) the balance of individual versus group training; (2) the need for training on specialized tools in context with specific roles; and (3) the role of coaching and how it was provided.

In terms of per axis training, the Process and Materiel axes garnered the most feedback. Specifically, process training was not adequately participatory and there was the desire to have the CET trained with consideration of (i.e., linkage to) the 'big picture' topic as well as the capability gap itself. Furthermore, the workflow was also not ready at the appropriate time.

In terms of the Materiel axis, the amount of training completed was viewed as insufficient (approximately 50% of the intended curriculum was actually given[4]). There was also concern over the alignment of the training; for example, the Department of Defense Architecture Framework (DoDAF) training was not targeted towards Exercise Gamma but attempted to leverage training that was arranged as part of the Marine Security Operations Centre (MSOC) project.

4.1.6 Evaluation Team

The general feedback in terms of the Evaluation Team addressed two main areas: (1) their role and level of support with respect to the CET; and (2) their involvement in training and coaching.

In terms of their role and level of support, the Evaluation Team was quoted as being "very responsive" to the needs of the CET. However, it was noted that the use of facilitators within meetings would have been useful and that the CET did not like a 'style' of support/feedback in which the Evaluation Team would 'ask questions' instead of providing immediate answers. Furthermore, the CET expressed discomfort at the use of the term 'Evaluation Team', despite the rationale and explanation provided.

In terms of involvement in the training and coaching, there was a strong desire for coaching to be provided in addition to the training sessions. Feedback stated that coaching was critical and had definite benefits ("it's a requirement"). However, the coaching provided was not viewed as sufficient, appropriate or what was expected. Specifically, the Evaluation Team was not seen as sufficiently proactive in terms of the requested level of coaching ("… frame the meeting, be actively involved, come back after meeting and give immediate feedback"). Furthermore, it was noted that coaching needs to be performed by experienced people and that embedding a 'Process person' within the CET "should have been an option". Finally, it was stated that coaching is required across all axes, not just in terms of the CEP.

[4] Refer to Section 3.6 for further information.

4.2 CapDEM Axes

The following section now outlines the results obtained from Exercise Gamma with respect to each axis. An overview mind map can be found at the end of the respective sections (Figure 5 for People, Figure 6 for Process and Figure 7 for Materiel).

4.2.1 People

Challenges within the People axis were primarily related to collaboration and communication, the team charter, leadership, roles and responsibilities, and use of contractors.

Collaboration and communication. As the effort started, progress relied on the availability of documents as part of the team 'finding their way'. However, as the team increasingly understood what they were supposed to do, a suitable collaborative protocol evolved. Thus, team collaboration was generally effective but with a great reliance on face-to-face communication. While the CET did feel that they communicated well, there was evidence of fragmented internal communication within the CET; for example, meetings were (at one point in time) regarded as tedious with a lack of discipline. The acknowledgment of their collaborative challenges coincided with the arrival of a new CET Lead, who changed the way the team worked. At that time, they self-organized in small focussed groups to make working easier; however, such an approach underlined the need to be more aware of information exchange between those groups: "[The] team leader encouraged small focus subgroups around specific themes—that worked well—it allowed concurrent issue working but the downside [was the] required communication and what [was] going on". Relatedly, some CET members were concerned about commenting on others' responsibilities/products. As one person stated: "I don't often know what other people are doing, why they are doing it and what it means to me… [I] don't want to comment/have the capability or authority to comment because of this". Notably, the CET felt that they were better able to fulfill their responsibilities and felt more productive when working within sub-teams.

Team charter. Although the team charter was introduced as part of the initial training, the CET did not continue to actively utilize it and examine how it could be used to support team effort throughout the exercise (e.g., no team discussion on their own 'rules of engagement'). The CET felt that there was inconsistency in role definition between PLA, CEP and team charter (e.g., "Not doing what is defined in the charter"; "I am doing more than what I am supposed to do"). Furthermore, a lack of strong coordination and varied priorities between the team charter and other governing documents (such as the PLA) directly affected exercise execution (i.e., the CET Lead stated that "[the] true deadlines were the PLA ones").

Leadership. Leadership impacted the CET in terms of knowledge, style and approach. Specifically, the background of CET Lead was deemed important ("It's important that the leader is knowledgeable to the domain"). Furthermore, there is the need for process expertise within the team leadership such that the team leader requires a global vision of the process in order to be effective. There was also a marked change in the style of/approach to leadership employed over the duration of the exercise. While the Evaluation Team was consciously non-obtrusive to facilitate an independent CET, for a significant portion of the exercise, select contractor(s) frequently interrupted CET proceedings, causing confusion and undermining leadership. Once this situation was addressed, fewer interruptions and unexpected inputs resulted in improved

leadership focus. Leadership focus, however, was also impacted by the CET Lead performing many of the functions assigned to other roles (e.g., CET Coordinator) that were not filled (see section on Roles and Responsibilities). Consequently, leadership was considered crucial and as was ensuring the right people were in the right roles (e.g., "If [we had] lesser leadership, we could have really been in trouble").

Roles, responsibilities and the use of contractors. The clarity of roles, what the associated responsibilities were and who was filling those positions was not always clear throughout the exercise. In response to mismatches in terms of work styles and expectations ("some work not being done"), select individuals took it upon themselves to perform work that was the responsibility of other CET members[5]. Meanwhile, some CET members felt uncomfortable with contractors being too closely associated with the CET (e.g., attending all meetings), such that some contractors unduly influenced the work and the way the job was done ("We may be spending more time discussing tasks with contractors"). Those contractors who had focused tasks were appreciated while the CET did acknowledge their accountability on this issue ("The value of contractors is to provide them specific instructions with very clear guidelines, when done and how to do it – we failed to do that"). The CET did not feel that they were in control, or that they had the authority to change organization of the team. Indeed, the team leader did not always know the purpose of certain individuals and why there were at a meeting. The contractors sometimes seemed to be more confident than the CET on the work to be done, thus leading to an awkward dynamic on the team.

Team dynamics were also affected by the perceived optics of the exercise's organizational chart. Specifically, some individuals fixated on the title of a role and the position on the chart as implying a support position (e.g., the feeling of being 'demoted'). This approach also affected how certain roles were regarded, such that the CET rationalized that the role CET Coordinator was primarily administrative. Conversely, the CET Lead did not feel he had the authority/mandate to engage with SMEs. The result was an incomplete CET that increasingly realized the importance of these positions over the course of the exercise.

In line with the issues mentioned above under 'Team Charter', there was also confusion in terms of roles and responsibilities due to the multiplicity of events and initiatives surrounding the execution of Exercise Gamma. Specifically, the confluence of the PLA, the exercise workplan, and input from the Capability Management Working Group (CMWG) resulted in different direction coming from different leaders. Indeed, various individuals were aware of/involved in more than one effort, which created a tension in terms of execution ("They were more emotionally involved in the PLA than in the CET initiative"). Conversely, the CET felt there was a need for a better interface with Capability-Based Planning (CBP) and its planners (e.g., "We need someone [from] CBP to be more CEP aware to do what we tried to do").

Other issues included personnel availability as well as timeline and pacing. Specifically, the CET felt that there was not enough time to complete the work within the Comprehension Stage (i.e., sense of urgency to complete this stage). For example, one person stated: "We saw the light just in April to understand what [it] was that we needed to know. We missed one or two months".

[5] Conversely, various members wanted someone to operate the tools on their behalf, particularly in terms information management (e.g., Livelink) and the general organization/configuration management of the CEE. This issue is further explored under the Materiel axis (Sections 4.2.3 and 5.1.3).

This issue was exacerbated by concerns over CET member availability (e.g., full-time commitment to the effort) combined with the sentiment that there was too much emphasis on project management (i.e., more time should have been spent on completing tasks than on project management). One person stated: "I feel much time was lost to scheduling when we could have been completing our individual tasks".

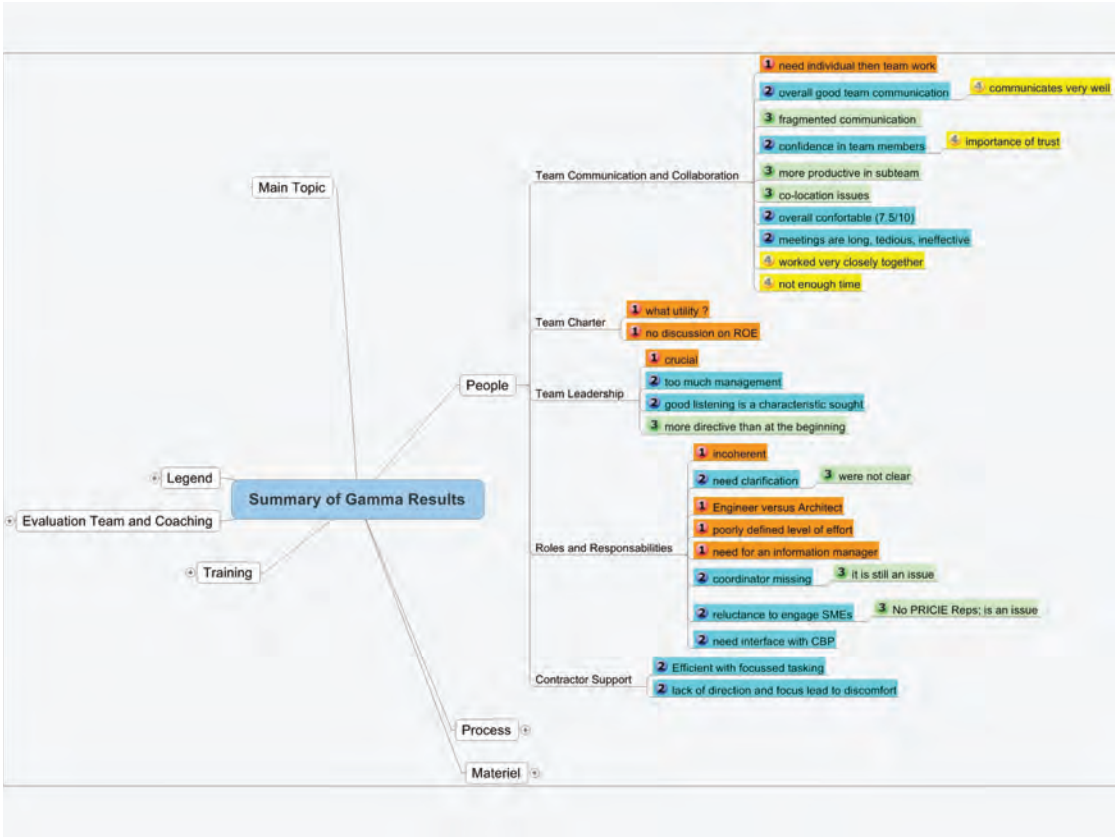


Figure 5: Summary Map – People

4.2.2 Process

Challenges within the Process axis were primarily related to cultural resistance and the comprehension of how the numerous elements of the exercise would coalesce together. Within this section, results are summarized along the following themes: understanding and assessment, documentation, process constructs, capability gap, deliverables, knowledge and timeline. As discussed further in the analysis section (Section 5.1.2), various improvements to the CEP were realized as a result of these challenges, some of which were applied within the exercise itself.

4.2.2.1 Understanding and Assessment

Challenges in terms of understanding and assessment of the CEP appear to have stemmed primarily from a mix of organizational cultures and linkage to a broader departmental context along with timely understanding and its iterative nature.

Culture and context. There was diverse perception in the level of achievement across the CET. Specifically, there was a marked difference in perception with respect to the degree of task completion and there was also an issue of resistance to unfamiliar work practices (such as architectures). Such variation corresponded to differences in team demographics (e.g., military vs. department vs. scientist/engineer), as did expectations in terms of outputs from the exercise. For example, there was an initial lack of understanding over what outputs were to be obtained (at the Inception Stage). Specifically, there was contention over the deliverables (and artefacts) as specified by the CEP versus those outlined in the PLA. For example, concern was expressed whether some of the outputs would be "what the VCDS wants to see", despite being at an early stage in the effort. Similarly, there was also initial uncertainty over the intent of the gate review(s); that is, the structure, organization and purpose of the gate review (particularly for the Inception Stage) were not clear a priori. Specifically, the CET did not know who would approve their work or what would be the conditions needed to meet expectations. For example, some participants errantly thought that the Evaluation Team was the approval authority at the gate review rather than the Capability Manager (e.g., "Not sure who was the approval authority"; "I didn't know who was going to give 'nay' or 'yea'"; "Not sure of the passing criteria"; "We tried to guess at criteria at passing the gate… there was none to refer to"). Subject to correction of the gate review presentation template combined with an explanation of intent by the Evaluation Team, this issue was not raised again.

Linkage to a broader departmental context was also a concern amongst the participants. Specifically, the CET was concerned about the relationship between the CEP and the CBP process and how useful it would be (e.g., "A lot of time was used to understand how the CBP was feeding our job"; "We struggled a lot on finding how we could use the […] outputs"). Throughout the exercise, the team spent a significant effort trying to figure how the CEP fit relative to the department's overarching force development process.

Similarly, a set of departmentally developed scenarios was to be utilized within the exercise to define and provide context for its capability gap (goal). Notably, however, out of a total of 15 planned scenarios, only five (5) were available for use. Correspondingly, the CET found it more difficult than anticipated to delineate the capability gap.

Timely understanding. A lot of direct and indirect evidence shows that the CEP construct was difficult to understand. The participants did gradually understand the process, but not in a timely fashion (e.g., "[We] understand the deliverables better after the gate review as opposed to when we were producing them"). In the initial focus groups, the CET mentioned they did not get the 'big picture' or global perspective. More specifically, they did not understand the link between the work performed and the force development options which were to be passed on to the decision maker at the end of the effort (see above, regarding 'context'). Additionally, there had been some confusion within the training and documentation as to whether the initial capability gap would be given to the team or whether they would have to define it. Consequently, the CET spent a lot of time addressing this issue, despite no instructions to do so (e.g., "In none of the

training or the deliverables was there anything on how to define the gap"; "[we were taught that we] will determine the capability gap during the Inception phase [Stage], but it is considered an input to start it").

Comments from the CET indicated that the Capability Engineering construct has merit; however, the best way to achieve proper understanding of the CEP was not intuitively obvious a priori. For instance, one CET member talked about the objectivity provided by the CEP, while another member believed that the CET should have made better use of the spiral approach, having been willing to "move on before having the perfect answer" (see above, regarding 'culture'). Regardless, while there was support for employing the CEP's main foundations, the CET did not feel they followed it sufficiently well to achieve key process characteristics, such as objectivity and traceability ("[The] CEP gives objectivity; the way we did it was not objective and lost traceability – [there is a] need to keep objectivity in terms of [the] process").

Iterative nature. Participant comments confirmed that they did not understand some key process characteristics. For instance, some saw the process as too sequential, indicating that the continuous consideration of performance, schedule, risks and cost through the 'Assess Force Development Options' technical sub-process was not properly understood (e.g., "Go from operational option to systems option to PRICIE. In the end, there may be constraints up front (e.g., costs) which guide up front"). Iterative progression was a key CEP characteristic, allowing for flexibility in producing deliverables, with process rigidity concentrated at stage gates and in terms of deliverable content. The CET, however, found these characteristics to be counter-intuitive and increased the challenge of applying the CEP (e.g., "Iterative nature of the process and its flexible nature make it difficult to manage, both in group and in terms of documents and templates"). Further, some CET members initially perceived the iterative process as representing a waterfall approach ("We ignored [the] training slide on [the] spiral…") while also finding its application 'culturally challenging' ("We could not accept we didn't have a perfect answer to move on").

4.2.2.2 Documentation

The main issues with respect to documentation were content and expression, consistency and coherence, focus and approach, as well as provisioning.

Content and expression. The CET noted a lack of certainty and a lack of guidance with respect to where they were in the global CEP picture. Specifically, they stated they were not confident about starting and finishing points within the process, and that there was a need to routinely reinforce the global CEP context – where they were, what was done, what was coming next, and so forth.

The workflow and task descriptions (provided both in the CEP online and separately as ad hoc documentation) were generally satisfactory. However, the CET stated that there was no guidance on how to adapt/customize the workflow. The workflow was also only available to the CET mid-way through the exercise, and was co-evolving with the process' templates (e.g., template and task descriptions before and after each iteration were not finalized). There was also an unclear understanding of some tasks (e.g., incomplete information), along with timing and ordering issues (e.g., some were too late, some too early and there was a need to revise sequencing and definition of certain tasks).

While the task descriptions identified artefact outputs, the CET members would have preferred bidirectional links between artefacts and their generating tasks (e.g., "Need to map architectural products to workflow"). Hence, both artefact-driven and task-driven CEP descriptions are required. Further, there was mixed preference for documentation to have been expressed in terms of (smaller scale) artefacts rather than (larger scale) deliverables[6].

During previous experiments, the CET had persistently asked for a workflow and a 'cookbook approach' to explain what work needed to be done, rather than replying on deliverable templates and following an overview of the process. As a result, a workflow was developed and given to the CET (although only midway through the exercise); nonetheless, its availability and utilization within Exercise Gamma did facilitate its validation by the CET. Curiously, however, in contrast to previous teams, Exercise Gamma's CET preferred a dataflow approach rather than a workflow. Indeed, some participants even preferred to return to a deliverable-centric approach instead of that based on a workflow (e.g., "[We] should focus on deliverables […] whereas this is focused on activities and artefacts").

The expression of the capability within the exercise was identified as a significant issue. In particular, the CET was confused by the use of different terms to refer to the capability either as a gap or as a goal. Specifically, exercise documentation used both terms in an inconsistent manner. Understanding the big picture was also made more difficult due to differing points of view (and interpretations) of the varying terminology.

The concept of an 'Operational Option' was also a source of confusion (and contending points of view). This matter was an issue up to and including the Elaboration focus group (e.g., "We don't understand how to recognize something as an operational option"; "Don't see the benefit of operational options… don't understand what they are, how they help. [Three CET members] have different points of view on what is an operational option"; "Not recognize SoS options as an operational option in disguise"; "We struggled for a long time as to what it means").

Commentary on the need for metric documentation was also noted, at both the Comprehension and Elaboration stages. Due to timing and resource issues, the documentation only covered metrics at the Elaboration Stage.

Consistency and coherence. In general, the main challenge in terms of consistency and coherence was the ongoing evolution of the documentation in parallel with exercise execution. Additionally, as the CEP was also evolving at the same time, there were difficulties in aligning versions of the documentation to the process as it was being executed at any particular moment. Furthermore, issues of process understanding, such as those mentioned above, also exacerbated the situation.

As the documentation was under development, the availability of certain components was not always as desired. The detailed workflow for each stage, for example, was available only at the beginning of that stage. Therefore, despite receiving an overview of the whole process and being kept informed of its development, this situation was not appreciated by some participants (e.g., "We are working blind because we have documentation on Comprehension Stage and not

[6] A typical larger scale deliverable would be composed of various smaller scale artefacts.

on the Elaboration Stage"; "Not knowing what happens next makes it hard to appreciate implications").

Inconsistency or contradictory information across the various documentation sources (e.g., the PLA, CEP documents, CEP online and ad hoc material provided by the Evaluation Team) were reported in the first focus group. Most documentation problems (i.e., inconsistencies, the need for improvements and updates) were primarily due to very little lead time between confirmation and actual start-up of the exercise. Specifically, there was insufficient time to adequately evolve the documentation based on the results from Exercise Beta.

Focus and approach. In general, there was a certain disconnect in expectation between the CET and the philosophy of the CEP. In terms of task description, the CET stated they would have preferred a more 'directed' approach; specifically, they wanted to have detailed and exact task information, more akin to a 'meticulous cookbook' than a sequence of expected results (i.e., typical workflow). The CET also desired to follow a critical path and looked for unwarranted meaning in the sample workflow (e.g., significance of its vertical axis). This desire for a more dogmatic workflow relates back to the mentioned issue of process starting and finishing points.

Furthermore, the CET stated that the documentation needs to focus on those things that change; for example, the "weaknesses and tasks that need improvement" are those which are repeated across iterations (versus singular components which were well documented). Metric documentation also needed to be similarly addressed (e.g., according to stages). There was also a portion of the CET that expressed the preference to use project management techniques, such as Gantt chart for deliverables.

Provisioning. Feedback also addressed the ways and means to provide documentation to the CET. Positive comments were received on the concept of an electronic version of the CEP, with the web-based CEP documentation (i.e., CEP online) being regarded as quite helpful. However, despite its popularity, two major issues were noted: (1) inconsistency between the online and manuscript-based documentation; and (2) initial difficulties accessing the online version (due to network restrictions and incompatibilities).

The CET also indicated the need to provide a better, less obtrusive and more transparent 'process update' mechanism. For example, a means to 'update and patch' the documentation during process execution needs to be found. Other potential improvements or solutions include the use of databases (for increased accessibility), stronger linkage with the tools, and reformulation of the documentation to be "less like a report" (e.g., presented as fill-in templates/paragraphs).

4.2.2.3 Process Constructs

Three main issues dealing with process constructs were highlighted: iterations vs. stages, serial vs. iterative, and breadth vs. depth.

Iterations vs. stages. The CET found the difference between iterations and stages confusing and wanted to know how to address this issue. Specifically, they requested clarity on how to understand, manage and execute stages in an iterative manner, including the impact this had on document creation and use of templates.

Serial vs. iterative. The CET stated they had perceived the CEP as a 'waterfall-like' process, and that its "serial nature was a problem". At the same time, however, they stated they had "ignored [the] training slide on [the] spiral" because "they couldn't deal with 'non-perfect' answers" relative to organizational culture (see Section 4.2.2.1).

Breadth vs. depth. The CET stated that in terms of domain understanding, their default approach was to go deeper before going broader ("…tendency is to dive too deep for narrow foci; they want to go deep before going breadth"; see Section 4.2.2.1). Such an approach, however, contradicts the iterative/incremental nature of the CEP.

4.2.2.4 Deliverables

The following issues were the main themes observed in terms of deliverables within Exercise Gamma: relevance, explicit responsibility, ease of approach, domain content and level of satisfaction.

Relevance. The CET generally appreciated the specified CEP deliverables. Notably, the CET acknowledged the importance of the strategic and management deliverables that they had initially not deemed as important at the beginning of the effort (e.g., "[Strategic Factor Analysis[7]] was the most important thing that we did"; "The Engineering Management Plan (EMP) was more important than the CET had realized"). The deliverables were also appreciated as a means to ensure traceability (e.g., "Traceability and top-downness are the key things we want to do here from the point of view of transformation concepts").

Explicit responsibility. There needs to be a very explicit and well-documented connection between a CET member's role and responsibilities and the DoDAF products on which they will work. While indicated, the connections were not sufficiently evident to the participants. Furthermore, the additional, ad hoc documentation created by the Evaluation Team's process advisor to address this concern was regarded as insufficient (e.g., incomplete and with too many inconsistencies and errors).

Ease of approach. Due to time pressures as the exercise neared completion, the CET shifted from a task-orientation to a deliverable-oriented approach, with the importance of the deliverables being made more concrete (e.g., "Less regimented… I don't want to know about them [i.e., tasks]. We reverted to [a] document focus"). While such a change was done in anticipation of being easier (see Section 4.2.2.1 regarding unfamiliar work practices), the CET actually found it difficult to do so.

Domain content. In terms of deliverable content, the CET was unable to sufficiently evaluate the utility of architectures within the decision process. While the CET did successfully illustrate the potential of architectures within the force development process, they were not able to make solid conclusions about their applicability or lack thereof. However, the products delivered by the end of the process showed that the CET had produced all expected deliverables, albeit sometimes more according to the CET's 'flavour' than that intended by the Evaluation Team.

[7] The deliverable referred to as the 'Strategic Factor Analysis' was technically known as the Strategic Context Analysis (SCA).

Level of satisfaction. In terms of deliverable content, the CET seemed generally pleased with the products they produced since they provided an 'end-to-end view' of the problem and its potential solutions ("linking one end to the other"). Some members of the CET, however, would have liked some of deliverables to have had more substance to them (i.e., quantitative results, *aka* "meat").

4.2.2.5 Knowledge

Issues in terms of knowledge within Exercise Gamma were primarily three-fold: (1) missing domain knowledge; (2) the sourcing and collection of information from stakeholders; and (3) understanding and interpretation of the 'Operational Option' concept.

An important issue for the CET was sufficient knowledge of effort's subject matter itself. The team felt it lacked sufficient domain knowledge (i.e., the definition of C4+I); in fact, the CET still had concerns regarding this issue by the time the Comprehension Stage focus group was held (e.g., "What is C4+I, so we can scope properly?"). The team spent a lot of time trying to scope the domain (e.g., "The functional decomposition was in effort to figure out what C4+I is; this may not be the case in the future").

The sourcing and collection of information were also issues (e.g., "Start collecting and then decide what to trim. I think that the way we collected information did not work. We cannot afford to wait until the end"). Moreover, the validity of information was also an important issue, such that most of the available information was denoted as 'draft,' thus making it difficult for the CET to feel certain about their efforts (e.g., "Found it problematic with everything being DRAFT… when can you reference/trust it?"). The sourcing issue resulted from difficulties in being able to sufficiently liaise with the stakeholders and the appropriate SMEs (which were missing from the CET).

There were also issues in terms of understanding the 'Operational Option' concept. In fact, there was significant confusion about such a notion as indicated by comments received up to and including the Elaboration focus group (e.g., "We don't understand how to recognize something as an operational option"; "Don't see the benefit of operational options… don't understand what they are, how they help. [Three CET members] have different points of view on what is an Operational Option"; "…not recognize SoS options as an operational option in disguise"; "We struggled for a long time as to what it means"). Indeed, it was only at the end of the Comprehension Stage that the concept finally made sense to the team. Further, there were also different points of view as to what an Operational Option actually was. While defined within the CEP documentation, various individuals wanted to apply the process using their own definition (i.e., interpretation) of the concept.

4.2.2.6 Timeline

The issue of scheduling (i.e., timeline and pacing) was also significant in terms of the process axis. Specifically, the CET felt that they were "… late and lost in the fog" such that one person stated: "We saw the light just in April to understand what [it] was that we needed to know. We missed one or two months". As a result, there was not enough time to complete the work within

the Comprehension Stage and the CET could not fully appreciate the CEP by needing to do it in such a condensed manner (i.e., a sense of urgency to complete this stage).

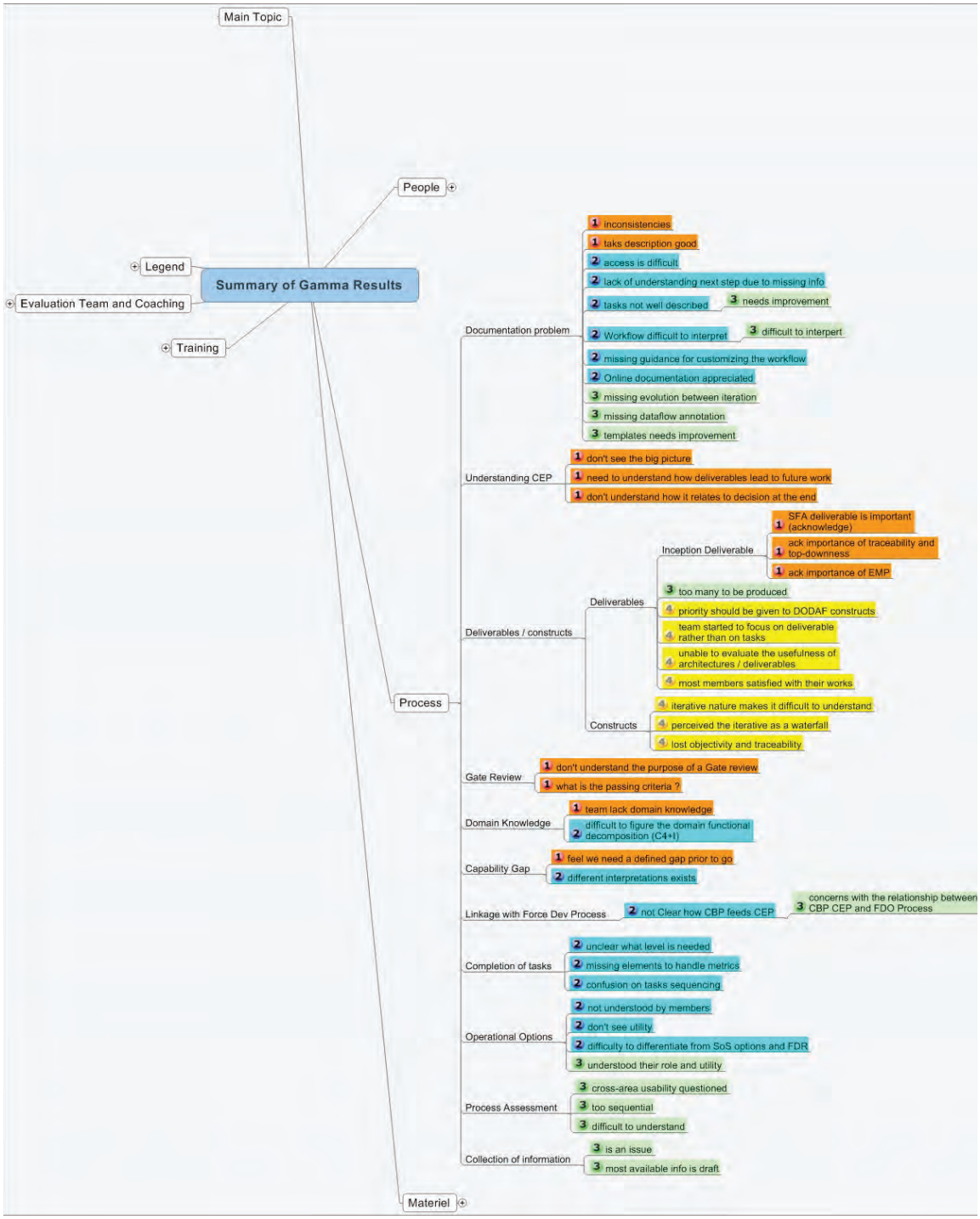


Figure 6: Summary Map – Process

4.2.3 Materiel

Challenges within the Materiel axis can be categorized in terms of the following themes: functionality, logistics, information management, personnel and infrastructure. Aspects of demographics, performance, trust, security and timeline are also touched upon within these themes.

4.2.3.1 Functionality

The Exercise Gamma CET utilized the 'standard' CapDEM toolset[8], along with an option analysis tool that was introduced by one of the CET members. Users benefited from the familiar interface and intuitive setup of both the CEE and the ACCESS Labs. In conjunction to a number of common tools and environments, a set of specialized engineering tools were also part of the CEE; these tools, however, were really only used by select members of the CET.

The extent to which the CET exploited CEE functionality was influenced by the level of confidence, comfort and training with specific tools, as well as demographic considerations (ranging from age to career track). Examples of a demographic effect include the use of hardcopy projector tool (not used before by any CET) as well as the desire for more desktop tools to complement and integrate with physically shared facilities like the ACCESS Labs (that is, the creation of a 'virtual facility'). Scheduling issues (i.e., timeline and pacing) were also significant, as the CET was generally not able to fully appreciate or explore the potential of the tools as its limited time and personnel resources were focused on domain and process (CEP) issues. As a result, some tools were used in a limited and/or sometimes incorrect manner.

Another key issue influencing CEE functionality was performance, such that it significantly impacted the use of (and trust in) many of the CET-wide general-purpose tools. The Livelink[9]-based document repository and collaborative portal/workspace was one such example: "Livelink did not have performance needed – always several seconds per click; cannot keep up with people's thoughts; either the tool is bad, installed wrongly, configured wrongly or [the] infrastructure is problematic". Conversely, due to the restricted use of some tools to specialized users, the trust in some technologies (i.e., the confidence in some tools and their capability) was primarily achieved via reliance on specific users and their experiences. Consequently, significant functionality went largely unappreciated, most often due to performance problems resulting from infrastructure issues (see below).

Functionality was also impacted by the need to conduct (portions of) Exercise Gamma at a SECRET classification level with a CEO (Canadian Eyes Only) caveat. Notably, Exercise

[8] Typical functionality provided by the Materiel axis throughout CapDEM and across the various evaluation exercises has included: requirements analysis; functional analysis; network analysis; human systems integration; model repository, data integration and management; document repository and management; audio teleconferencing; video teleconferencing (VTC); collaborative portal; shared collaborative workspaces; e-mail; and use of various network(s), either as tool host or communications fabric.

[9] Officially, Livelink constituted a 'content management system'. Subsequent to Exercise Gamma, the name 'Livelink' was retired and the product was re-branded as part of the 'OpenText ECM Suite' (where ECM stands for 'Enterprise Content Management').

Gamma was the first significant user of the classified CEE/ACCESS Lab, with these facilities still being under development (i.e., not at 'production level'). Accordingly, the CET felt that the environment was "not ready to deal with classified stuff". Further, the CEO caveat was seen to stifle the ability to be collaborative due to a lack of facilities (i.e., work places, available networks, etc.) which would enable the desired levels of access, processing and information exchange (for example, the lack of a 'virtual facility'). Such limitations, however, went beyond the scope of CEE but related to general policy (such as the handling and consolidation of data and information). The impact on information exchange necessitated the use of varied means to communicate and transfer information in response to various technical, geographical and security-related issues (ranging from printed copy and swappable disk drives to CDs and USB keys). In fact, this CET used a hardcopy projector as a way to deal with the inability to obtain electronic copies of certain information (due to security issues). The experience of transitioning to a classified environment also impacted technology use, as the CET was very cautious in terms of respecting security considerations (rules, regulations and practices).

Infrastructure issues (in particular, network infrastructure) routinely impacted the CET and their ability to use the CEE. Specifically, the various networks that were used by the CET to communicate and collaborate (including the DWAN) were outside the control of those involved in the exercise. As a result, any changes made to such networks (by the respective departmental authorities) affected the reliability and performance of CEE, and transitively, its usage and acceptance (i.e., trust and confidence) by the CET – both in terms of specific tools as well as the broader environment. Indeed, such changes were often not announced and created unexpected performance problems and application failure (in sometimes unpredictable or misleading ways). Further, due to the multiple authorities involved, there was no straightforward way for any of the exercise participants (be in the CET or the Evaluation Team) to address such issues (see the upcoming 'infrastructure' section for further discussion).

The CET also noted some concerns in terms of missing functionality. Specifically, the CET requested: better use and support for configuration management (CM), either as a tool (as was suggested) or in the application of CM principles; the availability of an automatic report generator from process artefacts as part of moving away from a 'document orientation' (i.e., requiring less manual document creation); the addition of risk and costing tools, as well as a tool to fit the 'PRICIE' structure; and the use of an enterprise architecture tool (at levels above the CET) in order to better acquire and organize relevant information (e.g., system attributes).

4.2.3.2 Logistics

Availability and access to facilities and technical support proved a constant issue for the CET over the duration of the exercise. Issues of team mobility and a desire for co-location versus distributed meetings were also encountered. Commensurately, the CET also expressed the desire to use and be integrated into the CEE from individual members' offices, requiring secure remote access to dedicated CEE facilities (i.e., the 'virtual facility' mentioned previously). Similarly, there was ongoing demand for IT support in terms of troubleshooting the CEE as well as providing real-time, on-demand coaching and/or operation of the tools on behalf of CET members. The desire for more timely and situational-based training was also noted.

In general, the varied logistical issues routinely distracted the CET from their focus and detracted from their application of the CEE.

4.2.3.3 Information Management

Two broad information management issues dominated the utilization of the CEE: (1) organization of and access to information for the team to use; and (2) classification of information along with the facilities and means to deal with such material (e.g., transport, communication, storage, separation, procedures, etc.).

The knowledge portal and document repository (realized via Livelink) was primarily used for networked file storage (i.e., as a shared drive replacement) rather than for collaboration and true content (information) management. Conversely, the CET requested support for constructs (such as "versions of relationships between things") that were not directly supported by Livelink and which would have required significant effort to develop and employ as part of an appropriately structured information management model. In the same vein, the previously mentioned tool support for the 'PRICIE' structure along with the use of an enterprise architecture tool (at levels above the CET) to better enable information collection were considered important. Further, various infrastructural issues also impacted the utility and application of information management practices; this issue is further explored below.

The issues of information classification and the means by which to transport, communicate and process said information were overriding concerns of the CET. Specifically, the CET wanted an expeditious means to migrate from unclassified to classified systems (i.e., between unclassified and classified CEE/ACCESS variants). However, as the first significant user of classified facilities (which were still under development at the time), the CET had to address these issues as best possible without any previous direct experience to call upon.

4.2.3.4 Personnel

As part of evaluating how well a particular software or hardware system met the needs of a particular usage context, both the influence and experience of the end user must be addressed. Hence, personnel considerations such as behaviour and attitude should be considered.

Within Exercise Gamma, the CET did not utilize the functionality of certain tools in the expected or intended manner. Additionally, various individuals were not interested in the broader Materiel axis, such that they did not want to address CEE elements that were not directly relevant to their specific role and/or immediate need. Some members had difficulty in recognizing the potential or relevance of a given tool, either with respect to other tools or with respect to how they could relate to the process (e.g., the architecture modelling/analysis tools). This mismatch and lack of appreciation for functionality appeared to correspond (to at least some degree) to demographic, role/responsibility and schedule influences.

Similarly, there was a lack of enthusiasm and (appropriate) effort by the CET to organize (or learn how to organize) its information in a way that would take advantage of the provided content management system (i.e., document repository). Specifically, the CET sought ongoing, real-time coaching for organizing documents along with a dedicated CET position to address (i.e., perform) this function in addition to assisting with other tool and technology issues.

The issues of interest and enthusiasm by CET members also impacted the team's level of trust in the various tools and technologies. Specifically, as certain technologies were primarily used only

by designated individuals, the perception of those technologies was affected transitively by the trust and confidence in their specific users.

4.2.3.5 Infrastructure

A key issue impacting the utilization of the CEE and ACCESS Labs within Exercise Gamma was use of multiple infrastructures (i.e., networks, facilities, labs, etc.). The issues of availability, performance, predictability and reliability were of specific concern, and were directly impacted by a lack of control over the multiple infrastructures (including changes thereto), insufficient awareness of the infrastructures' varying technical requirements, policies and limitations (including changes thereto), as well as a lack of personnel and expertise to address these and other technical issues resulting from the novelty of the broad and uniquely interconnected environment.

The CET utilized a mix of DRDC and DND resources, both classified and unclassified, to share information (as appropriate given security considerations) and collaborate across multiple geographic locations (sometimes in an ad hoc manner ranging from offices and labs to conference rooms and non-government facilities). The need to use multiple networks and provide multiple entry points to the CEE for purposes of location-independent access (including external Internet access) proved very problematic. Some difficulties were due to technical issues with certain software components, combined with a 'trust' issue between the CEE host network and the CET's primary point of presence network[10]. In particular, the primary point of presence network implemented ad hoc, unannounced policy changes that prevented a number of tools from functioning correctly and creating significant performance problems when accessed across networks (e.g., the Livelink document repository/collaborative portal).

The user experience was further confounded by the mixed use of unclassified and classified facilities and networks, their corresponding policies and procedures, as well as a lack of familiarity and comfort in terms of their use. Due to classification, some information could only be resident and processed on the classified CEE, while other information could be utilized on unclassified systems. Therefore, as part of facilitating a flexible and user-centric work environment, the CET used both categories of systems in combination. However, it was sometimes difficult to be aware of what information was available on what system, to maintain consistency in the case of duplication between systems and other information management issues (as denoted above). Further, the creation of parallel classified and unclassified environments sometimes made it difficult for participants to keep the rules, regulations, policies and procedures aligned to the correct environment (i.e., trying to remember what can/cannot be done in each environment, along with any differences in performing them). The result was a less than confident user experience.

[10] For clarity, 'point of presence network' refers to the main (unclassified) network used (by the CET) to connect to the CEE for purposes of conducting the exercise. The 'CEE host network' refers to the main (unclassified) network on which the CEE servers were located. Both of these networks were separate from the classified CEE network.

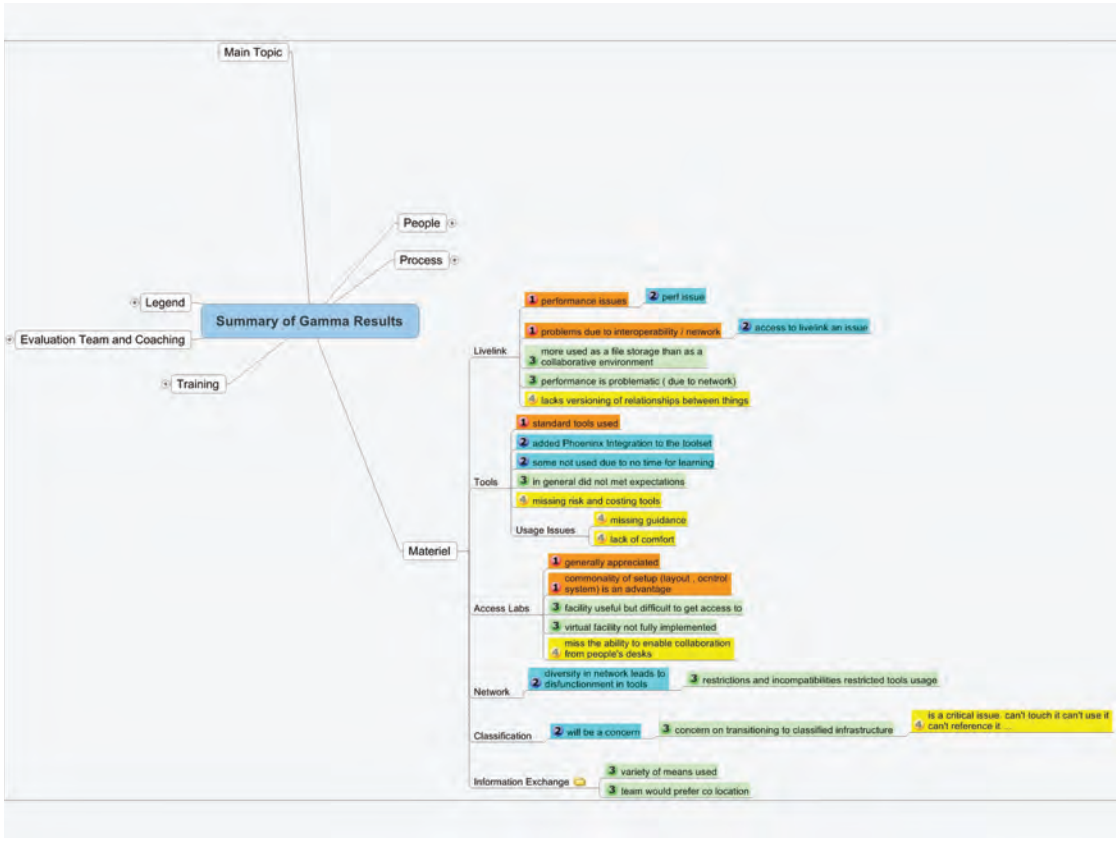


Figure 7: Summary Map – Materiel

5 Discussion

This section now offers an analysis of the various issues based on the results presented above. Recommendations are also put forward for further consideration of best practices and lessons learned to assist the future institutionalization of the CapDEM approach. The reader is also referred to [9] and [10] for additional commentary.

5.1 CapDEM Axes

The following section discusses the results obtained from Exercise Gamma with respect to each axis (see Section 4.2).

5.1.1 People

Based on the results presented in Section 4.2.1, the following discussion provides additional commentary and analysis on issues pertaining to the People axis. Axis-relevant artificialities are presented followed by considerations along the following themes:

- Team work, collaboration and communication
- Team charter
- Leadership
- Roles and responsibilities
- Contractors

In terms of CET experience, various artificialities relating to the effort being an exercise (rather than an actual operation) should be noted. These include:

- **Confluence of initiatives.** In order to realize sponsorship for Exercise Gamma, a number of stakeholder interests were coalesced. Subsequently, a variety of stakeholder and participant initiatives tertiary to the exercise impacted the perspective and conduct of the team. In particular, overlapping directives, competing objectives and the dual responsibilities of participants (such as to the exercise and their home organization), resulted in Exercise Gamma suffering from conflicting priorities. Consequently, the CET often had to choose between them and in this sense, exploitation 'got in the way' of evaluation ("…more emotionally involved in the PLA than in the CET initiative"). In the vernacular, there were basically 'too many cooks in the kitchen'.
- **Novelty.** The uniqueness of the exercise effort combined with the novelty of the approach to CET recruitment and newness of the process made it difficult to determine the driving challenges to team organization. That is, it was difficult to be certain if personnel issues (e.g., dedication and availability) were 'just the way things are' (and will always be), or was it specific to this group of participants – be it because of the exercise designation, the first significant external application of CapDEM, or the dual responsibility of participants (see above). In general, inappropriate recruitment plus training difficulties were confounding factors for other team issues.

5.1.1.1 Team Work, Collaboration and Communication

Despite feeling they communicated well, the CET did mention not feeling certain about how well they communicated and how well coordinated they were. In fact, they had a difficult time establishing a protocol because they hadn't figured out what to do, and were relying on documents to 'lead' them. In the same vein, they also wanted someone to use the tools for them (in particular, to perform tool and information organization). Consequently, communication did not necessarily lead to coordination in this particular case.

Indeed, it took a while for the CET to admit they had weaknesses in their communication. Meetings were considered as "boring" and while the CET realized they lacked discipline, they never corrected themselves. Subsequent to the introduction of the new CET Lead, who stated "They didn't [even] know they needed help", the team changed the way it worked. In particular, they self-organized in small focussed groups in which it was easier to work and collaborate. Such a change in organization, however, underlined the need for being more aware of information exchange (between those subgroups) and created a focus on communication issues.

The issues surrounding communication and collaboration were also significant in their effect on the level of trust within the CET. The issue of trust is relevant to successful application of the CEP as iteration requires trust of other team members due to the lack of completeness (i.e., trust in competence to provide suitable partial solutions). It also relates to not being condemned for work done along with its perceived value at a given point in the process. Similarly, there was an issue of members doing each others work either due to a lack of communication and/or trust it was done properly (i.e., confidence). In fact, there was a general issue of being comfortable in terms of commenting on others work due to ill-effective collaboration; for example, one member did not feel he was "really part of the team" until midway through the effort.

Notably, the issue of trust was mentioned near the end of the exercise, when the CET was rushed. Therefore, the question is whether such a concern was because the CET was approaching a more mature stage in team development (i.e., 'norming vs. storming'), or because of a heightened sense of urgency. Indeed, the level of effort at this time was denoted as "extremely involved and intense", with significant amounts of communication and working together. However, while the exercise deadline did help focus the team, it did not necessarily result in the correct application of the process, nor did it promote proper tool usage. In fact, due to tool usage patterns, confidence in the capability and correctness of various tools was linked to the trust in those CET members who were the prime users of those technologies. Similarly, confidence in the quality of the analysis performed was also related to the level of trust the CET had in those members performing that task. Consequently, issues of team work, collaboration and communication were not only related to technologies in their provision of an enabling capability, but also in terms of how interpersonal trust issues influenced the level of trust in technology. Trust in the data used was similarly influenced, particularly given the challenges in terms of SME access.

5.1.1.2 Team Charter

The main challenge for the team charter was its lack of authority compared to the other documents governing the exercise (such as the PLA). While the charter's contents were deemed useful, its utility was 'weakened' as it was not used as a (required) management tool. For example, the CET members did not examine how it could be used to support team effort (e.g., no

team discussions on rules of engagement). Going forward, there needs to be less dependency on team volition in terms of using the charter and a more defined link between the team charter and the day-to-day governance and functioning of the CET. That is, the charter must be mandated and used as a practical and authoritative document, not as an ancillary 'good practices' reference.

5.1.1.3 Leadership

Leadership within the CET was considered important by all members in a number of ways, ranging from general aptitude and a willingness to listen, to being familiar with the field ("It's important that the leader is knowledgeable to the domain"). The individual's background was regarded as important as part of being able to make appropriate decisions. It was also stated that the leadership needed to have 'process expertise' such that a global vision of the process would allow the team to be effective. While these attributes are reasonable, it is important to note that such a need was acute in this exercise due to the novelty of the effort and general lack of experience by the CET members. Future efforts that benefit from increased knowledge and experience by all members of the CET will shape this requirement differently.

Improvement in leadership focus occurred in conjunction with a change in leadership style, along with a decrease in the number of interruptions and unexpected inputs from certain exercise participants (specifically, fewer managerial inputs and certain contractors). From the start of the exercise, the Evaluation Team had made a specific effort to avoid interrupting the CET so as to ensure its independence and avoid undue influence. This approach was in stark contrast to the specific contractor(s) who routinely interrupted meetings, caused confusion and undermined leadership. At times, various contractors associated with the CET seemed more confident than staff members, leading to an awkward dynamic on the team. This dynamic also fuelled criticism of the Evaluation Team for an apparent lack of support, all the while the Evaluation Team was trying to promote a cohesive, self-sufficient and self-lead team structure.

Within this exercise, there were too many driving influences and subsequent responsibilities that ended up being addressed by the team leader due to the CET Coordinator position not being filled. As a result, the CET Lead had to fill multiple roles which resulted in performing liaison, and administrative duties in addition to producing the operational architecture[11]. Consequently, the work load on the individual in this position was not at the level or as focused as had been intended. Therefore, while the experience of the CET Lead for Exercise Gamma can be used as a reference, it cannot truly be considered commensurate with those likely in future applications. It does, however, emphasize the importance of leadership as well as suitably addressing all identified roles and responsibilities.

5.1.1.4 Roles and Responsibilities

As mentioned previously, the confluence of initiatives surrounding Exercise Gamma (ranging from PLA, the exercise itself, to the Capability Management Working Group) resulted in confusion due to many intersecting initiatives with many (sometimes overlapping) leaders giving different directions. As a result, people sometimes had 'divided loyalties' (conflicting priorities)

[11] This list refers to the final CET Lead who started as the Operational Architecture Lead and then took on some of the CET Coordinator functions (as that position was not filled). Later, when the original CET Lead departed, this person assumed that role.

between the interests of the various initiatives and their home organization. Consequently, the question is whether such an issue was more prominent because of the effort's 'exercise' designation, or whether is it a challenge endemic to the use of matrix staffing in which individuals are split between multiple efforts (e.g., 'dual-hatted'). For example, within Exercise Gamma, some participants asked why the CET should care about the PLA, while yet another stated he was "…more emotionally involved in the PLA than in the CET initiative".

Cultural and personality influences relative to specific roles and amongst multiple roles were also an issue. For example, amongst individuals and the various organizations represented on the CET, there was a mismatch in terms of work styles and expectations on management. These considerations also impacted how team members accommodated each other and worked together. For example, some individuals overtook other roles due to the perception of work not being done. Such a situation illustrated a failure in the team construct in terms of trust, confidence and collaboration. Subsequently, the leadership was also affected in terms of regulating such behaviour, as part of ensuring productivity and a sense of team cohesiveness.

Another aspect of culture and personality manifested itself as a result of eliminating the 'functional silos' which were problematic in Exercise Beta [7]. Unfortunately, the solution – a modified team structure – led to other issues in Exercise Gamma. Specifically, there was an unanticipated fixation on role titles and their positions within the org chart. In particular, certain individuals felt that the title and position implied importance within the exercise. Subsequently, they questioned the degree (amount) of their involvement, and for those involved in previous efforts, they were concerned that they and/or the importance of their work had been 'demoted' (lessened). Consequently, the use of two sub-leaders may not have been the best choice with respect to org chart optics. Unfortunately, because each CET will be different (from focus to member demographics, personalities and organizational representation), there may be an ongoing need to suitably represent and explain the intent of the team and its structure in order to avoid these types of situations. Indeed, this kind of issue may be potentially addressed through a more effective use the team charter (see above).

Issues surrounding specific positions within the CET, their scope of responsibility and their degree of importance were also problematic. This ranged from the CET Lead not being clear as to why some of the people in various meetings were actually present (indicating problems in understanding and awareness) to being unclear if certain roles were even necessary. In particular, the fact that CET did not realize the potential difficulties that could result from not filling certain positions implies that those roles were not properly assessed and their functions rationalized (despite input from the Evaluation Team). Notably, however, these perceptions changed over time as the CET became more familiar with the process and the work to be done. Consequently, it would seem that the 'big picture' perspective of why certain positions are part of the CET needs to be better explained to and understood by the CET and well as any supporting organization providing sponsorship, resources and staff. For example, consider the following roles: CET Coordinator and Subject Matter Experts.

CET Coordinator. This role was added to the CET structure based on the results of Exercise Beta [7], and undeniably, the Gamma CET did realize the importance of the role as the exercise went along. In fact, the perception of this role evolved considerably, from not being all that important, to then being deemed only useful for administrative work, to then being extremely important to team function, and eventually being overwhelmed even by its administrative

component with still more to do. The lesson learned was not to underestimate the value of positions within execution of a new process, particularly in the multidisciplinary context. Indeed, the role definition was reasonable but the problem was that the position was not adequately filled. In retrospect, this situation highlighted that role nomenclature (i.e., naming) can have unintended side effects in terms of how important it is considered. Specifically, the title this role was given resulted it being considered a 'support position' (which is, unfortunately, viewed diminutively); consequently, the role did not receive the attention it deserved and was impossible to fill given the current personnel challenges within the department. Indeed, someone had been assigned to this position; however, he did not show up at initial CET meetings, and did not respond to Evaluation Team inquiries as to his availability. Subsequently, and only in response to inquiries through uniform members, did he respond that he was "too busy" to participate.

Subject Matter Experts. As in Exercise Alpha [4] and Exercise Beta [7], Exercise Gamma had to go without (domain) SME support[12]. While there was much discussion as to the importance of SMEs, there was frustratingly little support to actually being able to obtain them. Indeed, SME availability remains a big challenge for DND. Moreover, the ongoing question is whether those organizations which would benefit from the CapDEM approach (such as CFD) will achieve sufficient import so as to ensure access to the required personnel and resources. To some degree, such a problem may be an artefact of the effort's 'exercise' designation, such that the 'importance' of a real operational context may increase the willingness to participate. Furthermore, the cultural considerations of the CET membership need to be taken into account. Specifically, civilian scientists and engineers vs. uniformed members typically have a different threshold and viewpoint on engaging external personnel to address certain kinds of problems (e.g., the military don't like to engage people prematurely – particularly other more senior personnel). Indeed, the CET Lead stated he did not feel he had the authority to engage the SMEs (i.e., he required an authoritative mandate to do so). However, this was particularly problematic given his supplemental capacity as acting CET Coordinator, who by definition was supposed to be the SME liaison. Therefore, aside from the difficulty experienced by the CET in performing their work, an important disadvantage in lacking the full CET (i.e., with SMEs and a CET Coordinator) was that it did not allow for the evaluation of any issues (good or bad) resulting from using such an approach.

The issue of methodology-based SMEs was also highlighted in the requests to embed appropriate 'technical' personnel (i.e., CEP and CEE SMEs). As opposed to domain SMEs, this type of expertise would address the everyday operational concerns of CET in the execution of their work. Embedding such individuals within the team could be an option to mitigate the risks of the team becoming 'lost' within the effort.

5.1.1.5 Contractors

As in many departmental initiatives, contractors played a role both within the CapDEM TDP as well as Exercise Gamma. Within the exercise, those who had focused tasks were generally more appreciated than those who tended to provide more 'free wheeling' and often officious input. In the same vein, contractors seemed to be more confident than the staff CET members on the work to be done, leading to an awkward dynamic on the team. As a result, some contractors appeared to have had an undue influence on the work and the way CET members did their job. The CET

[12] The reference to 'domain SMEs' also includes the notion of PRICIE representatives.

did admit some responsibility in terms failing to corral contractor behaviour in terms of efficiency and suitability ("The value of contractors is providing them specific instructions with very clear guidelines, when done and how to do it – we failed to do that"). It would seem that such an issue related to the CET not feeling in control, such that they did have the authority to change organization of the team (as expressed previously). Therefore, it will be important in terms of future efforts that the CET feels sufficiently proficient and aware of what is appropriate in terms of capability engineering practices that they can exercise proper judgement in addressing team issues, and specifically those involving contractors. Doing so will be an important part of managing and dealing with any potential issues of bias or conflicts of interest amongst participants and across concurrent or related initiatives (see above on 'exercise artificialities' as well as the discussion of the Capability Management Support Centre[13] concept in [10]).

5.1.2 Process

Based on the results presented in Section 4.2.2, the following discussion provides additional commentary and analysis on issues pertaining to the Process axis. Axis-relevant artificialities are presented followed by considerations along the following themes:

- Understanding
- Knowledge
- Documentation
- Deliverables
- Process Maturity and Assessment

In terms of CEP application, various artificialities relating to the effort being an exercise (rather than an actual operation) should be noted. These include:

- **Gate Review.** Documentation, organizational and rationale issues were the key concerns affecting gate reviews during Exercise Gamma (in particular, the Inception gate review). In terms of documentation, confusion resulted from erroneous adaptation of the gate review material (i.e., templates) from Exercise Beta. Once corrected, and the CET Lead and Capability Manager briefed, this issue was resolved. In terms of organizational and rationale concerns, the structure, organization and purpose of the Inception gate review was not clear a priori, such that the CET did not know who would approve their work or what would be the conditions needed to meet expectations. Indeed, such considerations would be more straightforward in a real application (e.g., with no 'Evaluation Team' involved). However, the issue highlights the general concern over reporting and accountability within the application of the CE construct. Indeed, clarity on those issues was required so that the CET could comfortably proceed.
- **Context and Readiness.** The conduct of the effort as an exercise as well as the participants being aware of its 'experimental' nature affected how the effort was approached. Further, the unique governance of Exercise Gamma resulted in its timeline being driven somewhat independently of actual experimental (e.g., Evaluation Team) readiness. These two issues

[13] As of this writing, this concept has evolved and the Capability Management Support Centre (CMSC) is now known the Centre for Capability Analysis (CCA) and is being perused as part of Project Accord.

intersected with cultural considerations such that larger departmental topics were paramount insofar that exploitation overtook evaluation in the mind of many participants. Examples included: dissecting the process relative to stakeholder granularity instead of process context ("…artefacts […] a lot are not what VCDS wants to see"); individual vs. team orientation in terms of CBP correlation, in which individuals tried to link between their job and what would be used from CBP outputs; and scenario importance, in which there was considerable focus on the state of scenarios as made available from the exercise stakeholder (only 5 out of 15 departmental scenarios were available). These topics will be further considered in the context of process maturity, as discussed later in Section 5.1.2.5.

The lack of domain knowledge (e.g., the definition of C4+I) and the apparently ineffective training (e.g., attempted to provide big picture but "it didn't stick") were additional examples of insufficient readiness. Concern over information validity, process documentation and various CEE issues (as detailed in upcoming sections) were also examples. The team spent an undue amount of time trying to address some of these concerns, which typified the unique situation of the exercise, rather than what would likely occur in actual operational situations, in which participants would more likely know the domain in which they are working.

An overriding contextual issue was the impact of 'meta-influences' on the use of the process. Such influences are deemed 'meta' as they are above and outside the exercise's sphere of influence. For example, the sourcing of missing domain knowledge and collection of information from stakeholders are critical to the successful application of the CapDEM approach. However, the ability to address these issues is more dependent on the importance and level of commitment by CET members and the department than it is dependent on the approach itself. That is, the successful application of the process depends on critical factors outside of its control. As Exercise Gamma was a trial application, the level of support by its CET and stakeholders (i.e., the broader department) was (in their opinion) commensurate to that context. Unfortunately, such a difference only permits an approximation of true usage context and thus impacts its evaluation accordingly.

5.1.2.1 Understanding

As introduced in 4.2.2.1, a combination of direct and indirect evidence illustrated that the CEP construct was difficult to understand, particularly in a timely fashion. The CET stated they often felt as if they were "lost in the fog" and struggled to understand the effort in its entirety for nearly half the experiment. As a result, the CET fell behind schedule and needed to rush during the final stages. Indeed, they developed a sense of urgency (akin to cramming for an exam) that resulted in higher productivity within the last 1½ months than that achieved up to that time. As the CET finally saw the potential of the process and its iterative nature by the end of the exercise, it is believed that if the same CET were to perform a second instance of the process, they would produce significantly less encumbered results, and that a large number of the problems encountered wouldn't occur due to increased understanding from experience. As it was, however, CET did not (and could not) fully appreciate the CEP by doing it in such a condensed manner.

Based on the feedback received, it was realized that the provided training had failed to instil the 'big picture' to the CET. That is, despite providing a global overview at every training session, including where the CET was relative to the overall effort, what had worked to that point, and what was coming next, the CET had a difficult time understanding how the work they performed

would ultimately result in force development options which would be relevant to decision makers. Commentary as to whether all CEP products were "what the VCDS wants to see" was a sign of immaturity in process application (not the process itself) and a failure to see how various levels of products would culminate in the appropriate manner through the appropriate process constructs.

Undeniably, the CET did not understand some key process constructs and characteristics. For instance, some members saw the process as too sequential, indicating that the continuous consideration of aspects such as performance, schedule, risks and cost through the 'Assess Force Development Options' sub-process were not understood. In spite of that, some members didn't think that cost constraints were considered early enough, while yet others criticized the CEP Capability Engineering Decision Framework (CEDF) for reducing the problem "to just money". Other examples included:

- Iteration vs. stage: Confusion over which construct was which and how they related to each other was encountered. Specifically, the CET needed clarity on how to execute, manage and understand stages in an iterative manner. One member's perception of performing the entire series of stages within each iteration was an example of such a misunderstanding. Going forward, this kind of relationship and its progression must be more clearly communicated.
- Workflow: By design, there was not really a critical path through the CEP. As such, the CEP was not intended to be a prescriptive 'cookbook' but provided the CET the freedom and the responsibility to progress their own work using the stages and iterations based on a series of expected outputs. The attempt to utilize a previous effort's workflow was problematic as it was too specific to the given question and technical environment they used. Going forward, workflows should be specified suitably orthogonal to (i.e., independently of) the specific problem and technical environment. This topic will be discussed further in the upcoming Materiel section.
- Depth vs. breadth: Part of the reason that the CET found it difficult to utilize the CEP was their predilection to address topics more in terms of depth than in terms of breadth ("…tendency is to dive too deep for narrow foci; they want to go deep before going breadth"). While such an approach is a cultural tendency within the organization, it contradicts the inherent iterative and incremental nature of the CEP, and will therefore require concerted effort to adopt such a way of working. Indeed, it will be a function of experience and maturity in the application of the process that will enable an increasingly smoother and more natural application of the approach across an increased range of topic areas.
- Iterative progression: The iterative nature of the CEP can make its management and application somewhat challenging. One intended benefit is flexibility in the production of deliverables, such that they can be developed incrementally as a whole set, in relative concert with each other. Equally, the early identification of non-viable options as the iterations progress allows work on infeasible alternatives to be suspended in a timely manner and future effort to be focused on any remaining options. Indeed, both situations gain from the ability to get feedback at multiple points in the process. Attaining such an end, however, requires the discipline to continuously synchronize the advancement of deliverables rather than necessarily taking any particular output to completion in advance. The result is a series of intermediate products that are a progression to the final deliverable (much like the 'track' of a moving vessel towards its eventual destination). Within Exercise Gamma, however, the

CET members had a difficult time "letting go" and "moving on" such that further information would be fleshed out later ("We could not accept we didn't have a perfect answer to move on"). This reluctance was seemingly influenced by issues of work norms, trust and culture. Based on the CET demographics, the work norms of its members were such that they had a high desire for accuracy and correctness (associated with technical and military backgrounds). When combined with a lack of familiarity with the process, facets of the 'not created here syndrome' were manifest such that the team decided to do things their own way ("… ignored [the] training slide on [the] spiral…" as they "couldn't deal with 'non-perfect' answers in DND culture"). Cultural issues of trust and accountability were evident in that team members did not necessarily feel comfortable relying on interim products from other members (i.e., did not trust others to have materials ready as appropriate), especially given the apprehension of potentially being held responsible for incorrect or prematurely released information/analysis. The issue of trust would seemingly stem from a lack of maturity in terms of the process (i.e., being a new construct), its application (i.e., a lack of experience with the construct) and as a team (i.e., a lack of familiarity with new members, specifically their personalities, work practices and ethics). Concerns over accountability reflect a cultural predisposition to 'denounce' those responsible for work done when difficult situations arise. Such concerns being notable even in an exercise context were problematic for the team both in terms of input and output. As input, the CET was frustrated by only being able to obtain 'draft' information; as output, there was reticence that iterative versions may be incorrectly used and attributed. Such anxiety regarding inappropriate use of premature results (i.e., early iterations) will need to be overcome in order to take advantage of the intended benefits of the CEP. Similarly, the intersection of these issues between the People and Process axes highlights the need for further research into how to provide better support for such constructs within the organization and its approach to staffing.

- Representation: The physical representation of the process may have added to the difficulty in understanding the process, due to the inherent challenges in representing an iterative, incremental effort in a flat, static diagram. Similarly, the process documentation (such as the templates) was not necessarily intuitive in such a context (e.g., "Iterative nature of the process and its flexible nature make it difficult to manage, both in group and in terms of documents and templates"). Consequently, there is a need to avoid the process representation from negatively influencing its application while also finding a more suitable means to represent a dynamic and multi-level process. This topic is further discussed in the upcoming section on documentation.
- Capability gap: While the targeted capability (be it a gap or a goal) is a fundamental driver for the CapDEM approach, its determination was not intended to be part of the exercise. Nevertheless, the CET spent a significant amount of time addressing this issue along with various others not intended to be part of the exercise. This foray was primarily rooted in the following:
  - Terminology and interpretation: Despite attempts to rationalize any difference in terminology, the lack of consistency within the documentation, training and amongst participants in referring to the capability as a gap or as a goal created confusion for the CET. Further, it was noted that different interpretations are possible with respect to these terms, given the variability in their expression (both inside and outside the department).

- Perspective: As various personnel involved in Exercise Gamma were also involved in related efforts (such as the CMWG), their impressions were sometimes coloured and behaviour/outputs influenced as a result of their dual roles and the different perspectives between those efforts and the CEP (see Section 5.1.1.4).
- Difficulty: The capability gap for Exercise Gamma was not easy and some CET members put an emphasis on having the complete gap understood before even starting to think about operational options. As the capability gap was provided to the CET through the use of a CFD-provided scenario, the limited availability of such scenarios had a significant impact (as the CFD CBP team had only completed 5 out of 15 scenarios). In an actual operational context, these considerations would be more suitably defined (i.e., less artificial).
- Focus: While the relationship between the CEP and the department's CBP process is clearly important, the CET was sometimes overly concerned about the relationship and how useful it would be. In particular, their focus on the CEP proper was sometimes diluted relative to concern over the CEP interface with other (departmental) processes. It is anticipated that this issue will tend to be of less concern in the future given increased experience in applying the process, resulting in increased understanding of the CEP and the interface to other processes.

5.1.2.2 Knowledge

The availability, sourcing and collection of domain knowledge are critical enablers for the successful application of the CapDEM approach. Consequently, the results identified in Section 4.2.2.5 merit further consideration given the previously outlined influences and issues affecting process understanding.

- Operational Option. While some inconsistency in the understanding of an 'Operational Option' may have been in part due to documentation issues (see next section), the primary problem was that various individuals wanted to apply the process using their own definition. As denoted in Section 5.1.2.1, individuals' perspective and understanding of key process elements were influenced by their various ancillary efforts. In the same vein, the various changes in team leadership created the opportunity for such divergence to become established within the group. Hence, a general lack of experience (i.e., confidence) by the CET combined with a lack of SMEs created an opportunity for such confusion to thrive.
- Subject Matter Experts. The role of subject matter experts (SMEs) as knowledge providers within the CapDEM approach can generally be categorized in two ways: (1) knowledge as the basis for analysis; and (2) knowledge as part of facilitating the analysis.
  - Basis for analysis. This category of SMEs is intended to provide access to 'real world' operational expertise in terms of information to be used by the CET within application of the CEP (e.g., PRICE representatives). This information constitutes the domain knowledge on which the analysis is based. The availability of that knowledge (and thus access to the associated expertise) is essential to ensure that the information being processed is both suitable and valid. Notably, because so much of the information available for use in Exercise Gamma was denoted as 'draft', the CET felt apprehensive about the reliability of their results. Difficulties in liaising

with the stakeholders and the appropriate SMEs further exacerbated those concerns, often leaving the CET feeling frustrated.

- Facilitation of analysis. Due to the various challenges and issues in applying the CEP and utilizing the CEE, there was a need for SMEs to provide ongoing, real-time support and coaching in terms of the process and tools. The manner in which to best provide such expertise was the subject of debate throughout the exercise (see sections 4.2.1, 4.2.3.4, 5.1.1.4 and 5.1.3.5). However, due to logistical and personnel issues, a satisfactory level of support was never reached. This issue consequently resulted in frustration amongst not only the CET, but the Evaluation Team as well.

- Separation of knowledge from process: Due to the novelty inherent in so many aspects of the exercise, it was often difficult to clearly distinguish the source of particular problems. In particular, while process and knowledge are inextricably linked, they are not the same. It is generally difficult to discern the difference during early application of the process due to a lack of experience of what is process and what is driving the process. While such a consideration is not particular to the CEP (and is indeed a much broader issue), it is key to realizing that the inability to address domain knowledge should not be misattributed as a process failing. That is, as mentioned in the introduction to Section 5.1.2, meta-level influences must be appropriately isolated in order to accurately identify any problematic process issues.

5.1.2.3 Documentation

Documentation considerations generally fit in one of two categories: (1) content and expression; and (2) focus and approach.

Content and expression. In terms of content and expression, the issues of most concern were related to workflow, tasks and update logistics.

- Workflow. As mentioned previously, there was not really a 'critical path' within the CEP, as it was not intended to be a directed (i.e., prescriptive) process; rather, it was intended to outline the sequence of expected results, giving the CET the freedom and the responsibility of managing their own work (i.e., both descriptive and deliverable-centric). Conversely, the CETs from the previous experiments (in particular, Exercise Beta) had repeatedly asked for a workflow and a 'cookbook approach' to direct their efforts.

  Consequently, a workflow was developed; however, it was completed only midway through the exercise. While this scheduling did allow the workflow's suitability (correctness) and utility to be validated by the CET through application in the latter half of the exercise, the CET did not appreciate its late availability. Some members considered the workflow insufficient, open to misinterpretation, and somewhat ambiguous (i.e., they would have preferred a previously vetted workflow). Unfortunately, the previously validated workflow was tied too tightly to an earlier incarnation of the CEE (see 'workflow' under Section 5.1.2.1), reaffirming the necessity of orthogonality in its specification.

  Contrary to earlier feedback, some participants within Exercise Gamma subsequently expressed a preference to return to a deliverable-centric approach instead of one based on workflow. Such variation in commentary both for and against workflows confirms that

different CETs have had – and will continue to have – different ways of working and approaching the process. Indeed, both deliverable-centric and task-centric methods are complementary means of understanding the process, and going forward, support for both will foster greater understanding and acceptance of the process within the department. It will, however, make documentation implicitly more difficult due to the need to ensure consistency and continuity between perspectives.

As part of facilitating both approaches, an 'artefact-centric' methodology was proposed. As artefacts are generally self-contained, fine granularity information fragments (e.g., paragraph, figure or table) which together compose a document, both deliverables and tasks can utilize the same fragment (i.e., artefact). The potential of such an approach is to enable increased automation in terms of deliverable composition. Doing so helps maintain consistent and complete documentation, in which less effort is spent on reporting administration and more on artefact content ("…make it less like writing a report…"). However, an artefact orientation has a significant effect on tool use and information structure, requiring more customization and tighter integration between all three axes than was possible during the exercise (see the Materiel section for additional commentary).

- Tasks. The main considerations in terms of tasks were their understanding, scheduling and description. The concurrent evolution of task definition, sequencing and their documentation constructs (i.e., templates) made understanding and scheduling difficult. Indeed, one source of such difficulties was that while a task could be performed within the bounds of multiple iterations, there was only one description provided within the documentation. Further, the evolution of the CEP during the course of the exercise meant that the CET had to deal with multiple versions of the documentation constructs (e.g., templates and task descriptions). Additionally, task descriptions were also complicated by the CET's desire for exhaustive detail on each task, the desire for focus on aspects which changed between iterations along with the early provision of metrics (starting at the Comprehension Stage).
- Update logistics. Issues of how to disseminate modifications to the process and its documentation were of concern to the CET, including being able to more easily 'update and patch' in situ (i.e., mid-execution), so as to support future multiple and concurrent applications. To this end, the introduction of electronic documentation (via the 'online CEP') was well received. Regarded as easier to use than a paper-based approach, it is also more amenable to future modifications, including in-place updates.

In general, however, it is worth noting that some of the complaints received during the exercise seemed misattributed and/or 'unjustified', ostensibly stemming from difficulties in understanding and documentation. Indeed, future operational incarnations of the CapDEM approach will not likely suffer from the artificialities the exercise, or its constricted development timeline. For example, some users "felt blind" because certain documentation components were not immediately available. Rather, increased application within the department and being more solidly rooted in an organizational structure would naturally correspond with higher availability, increased consistency and fewer incongruities across documentation sources.

Focus and approach. In terms of focus and approach, the issues of most concern were related to orientation and philosophy. It is again noteworthy to emphasize the impact that orientation (i.e., artefacts vs. deliverables vs. tasks) will have on technological support (i.e., tools), as well as

the composition of documentation and outputs. The desire for increased automation through the use of report generators and artefacts needs to consider the balance between ease of use and productivity versus the freedom and flexibility of a more manual approach. Similarly, the philosophical difference as how to best approach the process (i.e., descriptive vs. prescriptive) also influences the level of detail provided versus that desired by some participants. To what degree future versions of the process will need to balance these two approaches is unclear at this point and requires further consideration based in part on anticipated demographics (i.e., cultural and experiential perspectives) of future CETs. This philosophical consideration also relates to the desired ability to customize the CEP (and its workflow). While such a feature will be desirable as the process becomes more widespread, premature use of customization in lieu of proper understanding and application will negatively influence the process' perceived reliability.

5.1.2.4 Deliverables

Issues in terms of deliverables generally fit in one of three categories: (1) relevance; (2) process outputs; and (3) content and satisfaction.

Relevance. By the end of the exercise, all expected deliverables had been produced by the CET. While the character of some deliverables deviated from what was intended, the specified deliverables were appreciated by the CET, both in terms of ensuring traceability as well as providing for an 'end-to-end view' (see Section 4.2.2.4). The CET ultimately understood the potential of the process and its iterative nature, despite having to struggle with it for nearly half of the exercise. Notably, there was general agreement (both amongst the CET and the Evaluation Team) that should the same CET perform a second application of the process, their efforts would be significantly less encumbered.

Process outputs. The CET desired a very explicit connection between a member's responsibility and the products they 'needed to touch' (i.e., produce, use, amend, etc.). While such connections were documented, the level of explication provided was regarded as insufficient and there was a strong negative reaction to any errors. In general, the clarity of deliverables and their documentation were an issue of process maturity, such that alignment between team member and outputs (deliverables) would naturally evolve as they are validated over time. Nonetheless, CET feedback spoke to immediate concerns, based in part on their experience within the exercise. For example, as the CET started to run out of time to complete the exercise, they shifted from a task-based approach to a deliverable-oriented one, thinking that it would be easier. However, in reality, that approach was also difficult to execute and they continued to feel under pressure. In the objective sense, this situation illustrates that there is no perfect representation of the process and that the level of clarity needs to be inversely proportional to the level of familiarity with the work practice (i.e., the less familiar the work practice, the clearer the explication needs to be to avoid increased resistance to that portion of the process).

Content and satisfaction. As Exercise Gamma was intended to provide results as a trial application (not just as an evaluation exercise), the content of the deliverables was evaluated from a broader perspective, considering both client and participants. As per Section 4.2.2.4, CET members were generally pleased with the products produced, but they would have preferred more substance (i.e., detail). Notably, this preference varied within the team and was generally aligned with cultural and demographic groupings. Going forward, the merit of creating benchmarks for deliverable completion and how to provide guidance in support of such benchmarking remain

open questions. In terms of client goals, the exercise did illustrate the potential of architectures and capability engineering within the force development process; however, the CET was not able to make solid conclusions about their applicability within the decision process. Nonetheless, satisfaction was expressed with the outcome of the trial application and the learning that resulted [14]. As noted, in order to accurately demonstrate the utility of architectures and capability engineering within the decision process, a broader comparative study would be required, not just a single 'one off' application. Regardless, the exercise was regarded as an important and necessary step in that direction.

5.1.2.5 Process Maturity and Assessment

A number of previous topics merit consideration in terms of process maturity and their effect on assessment. Such overarching issues provide a lens for examining the particularities of the exercise in a more holistic manner.

As the last of three evaluation exercises, Exercise Gamma benefited from the experiences and lessons learned from both Exercise Alpha and Exercise Beta. That being said, the cultures of all three evaluation exercises were substantially dissimilar, significantly due to very different CET composition. The cultural influences were in part significant because they impacted the conduct of the exercises, ranging from CET interaction to CEP interpretation as well as CEE application. In terms of the CEP, cultural influences affecting the interpretation of 'technically objective' processes are specifically challenging when the process is descriptive rather than prescriptive (see Section 5.1.2.3) and there is a general lack of experience with the process being applied. That is, in the case where there is little previous experience to draw upon in terms of applying the process, the interpretation and opinion of the practitioners can be particularly influential. Further, because of this heightened subjectivity, team structure (e.g., demographics) and dynamics (e.g., personalities) can have an unintended level of influence on CET conduct.

For example, both a degree of impatience and a degree of obstinacy[14] were encountered throughout the exercise. In particular, the determination to address specific issues and avoid interactions with relevant individuals embodied obstinacy: the CET spent a lot of time addressing issues not intended to be part of the effort (see 'capability gap' under Section 5.1.2.1) and did not want 'to bother people' by asking questions. Similarly, members of the CET had diverse opinions on what constituted an appropriate level of achievement in terms of tasks (Section 4.2.2.1). Correspondingly, there was a tendency for some individuals to complete work and to delve into details (Section 5.1.2.4) versus advancing it only to a certain level. Consequently, members sometimes expressed a degree of impatience regarding such variable behaviour. Impatience was also noted in their reaction to the CEP documentation and CEE availability/configuration, each of which impacted the team's work practices.

It is also important to note that some of the novelty-related issues are endemic to the early application of a new process by a new team using a new environment. That is, some of the difficulties encountered by the CET are not CapDEM-specific but would be common in any similar situation. Therefore, these kinds of issues should not be misattributed and result in a

[14] Note that these attributions are not intended to identify or be critical of any particular individual on the CET; rather, they are to highlight common personal attributes and the potential to result in unintended consequences.

falsely-based critique. Maintaining such separation is sometimes difficult, but it is key in being able to properly address instance-specific problems and to distinguish them from those that are more generic.

For example, while the specific issues the CET had with documentation may have been unique to the exercise, issues of documentation quality and consistency are common to any new and evolving effort, not just CEP. While it is important to highlight relevant particularities for the exercise, such as the issue of co-evolution of documentation and process, the key observation is its degree of impact on the team. For instance, given the difficulty a relatively small team had with the documentation issues, it is likely that such issues would be even more disruptive in a full-size team? Or conversely, would the proper completion of all roles offer a degree of clarity such that documentation issues would not have been as impactful? Similarly, the rationale for increased coaching is not unique to the CEP, but indicative of its level of maturity and a lack of familiarity by new practitioners.

Similar considerations include: CBP linkage, CEP understanding and process assessment.

- CBP linkage. Throughout the exercise, the CET spent a considerable effort trying to figure how "it all fit together". To some extent, the team did not seem confident that linkage to appropriate departmental processes had been considered in its development ("To be relevant, the CEP must keep pace with the entire capability force development process as they both continue to evolve – it has not. Most of the discussions we've had with the capability planners has revealed at least a minor inconsistency or deviation and would therefore support this claim"). Such concern and commentary belies the reality of the process' actual development and is more commensurate with issues universal to product readiness. For example, consider any given software development effort: the testing and release of the product are based on 'frozen' versions of the code base (i.e., business rules) despite ongoing flux towards subsequent releases (i.e., as the business rules continue to evolve). There is a natural balance between practicality and agility that will always exist in such a context; therefore, the key in terms of CBP linkage and the CEP is find that point of balance. It is not realistic to expect multiple moving targets (i.e., evolving processes) to be completely correlated, particularly when they are person-based (vs. machine-based) processes, and therefore subject to practitioner variability (e.g., familiarity, competence, etc.). Furthermore, the expectation of such tight coupling is not amenable to evaluation efforts, reflecting the issue of experimental vs. operational focus (see 'Confluence of initiatives' under Section 5.1.1). While clearer expectations on this issue are expected as the process matures and the number of experienced practitioners increases, it is recommended that future CEP versions formalize more easily identifiable linkages (both to alleviate these concerns as well as their perception). Furthermore, as the development and utilization of the process become under the purview of a single organization (e.g., CFD), synchronization will undoubtedly become more straightforward (than was possible across organizations, as in CapDEM and Exercise Gamma).
- CEP understanding. Aside from any complexities inherent in SoS engineering, two challenges overarching CEP understanding were its newness and the related lack of (practitioner) expertise. As a result of these challenges, the CEP was arguably too easily the subject of influence from ancillary initiatives, particularly in the context of competing priorities (Section 5.1.1). That is, given such a flurry of activity, there is a tendency to question that which is new and unproven (i.e., the CEP), rather than try to identify the actual

source (such as an existing process). The result is a predisposition to hastily evaluate efforts on surface considerations (i.e., 'low hanging fruit') instead of a more thorough deliberation of why things were as they were (such as process interfaces or the suitability of other (possibly existing) processes). For example, consider the comment that "[the] keyword is artefacts; a lot are not what VCDS wants to see". Indeed, this statement would suggest a lack of utility in terms of process outputs. However, such commentary presumes that all outputs from the process are directed at the same level of management (i.e., decision). In particular, it fails to realize that (fewer) high-level constructs may legitimately benefit from a larger number of low-level constructs. That is, the process needs to generate outputs that are for internal use and analysis, not just those which are visible to the final management level. This issue is evident between the exercise's various governance documents (e.g., PLA and CEP initiative), and illustrates the cultural predisposition to not always recognize the value of intermediary products and their relevance to higher-level outcomes. Indeed, it is this same cultural issue that impacts the ability to appreciate the iterative nature of processes like the CEP (as discussed under 'Iterative progression' in Section 5.1.2.1). Previous topics, such as the capability gap and CET roles, are also examples of issues that needed to be re-evaluated as the exercise progressed.

- Process assessment. The assessment of the process was difficult for a number of reasons. First, the CET could not fully appreciate the CEP by virtue of doing it in a condensed (and skewed) manner. For Exercise Gamma, the CET stated they would have preferred a combined process rather than a second iteration (because they were so late, they aimed for a lesser amount of work); however, such a context will not necessarily be the case when the application of the process is more established and there is increased familiarity and comfort in terms of experienced CETs. Second, there was a natural variance in the conduct of the process due to the process specification being more descriptive than prescriptive. However, the amount of variance in Exercise Gamma was regarded as atypical of that going forward, assuming increased process maturity and practitioner experience. In that regard, however, it will be important to limit any workflow customization, so as to prevent unnecessary divergence from recommended practices. That is, it will be important to ensure that practitioners know and utilize 'the basics' first. Third, the CEP must be applied in such a way as to enable its objectivity and traceability; unfortunately, its application in Exercise Gamma did not do so ("[The] CEP gives objectivity; the way we did it was not objective and lost traceability – [there is a] need to keep objectivity in terms of [the] process"). Finally, there is a need to appropriately demarcate between issues. The classic example that was experienced in the exercise was keeping process understanding and domain knowledge linked but separate. During the initial application and learning of a new process, it is often difficult to disambiguate between new knowledge and new process. While they will seem the same, by definition they are not – such that knowledge is effectively input to the process and the process is independent of that input. However, in situations when 'everything is new', it can be difficult to separate them. As a result, it can be difficult to discern those which are problems in terms of domain knowledge versus those which are problems in terms of the process. Indeed, this general problem does exist outside the CEP; however, it is key to 'keep things straight' in order to properly assess the process and not to misattribute domain knowledge issues as process failings.

5.1.3 Materiel

Based on the results presented in Section 4.2.3, the following discussion provides additional commentary and analysis on issues pertaining to the Materiel axis. Axis-relevant artificialities are presented followed by considerations along the following themes:

- Understanding and usability
- Functional grouping and alignment
- Information and knowledge
- Logistics
- Personnel
- Technology, facilities and infrastructure

In terms of CEE application, various artificialities relating to the effort being an exercise (rather than an actual operation) should be noted. These include:

- **Novelty.** Combined with the security requirements of Exercise Gamma, the diverse and developmental nature of the classified CEE made it difficult to delineate systemic challenges from those which were transient. That is, it was sometimes unclear whether certain issues (e.g., performance, interoperability, etc.) were specific to the way the CET was attempting to utilize a particular tool, that tool's configuration, the specific underlying infrastructure being used, an inherent technological limitation, or a regulatory (policy) consequence. As a result, the team's perception of the technology (i.e., the tools, their availability, dependability and performance) was adversely impacted (i.e., skewed) based on the idiosyncrasies of a developmental prototype.
- **Context and Readiness.** The development of the classified CEE paralleled the 'confluence of initiatives' and 'meta-influences' that impacted both the CET and the CEP. Specifically, CEE development and management were under the auspices of DRDC CORA (as opposed to the CapDEM TDP), which resulted in sometimes competing priorities. The end result was that its development timeline was driven somewhat independently of the actual exercise. Specifically, the status of CEE afforded a limited amount of flexibility in terms of configuration, availability and accessibility to the environment and its associated facilities (e.g., the classified ACCESS Lab[15]).

  A lack of familiarity with the CEE and its components combined with deficient and ineffective training further contributed to insufficient readiness. Information validity, process integration, as well as specific functional and configuration issues (as detailed below) were also overriding concerns. While some of these concerns were unique to the exercise context, they often preoccupied CET members in a manner unlikely to be found in an actual operational situation (in which more time-tested environments would be used).

  As with the CEP, a number of issues outside the exercise's sphere of influence had significant impact on the use of the CEE. Examples of such 'meta-influences' include the

[15] The classified ACCESS Lab initiative began as part of the CapDEM TDP but quickly transitioned to an independent effort managed primarily by DRDC CORA. Consequently, the lab was and still is commonly referred to as 'ACCESS CORA'.

operational constraints and configuration rules associated with various departmental resources; a case in point being network policies and security regulations. Specifically, the ability to address such issues is more dependent on the use and availability of well-supported operational infrastructures and suitable technical personnel than it is on the approach itself. Consequently, the successful realization of the CEE depended on critical factors outside of its control. As Exercise Gamma was the first 'significant' effort to be executed on the new classified CEE, a variety of technical, logistical, training and operational issues came to the fore. Further, the ongoing evolution of CEE design and architecture as part of exploring how to better meet the broad process and personnel requirements made it difficult to converge towards a 'definitive' CEE. That is, because the implementation of the CEE necessarily changed as a matter of course throughout CapDEM as well as between the evaluation exercises, there was a lack of confidence and certainty in terms of its robustness. Based on the maxim that "the devil is in the details", various lessons (from technical, operational to logistical) were learned from the considerable and often unforeseen effects of seemingly minor changes in terms of implementation details. Hence, the challenge is to appropriately reflect such a cause/effect hierarchy in a manner useful in guiding future CEE design and development.

5.1.3.1 Understanding and Usability

The tightly coupled themes of understanding and usability underlie many of the issues that affected the CEE during Exercise Gamma. In particular, a lack of understanding of how to use particular tools as well as how to use them in conjunction with each other exacerbated the level of difficulty experienced (i.e., usability). In general, the utility of the CEE was not appreciated nor capitalized upon (i.e., taken advantage of) by the CET. The CET did not effectively or efficiently utilize many elements of the CEE and exhibited the classic 'training vs. doing' divide. For example, while the team expressed a desire for more and better training of the CEE, doing so was afforded little time and availability by the CET. Similarly, there was often concern over whether the tool suite was sufficient or modifiable enough (i.e., customizable) to do the work at hand while not yet having a sufficient sense of what tool could do; that is, they often worried about whether the CEE was capable of a function and who would be responsible for it, rather than investigate how the tools could have worked together to meet their needs. This issue is an example of how the team's work methodology (e.g., curiosity vs. instructive) was incompatible with the non-operational readiness of the CEE. Combined with issues of workload (e.g., time), the issues of knowledge and awareness became pivotal.

As part of working together, all members of the CET need to be at ease with entire tool suite to avoid potential communication problems through better understanding of other participants and each other's contributions to the effort. That is, the CET requires a global sense of CEE capabilities through a basic level of knowledge, such that people can access information for their own purposes. It is not intended that everyone should have the level of knowledge required to use any given tool to process information. Subject matter experts and/or specialized users are still warranted, but as part of forming a cohesive holistic team, knowing 'the language' of the work environment is a necessary and important part of enabling users' trust in the technology as well as other users and their use of the CEE.

The above discussion alludes to the general issue of connectedness both amongst CET members and between CET members and their work environment (i.e., the CEE). In situations where

"everything is new", be it team members, the work processes they are applying, or the technology they are using, it is important to 'ground' people with a sense of certainty. Given the objective and pervasive nature of technology, it is often intended to address this need; however, in Exercise Gamma, this was not generally the case. Due to the novelty and diversity of the CEE, many members of the CET had no prior exposure to the tools being used; as a result, their level of comfort was less than optimal. Consequently, there was sparse usage of many CEE components by such individuals, and various tools (such as the Livelink portal/repository) were used in less than an ideal manner. The previously mentioned difficulties with training and the influence of demographics further exacerbated the situation in which surprising approaches to tool use and associated requests for support were problematic for the Evaluation Team to address in a timely fashion. As a result, satisfaction across the whole of the CEE was generally lessened.

An unfortunate consequence of the above was a lack of cohesiveness and ownership with respect to the use of the technology. Specifically, there was an expressed desire to have certain tools actually used on behalf of the CET (i.e., have an operator provided). In fact, depending on the tool and/or the type of task to be done, there sometimes seemed to be a disdain towards tool use, particularly in the sense of preparatory (e.g., foundational, organizational) steps which were seemingly regarded as an administrative function instead of a relevant aspect of their work. While some CET members were strong advocates of specific tools and their potential within application of the CEP, there sometimes seemed to be a general sense of apathy amongst many members in terms of the CEE and a reduced sense of responsibility for their use in specific work contexts (for example, see 'data model' under Section 5.1.3.3). Going forward, a much more cohesive approach and a clearer delineation of responsibilities with respect to technology use, along with a stronger ability to assist in problematic areas will be required (see discussion under sections 5.1.3.5, 5.1.3.6 and 5.2.2).

Finally, it should be noted that the sense of urgency incurred during the latter weeks of the exercise (see Section 5.1.2.1) provided a different experience for the CET in terms of the CEE (vs. the CEP). Unlike the CEP, in which the CET made stronger attempts to execute the process during its schedule extension, tool usage was not approached in the same manner. Specifically, the desire to expedite their work and not 'waste time' resulted in the CET following 'the path of least resistance' with respect to tool usage. Hence, some elements of the CEE had reduced usage (as there was "no time") or some elements were used in a limited or unintended (sometimes incorrect) manner. Thus while the sense of urgency arguably helped focus process issues, it tended more often than not to inhibit and/or hinder materiel application.

5.1.3.2 Functional Grouping and Alignment

As mentioned in the introduction to Section 5.1.3, while there was the notion of a 'standard CapDEM toolset' for purposes of conducting the TDP, the ongoing evolution of the CEE throughout CapDEM made it difficult to converge towards a 'definitive' CEE[16]. Arguably, while it could be useful (in some ways) to direct that specific tools and/or functions be used at particular points in the process, doing so is inappropriate for several reasons:

[16] The notion of 'definitive' denotes the specification of the CEE at the granularity of specific and individual tools (e.g., product name, vendor, version, etc.).

- **Evolution.** Excessively fine granularity in terms of process and tool interaction makes application of the process rigid and the technology fragile; that is, because both axes will evolve over time, overly tight integration would require an untenable level of maintenance of both axes to ensure their continued alignment. In addition to the commercial and political sensitivities of specifying particular hardware and software, overt dependencies between process steps and specific tool features/functions can easily become out-of-date, resulting in confusing, incorrect and potentially counter-productive or inoperative linkages.
- **Adaptability.** Excessively fine granularity in terms of process and tool interaction also does not readily facilitate environment adaptation. As each new instantiation (i.e., instance) of the CapDEM approach is realized based on its own problem specification and with its own CET, there is the need to be able to adapt the supporting CEE environment based on instance-specific preferences and requirements. Without doubt, the commonalities in terms of interface and organization between various CEEs were highly beneficial and appreciated by its users. However, the open-ended potential of requirements resulting from a broad user base, diverse usage contexts and situation-specific logistics (ranging from government procurement practices to technical infrastructure considerations) did limit the ability and utility of recommending specific applications.
- **Philosophy.** Excessively fine granularity in terms of process and tool interaction also goes against the non-prescriptive philosophy taken both with CEP and CEE usage. As with the process, the intent (and hope) was not to prescribe technology but enable informed, creative and evolutionary solution development by the CET through the provision of classes of tools to enable and facilitate the various engineering and analysis tasks. That is, an inappropriately tight coupling between process and materiel axes does not readily allow for individual variations in work practices and novel (i.e., creative) approaches therein. A balanced approach which provides alignment between technology and specific CET roles therefore offers educated users a means to capitalize on best practices and individual expertise.

Accordingly, the approach taken was to identify functional groupings, validate their use and document their issues and evolution throughout execution of the TDP. Within Exercise Gamma, for example, an option analysis tool proposed by one of the CET members was added to the CEE to augment its existing functionalities. Other changes, such as those necessitated by the exercise's security classification, were evolutions due to changing usage requirements. Furthermore, while CET feedback highlighted the need to add risk and costing tools, the need for support in those functional categories had been previously anticipated; and in the case of costing, a specific tool had been provided to earlier CETs. However, that tool was later found to be unsuitable and subsequently removed from the CEE. Nonetheless, the confirmation of need highlights the value in identifying various possible evolutionary paths for the CEE, including the need to address functional areas that are not well-served by currently available tools and technologies (i.e., promote their development either within industry or as research efforts).

Consequently, a more utilitarian approach was to formulate a CEE reference architecture, defined in a reasonably 'tool-agnostic' fashion. Note, however, that such an approach can still come with significant challenges in terms of implementation (see Section 5.1.3.6). Additionally, while a functional approach is useful, it can be difficult to discern and convey the idiosyncrasies of general usage versus the means to realize a particular effect. An example from Exercise Gamma

would be the use of Livelink for both general file management as well as trying to make it serve as a data/model repository (see Section 5.1.3.3).

5.1.3.3 Information and Knowledge

As with the issues of understanding and usability, two broad concerns in terms of information and knowledge[17] management also underpin CEE utilization: (1) information organization, representation and access; and (2) classification of information and the facilities (e.g., transport, communication, storage, separation, procedures, etc.).

Organization, representation and access. The organization of the information utilized within Exercise Gamma, including its representation and access (availability), was of considerable concern by the CET. Part of this concern was in terms of the knowledge portal, realized via a content management system (i.e., Livelink), for use as a central repository and collaboration hub.

Unfortunately, the reality of portal use was not as anticipated. Specifically, it was used less and in a less than advantageous way both in terms of information storage and collaboration. Indeed, portal use and the CET's information management practices were impacted by a number of factors: existence and awareness of infrastructural, compatibility and performance issues; personnel and training issues, including understanding (of the tool and information management practices) and user preferences (e.g., favouritism towards other tools). There was significant reticence by members in terms of how to address these concerns; specifically, numerous CET members wanted assistance to utilize Livelink for tasks such as creating and organizing documents, including the maintenance of versions and relationships between them. The level of assistance ranged from an on-call coach to the preference of 'taskable' support personnel to do these tasks on their behalf. This request was not expected and efforts to provide the desired level of support could not be realized in sufficient time to be useful. Indeed, it was anticipated (by both design and experience-to-date) that the CET itself would be sufficiently capable, interested and motivated to utilize the portal and organize its information in the repository by itself. However, this was not the case and to some degree, such an expectation was both resisted and derided.

In general, the approach taken was more akin to a network drive than for collaboration and content (information) management. Accordingly, the use of configuration management (CM) was an issue. Ideally, the focus would have been the application of CM principles using the provided toolset; however, such an approach was problematic given the existing issues of understanding and information management. Consequently, a more conscious effort on how to utilize CM practices within the CEE needs to be made.

For example, consider the notion of an 'artefact-centric' approach to the CEP (see Section 5.1.2) and the desire to move away from a 'document-oriented' approach (i.e., "…less like writing a report…"). In such a case, in which report generators would automatically compose deliverables from artefacts, the unit of consequence is an 'information fragment' such that deliverables and tasks refer to and exploit the same information fragment (i.e., artefact). Doing so reduces duplication and assists in reducing error and maintaining currency between related tasks and deliverables. Furthermore, the use of such a 'composable' approach has the potential to be

[17] For purposes of this discussion, the terms 'information' and 'knowledge' are generally used interchangeably, except when explicitly differentiated to identify specific characteristics.

automated. However, such an orientation has a significant effect on tool use and information structure. In particular, an artefact is at a higher granularity than a document (e.g., a paragraph, figure or table which together comprise a document); therefore, an appropriate information (data) model must exist by which final outputs (e.g., final reports, deliverables) can be specified as functions of elements of the information model. As the standard COTS tools utilized within the CEE function at a 'document' level, a tighter and customized approach would be required to reformulate deliverables as composites of a finer granular data model. In terms of Livelink, its nested constructs (i.e., compound documents[18] and documents) could have been explored as a potential way to do so. Indeed, this approach was proposed by the Materiel axis advisor; however, the resources necessary to realize the approach were not available. Going forward, there would be significant benefit to providing for varying granularity and composability in terms of information management. Notably, a degree of CEE customization (e.g., connectivity between architecture and documentation tools) and tighter integration between axes would be required to more clearly identify which role and technology would align with (i.e., be responsible for) a given artefact and the relevant part(s) of the process.

A related information management peculiarity was the CET's request for the ability to have "versions of relationships between 'things'". The standard approach to CM utilizes versions of 'things' (such as documents) with known relationships between them. Accordingly, in the case such that a 'thing' or the nature of a relationship between 'things' change, a new 'configuration' results. Within Exercise Gamma, it was unclear how such a model could be implemented within the CEE (i.e., Livelink); specifically, it would have required more expertise and time than was available to design and implement any probable solution. Further, the Evaluation Team (through the Materiel axis advisor) also deemed such an approach as inappropriate. For example, consider two possibilities in terms of realizing a 'versioned relationship' within a configuration managed informational model: (1) link a version of 'Document A' to a version of 'Document B' to a version of 'Document C' (effectively a transitive baseline across a group of versioned documents); or (2) create a version-able object which itself can represents different kinds of relationships (as an instantiable first-class object) combined with the use of tagging (such as through Livelink classifications). Aside from the complexity of understanding the issue, addressing it was deemed a 'red herring' and outside the scope of the exercise (that is, it was not required in order to do the work). Rather, the issue was an (interesting) consequence of the way the CET approached their information management. Going forward, the linkages and impact between information modelling, tool outputs, process outputs (e.g., deliverables) and their construction relative to each other needs more consideration. The importance of training and suitable SMEs in terms of these issues also needs to be more clearly articulated, so as to help ensure the CET maintains focus and avoids unnecessary tangents. Further, there needs to be clarity in terms of the suitability and the implications of using the same or different technologies (tools) for both general file management and for a structured data/model repository.

In terms of the impact of information management practices on collaboration, the CET generally employed classic editing of individual documents rather than collaborative use of shared documents. Indeed, the CET could have used the CEE functionalities to be collaborative, but they would have had to make an explicit effort and manage documents according to a particular methodology. Such a tendency reflected a lack of experience with collaborative systems along

[18] A 'compound document' is the Livelink nomenclature for one composed of other individual documents. The idea is akin to MS Word's 'master document' and the notion of 'object linking and embedding' (OLE).

with unreasonable expectations upon the collaborative system; indeed, while many collaborative technologies are transparent, the logistics of sharing and the potential side effects on the materials being edited need to be kept in mind. Notably, CEE performance (specifically Livelink) was an issue impacting their desire to use these features. Consequently, the situation was an example of infrastructure impacting performance impacting choices of tool feature/function impacting the overall extent of collaborative behaviour. Specifically, in situations such that certain behaviours are not routine, small technical issues can be seen to have unintended consequences in which people will revert back to 'what works' and 'the path of least resistance'.

Lastly, the collection of information was also difficult in terms of input from organizational levels above the CET. Specifically, there was a desire expressed for the use of an enterprise architecture tool to assist in getting and organizing system attributes. More generally, this issue speaks to the need to provide technological support along the interface between the CEP and other departmental processes. Going forward, clarity as to relevant organizations, processes and systems will need to be provided as part of addressing this issue; however, for purposes of the evaluation exercise, this concern was beyond scope.

Classification. Information classification and the means by which to transport, communicate and process said information was an overriding concern of the CET. Of particular note was the desire for an expeditious means to migrate from an unclassified to a classified CEE. Both of these considerations were frustrated by the prototypical nature of the classified CEE, such that there were still 'growing pains' associated with its finalization and initial use. Combined with the issues of information management (see above), logistics (Section 5.1.3.4) and infrastructure (Section 5.1.3.6), the result was an inconsistent and sporadically unavailable environment which frustrated both the CET as well as the Evaluation Team.

Despite the legitimacy of the above concerns, classification was sometimes a pretext for not resolving (and even avoiding) certain issues; that is, it was easy to blame the environment. For example, the CET said the environment was 'not ready' to deal with classified material. However, given the environment was certified to Level II, such readiness was characteristically more procedural and knowledge-related. That is, since the exercise was the first use of the technology (both as an environment and by many individual CET members), knowing what and how to do things were mutually confounding factors. Rather, the bigger difficulty was the ability to be collaborative due to facility issues (e.g., lack of classified work places, network availability, etc.) combined with the knowledge issue of how to access, process and exchange information. Indeed, the collection of information from other sources, including SMEs and other classified environments, was difficult both because of such technical limitations but also due to a lack of procedural experience. Furthermore, the use of the 'Canadian Eyes Only' (CEO) caveat stifled collaborative efforts due to most departmental classified systems being CAN/US, not CEO. Thus, the problem of classification (and caveat) must be addressed and educated at a higher organizational level than possible within a single instantiation of the CapDEM approach; that is, the CEE must fit relative to the broader departmental capabilities and procedures as part of facilitating institutionalization and growing the interface between resources considered part of the CapDEM approach and other relevant departmental actors.

5.1.3.4 Logistics

The above concerns regarding facilities (e.g., lack of classified work places, network availability, etc.) speak to the larger issue of exercise logistics and the logistics of applying the CapDEM approach. While these two issues intersect, it is important to realize they were not the same and will naturally differentiate going forward.

Logistics, as typified by the availability and access to facilities and technical support, proved to be a preoccupation for the CET within Exercise Gamma. Specific issues such as team mobility and a desire for co-location were encountered. There was also the desire to be integrated into (i.e., connected to) the classified CEE from individual member's offices (workstations). Notably, the connection to the classified CEE outside its physical boundaries (consisting of the classified ACCESS Lab and adjoining server and storage rooms), would have required a complete virtual environment based on external connectivity to the dedicated CEE facilities.

Interestingly, the requirement for a complete virtual environment was somewhat at odds with the team's opposition to distributed meetings. Indeed, CET desire for co-location would limit the potential value of employing a distributed environment. However, it would seem that the primary motivation behind the virtual environment ('virtual facility') was to enable the use of the classified CEE from individual offices in order to avoid the need to use a dedicated classified facility, such as the classified ACCESS Lab. As the use of specialized facilities for classified meetings has been the norm and there was no precedence for such an office-oriented approach, it seemed that such a request was based primarily on workplace comfort and preference (possibly indolence).

It should be noted that many of these concerns are outside the scope the exercise and while they are relevant to individuals within the CET in terms of their experience in applying the CapDEM approach, they are less affected by CapDEM-specific issues and more about general resource and personnel issues. An example is that commonplace office logistics (e.g., moving offices, transferring between buildings) were not an exercise-level responsibility. Rather, the exercise management attempted to mitigate the impact of such issues on the CET members; however, the provision of secure computing at individual workstations/offices was an issue broader than CapDEM. Specifically, it was not possible (nor realistic) to address all the logistics (technical and security) that resulted (e.g., ensuring network runs to new office spaces and providing for structural constraints to enable secure office processing (including window coverings and controlled physical access)). While the exercise provided an example context and additional impetus to provide for such a capability, it would be extremely unlikely to be a sufficient requirement and could not be the sole source of resources to address such needs.

Within Exercise Gamma, logistical issues detracted from CET focus and CEE application. Going forward, clearly identified and reliable logistic support will be required to ensure both of these needs are met. This support includes the need to ensure environmental and infrastructural readiness in a more reliable and timely manner, as part of not undervaluing the importance of these issues to the CET and to the successful use of the CEE. Conversely, the difficulty associated with achieving such a reality should not be underestimated given the various issues outlined in Section 5.1.3.6.

Naturally, with increased experience will come fewer problems in terms of how to access, process and exchange information. The collection of information from other sources, including SMEs and other classified environments will change over time as the process becomes more embedded in departmental practice, and both experience and benefits accrue, promoting awareness and lessening concern through familiarity and acceptance by the user community. Further, the design and capabilities of facilities will continue to evolve based on contemporary work practices.

Notably, a benefit resulting from CET interest in using the classified CEE at external offices (workstations) was the highlighting of its mutually exclusive configuration constraint[19]. Indeed, the notion of realizing a concurrent yet dissimilar virtual environment configuration to that active in the lab is a lesson learned. Dual internal/external configurations were not part of the original design specification; hence Configuration A being active in the lab implies Configuration A will be active on the external virtual environment, such that a different Configuration B would not be useable at that time. This constraint could result in potential conflicts between internal and external CEE users. Going forward, should security issues be addressed such that classified CEE access external to the classified ACCESS Lab become viable, further examination as to the support of different internal and external configurations will be required. Indeed, whether or not multiple external configurations could be made available at the same time would also require further study and engineering. Presumably, the value of such functionality would markedly increase should CEE use become commonplace given the institutionalization of the CapDEM approach, in part based on the frequency and relative consequence of such requests. Notably, however, based on previous development experience with the classified CEE and ACCESS Lab, achieving such modifications would not be trivial.

5.1.3.5 Personnel

A critical factor impacting CEE application is personnel availability, training and integration. While the technical considerations of the CEE are obviously a critical enabler, those using and supporting the CEE are the lynchpin underpinning its successful application. In particular, the provision of quality technology without appropriate, sufficient and effective linkage to personnel and process axes will result in less than optimal benefit. Thus, ensuring the appropriately skilled personnel are on the CET, either as core members or SMEs, is a key facet of realizing a beneficial application of the CEE.

Within Exercise Gamma, the CET did not utilize the functionality of certain tools in a suitable manner. While there was the intention to allow for exploration, novelty and creativity in the use of the CEE, the Materiel Advisor (Evaluation Team) attempted to broadly steer the CET towards certain flexible but utilitarian approaches. However, the degree to which assistance could be provided was outpaced by the needs of the CET, resulting in members using ad hoc approaches that sometimes did not provide a sustainable solution. Sometimes these approaches became sufficiently ingrained that changing them would have been problematic given the time and resources available. These circumstances typically aligned with a lack of appropriate knowledge in terms of individual technologies, general organizational and information (knowledge)

[19] A configuration in this context refers to the combination of select active networks (e.g., network enclaves) at any given moment. Specifically, due to security restrictions, only certain networks can be active within the environment at the same time so that likelihood of cross-contamination between them is minimized.

management practices, along with unrealistic expectations. The epitome of this situation was the use of the Livelink content management system as an information and knowledge management tool. Specifically, there was a significant disconnect between how the CET envisioned their information, how it should be organized and represented both conceptually and within Livelink, as well as the knowledge, ability, time and resources available to the CET (and the Evaluation Team).

At the same time, there was an apparent lack of interest by the CET to directly address these issues. Rather, the CET seemed to prefer that these issues be taken care of by someone else, regarding them as a low-level support function in contrast to an important part of how to articulate and express their work. In reality, such issues span the spectrum, from formulating the conceptual basis by which work can be described to the reality of software 'button-ology'. Further, various individuals seemed somewhat inclined to address only the CEE elements that were directly relevant to their role and/or immediate need. For example, some members had difficulty in recognizing the relevance of one tool versus another, as well as the relationship between certain tools and parts of the process. The lack of such a global perspective would seem to be linked either to an incomplete 'big picture' understanding of the CEP (as mentioned previously) or as representative of an intellectual bias in terms of engineering and analysis techniques. Irrespective of cause, however, the CET's lack of positive engagement with the CEE served to further a negative feedback loop in terms of its use (i.e., created a self-fulfilling prophecy of problem abetting problem). Indeed, legitimate concerns were sometimes used as excuses when the team became frustrated within the exercise, be it in terms of process or technology. Hence, lack of interest and enthusiasm further clouded technical issues (such as performance) and the ability to respond to them in terms of CET satisfaction.

Going forward, a much more cohesive approach and a clearer delineation of personnel with respect to technology use will be required, as will a stronger support capability to assist in problem areas. It is recommended that a means for enabling and advocating suitable use of the CEE be made integral to the CET structure. This integration could be provided either by a dedicated CEE-focused team member, or through multiple team members whose CEE-focused responsibilities and skill sets are stringently incorporated into their role definitions (a potential application of the Team Charter).

5.1.3.6 Technology, Facilities and Infrastructure

The realities of distribution and security in terms of the Exercise Gamma CEE provided a number of challenges both for the CET as end user and the Evaluation Team (Materiel Advisor) as the responsible interface between the CET and the environment's implementers and service providers (e.g., various network and facility personnel). Certainly, a number of legitimate technical issues vexed the CEE; however, a variety of those challenges were of consequence primarily due to the prototypical/experimental nature of the exercise. Therefore, it is necessary to differentiate between the two contexts, in order to address the actual underlying issue and not be sidetracked by situation-specific irritants.

It is also noteworthy to consider that the unlike the CET and CEP, the CEE is unique in that to some degree, it was an integrated and cumulative interface to a conglomeration of systems owned and under the control of various disjoint organizations. For example, the CEP was a construct defined and owned by the CapDEM TDP; therefore, the Evaluation Team was naturally aware of

its status and evolution. The CEE, however, was a combination of tools and technologies that existed on, and communicated over, a variety of infrastructures (i.e., servers, networks, etc.). Due to the large number of stakeholders involved in realizing the CEE, various idiosyncrasies of, and dependencies between, components and the supporting infrastructures were not always clear or recognized. By virtue of this reality, the resiliency of the CEE was very difficult to ensure.

Within Exercise Gamma, the primary technology themes included:

- **Realistic application.** Who uses specific tools (i.e., which roles and with respect to which responsibility or function) and how the tools fit with the process (i.e., stage, function, etc.).
- **Functional specification and adaptation.** The need to be able to flexibly adapt the tool suite by adding analytical tools as they become required is important. Further, there needs to be clarity on missing functionality and how to satisfy unique CF/DND considerations using standard tools (e.g., how to appropriately address PRICIE).
- **Performance and usage experience.** The need to ensure suitable, equitable and resilient performance for all tools, including awareness of how potential issues at the technology/policy divide can significantly impact the usage experience (e.g., unsatisfactory tool performance primarily due to cross-network policies).
- **Access and availability.** There is a need for readily available and flexible access to specialized facilities (such as the ACCESS Lab) as well as the desire for external access to the CEE (i.e., from outside the lab) through the realization of a 'virtual facility'.

In terms of resiliency, the cross infrastructure deployment of the CEE within Exercise Gamma was highly problematic. While this issue was specifically exacerbated by the prototypical and experimental nature of the exercise, ample and ongoing effort will be required to minimize usage and compatibility problems in future environments while still affording users a fluid, intuitive and dependable CEE. A key issue impacting the availability, performance and reliability of the CEE was the lack of control and awareness over the multiple infrastructures (i.e., networks, facilities, etc.) utilized by the CET (see Figure 8). The need to use multiple networks and provide multiple entry points to the CEE for purposes of location-independent access (including the Internet) proved very problematic, as each new access point inferred a new network infrastructure with

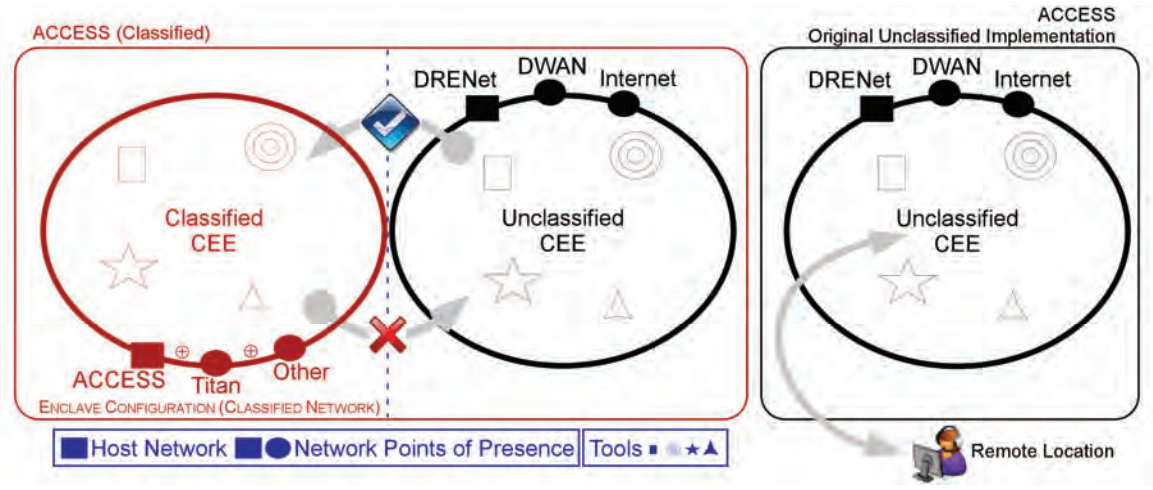


Figure 8: Dual CEEs – Illustrative Structural Comparison

which to be compatible. As an example, many of the difficulties experienced within Exercise Gamma were due to unknown technical requirements with certain software components (i.e., implementation side effects), combined with a 'trust' issue between the CEE host network (DRENet) and the CET's primary point of presence network (DWAN). In particular, the primary non-host network used by the CET implemented ad hoc, unannounced policy changes that prevented a number of tools from functioning correctly and/or creating significant performance problems.

The above effects were further confounded by the mixed use of unclassified and classified facilities/networks, their corresponding policies and procedures, as well as a lack of familiarity and comfort in terms of their use. The key challenge with the mixed use of unclassified and classified facilities/networks was that certain information could only be stored and processed within a classified setting. However, due to the limited ability to readily and freely work in a classified setting, there was the need (and strong benefit) to do as much as possible using the unclassified CEE. Therefore, the issue of consistency and linkage (in terms of analysis and information) between the two security levels was arduous and required deliberate effort to maintain and utilize both systems in a logically cohesive yet physically disjoint manner. Short of providing sufficient classified facilities to enable CETs to do all their work in a classified manner, there will continue to be a need for simpler (i.e., automated) and approved methods to facilitate exchanges between environments of differing classifications. While the issue certainly affected Exercise Gamma, addressing it was outside the scope of the exercise. Indeed, such an issue offers significant technical and policy-related challenges, and is important to many efforts within and between government organizations. Consequently, the challenges in this area will need to be addressed by a broad range of R&D initiatives.

The overall result was a less than confident user experience. Ultimately, the desire for a complete and fluid virtual collaborative environment was not met. Hence, short of providing cross infrastructure service level agreements including a means for suitable notice and redress of infrastructural changes, a recommendation is that the CEE should exist on, be managed and supported by, a single network infrastructure (not precluding differences due to required security classification). Correspondingly, the CET would benefit from working solely on that particular network for purposes of utilizing the CEE. External access to the CEE remains desirable, albeit limited by security considerations of potential end points. Moreover, the variety and configuration of access points needs to be limited and well-controlled as a matter of pragmatism.

Beyond the desire for 'commonality' across security caveats, there was the desire for 'commonality' amongst the various components of a given CEE, to promote the seamless transition between them (i.e., transparent integration). For example, there was the request for more automated interaction between document preparation and architecture tools, so that there was less manual intervention required. Some progress on the data interchange issue had been made during earlier CapDEM efforts [13][15]; however, issues of scale and resources did not enable the provision of this type of support within the classified environment in time for the exercise. Achieving smooth information exchange was also made difficult due to the variety of sources and sinks used as a result of security, policy, geographical and technical issues. For example, as highlighted in Section 4.2.3.1, a variety of means (from printed copy to swappable hard drives) were used in response. This variety, combined with a lack of familiarity in terms of relevant information handling practices, lowered the fluidity and increased the disjointedness by which information was exchanged.

A number of other 'growing pains' and 'side effects' were also experienced in terms of the classified ACCESS Lab. While the users expressed that they liked the actual facility (albeit less aesthetically pleasing than the unclassified lab and a bit barren due to security requirements), the following were noted: (1) due to a change in the video system from that recommended by the Materiel Advisor, the implemented video system's performance was not satisfactory, and as a result, a lower quality (visual) experience was had by the CET[20]; (2) physical access to the CEE equipment (e.g., servers and network equipment) via the (classified) ACCESS Lab was problematic as it disturbed meetings and work sessions, was physically awkward in terms of room logistics, and caused concern from users in terms of interrupting classified activities; hence, better segregation of spaces and/or separate entrances need to be provided; (3) the desire for remote access to the (classified) CEE through a 'virtual facility' was stronger than anticipated, in part due to the CET's dislike for being facility-dependent (both physically as well as in terms of enclave configuration). Notably, this issue was not encountered in the original unclassified environment; further, the use of different enclave configurations effectively results in a modal system, which generally suits a more constrained and regulated environment – but at the expense of ease of use, agility, and ad hoc, creative application.

The importance of these kinds of experiential issues along with the performance of the computing environment (i.e., hardware and software infrastructure) is that they directly influence user acceptance and exploitation of end-user applications. As an experiment, the results of Exercise Gamma are best interpreted as indicative of the kinds of concerns that will need addressing in the early days of an institutionalized CEE so as not to skew or improperly bias its acceptance by the user community. As in this exercise, when users are relatively new to an approach, its value and utility are still open to interpretation by the user community. Given the complementary role of CapDEM's axes, the experience (and value) of each axis and the effort as a whole are impacted transitively. For example, the relative success of distributed teaming issues (in terms of function and work practices) are influenced by the suitability and success of the communications and collaboration technologies employed within the CEE. Conversely, the organization of team members influences what is required of the CEE to enable them to apply their part of the process. Consequently, as low-level computing infrastructure affects CEE end-user application performance, which transitively impacts acceptance and use of the CEE and its success in helping the CET execute the process, the infrastructural foundations that are generally outside the scope of the CEE are critically important to its success and that of the larger effort. As an example, consider Livelink, whose performance was significantly impaired due to various infrastructural issues outside the CEE (Section 4.2.3.5). Specific feedback denoted a sense of frustration and hesitation by its users: "Livelink did not have performance needed – always several seconds per click; [it] can not keep up with people's thoughts; either the tool is bad, installed wrongly, configured wrongly or infrastructure is problematic". While tool selection may have addressed certain difficulties, the performance of Livelink within a single network indicated the tool was not 'bad'. Further, its installation and configuration were per specification; however, the means by which tool was accessed (i.e., infrastructure and access configuration) seemed at odds with the tool (e.g., was fragile and too easily 'broken'). Hence, this 'downstream' technical compatibility issue had significant impact on user acceptance (i.e., 'buy-in'). No matter which tool is used for information management, the users' infrastructure and broader environment must not impede its function so the user community can properly assess its worth. Otherwise, transitory and isolated

[20] Indeed the issue was significant enough that lab management decided to revert to the originally proposed video system design; unfortunately, the issue was not remedied within Exercise Gamma's timeline.

problems with the technical environment can inappropriately bias users' perceptions of the technology while also colouring their view of the other axes.

Not surprisingly, and as in previous exercises, there was a demand for increased IT support from the CET. While the specifics of the requests aligned to the technical challenges discussed above, it is notable that the demand for such support did not result from the specific technical environment itself (as there were different CEE implementations between exercises). Rather, the demand tended to align according to the CET's familiarity and comfort with the CEE, both as a group and as individual members (such as skill set, aptitude, role and demographics). In reality, the demand for support will always exist due to the changing CET membership and their familiarity with the process and the specific environment. Within the exercises, a significant problem was that no actual IT people were available in a dedicated manner; rather, ad hoc IT personnel were 'borrowed' according to availability. Consequently, such personnel were not necessarily aware of CEE specifics in sufficient detail, such that common support tasks routinely took longer and involved more people than usual. Such a situation was obviously less than ideal and often frustrated those involved, thus unfortunately influencing the users' perceptions and acceptance of the environment. Going forward, this issue will become less of a problem as the CEE is integrated into the departmental IT infrastructure.

In the same way, time and experience will highlight and focus those technology issues that are more endemic to the particular approach, such as knowledge and information management (e.g., collaborative vs. individual documents, relationship versioning, configuration management, and artefact-based report generation) and those that will need instance-specific consideration (such as demographics and scheduling). Demographic influence was seen across the various experiments[21], showing up in tool selection and usage, as well as how the group worked together with respect to technical issues. For example, Exercise Gamma was the only exercise to use the document projector (a near middle-aged military member who employed paper documentation to deal with security issues). The demographics (at a team level) corresponded to a difference in how the CET would respond to technical issues. For Exercise Gamma, the CET did generally not try as a team to solve technical problems. Rather, they wanted support personnel to assist them in that regard. This approach was in stark contrast to Exercise Alpha (who engaged the technology) and Exercise Beta (who gave up quickly and did things manually). These variations aligned to how exploratory the individual teams were, including tool use. In Exercise Gamma, CET members sometimes seemed isolated in their technological issues (it was observed that team members seemed to help others at group meetings rather than off-line) and it was sometimes too easy to blame the environment and use the classification issue as a pretext for not resolving the problem at hand. Consequently, this behaviour raised concerns over CET communication, particularly in terms of holistically facilitating collaborative work practices versus exchanging information and analysis for output purposes. Further, as the CET increased its focus on the

[21] Exercise Alpha's CET consisted of entirely of DRDC scientists, engineers and other technical-types; their general approach could be described as 'experimental'. Exercise Beta's CET was a blend of civilian departmental staff (primarily DRDC scientists and engineers) and various contractors with a military lead; their general approach could be described as 'do it this way'. Exercise Gamma's CET was a blend of military and civilian departmental staff (science/engineering and project management background) and contractors with a military lead(s); their general approach could be described as 'just get it done'. The departmental staff in Exercise Beta and Exercise Gamma drew increasingly from DRDC CORA (as opposed to other DRDC centres). Note that a number of the contractors employed within Exercise Beta and Exercise Gamma were also former CF members.

validation of its products (i.e., completing the system views properly) near the end of the exercise, the scheduling did not afford them have the opportunity to suitably appreciate the tools or their utility. Consequently, the ability to extract specifics in terms of tool use was inhibited (see Section 5.1.3.2). Ironically, the sense of urgency that may have helped the Process axis (Section 5.1.2.1) generally inhibited or hindered CEE application, such that the CET utilized the 'path of least resistance' due to the time shortage rather than necessarily finding the best way to accomplish the task.

5.2 Approach and Methodology

The following section provides further discussion of selected methodological aspects of Exercise Gamma, specifically the areas of training and the Evaluation Team.

5.2.1 Training

Based on the first two evaluation exercises, the training component in Exercise Gamma was formulated with the intent to provide hands-on, participatory training across the various axes.

In a typical exercise/experiment, the often minimal, abbreviated and sometimes inappropriately customized training fails to meet expectations. To some degree, this was true of Exercise Gamma. It is important to realize, however, that 'burst' training cannot be expected to provide proficiency; that is, such training does not equate to expertise. Given the future institutionalization of the CapDEM approach, a suitable and sustainable training programme will need to be developed in conjunction with the appropriate departmental/governmental organizations (e.g., Canadian School of Public Service (CSPS)), based in part on experiences and lessons learned from actual projects. Further, many of the issues related to the provisional nature of the training provided in the evaluation exercise will less prevalent. Key elements to include would be:

- **Utilize formal training staff.** Professional trainers (i.e., people that know how to train) must be involved (both in development and delivery of the training). Further, if multiple trainers are involved, it is important to ensure a unified, consistent and cohesive picture within and across the axes to avoid confusion by the CET. Within Exercise Gamma, ad hoc personnel provided the training, resulting in well-intentioned but generally inadequate training with differing (sometimes conflicting) trainer viewpoints.
- **Balance training relative to individual needs.** Within Exercise Gamma, individual members of the CET had varying familiarity with the various axes and their aspects/components. Consequently, the uneven levels of training amplified the need for follow-on coaching. Therefore, the ability to provide more flexibility in terms of individual training needs would be useful.
- **Develop a fuller and more robust programme (i.e., syllabus).** Within Exercise Gamma, the training programme and materials were limited due to the experiment's timeline and Evaluation Team resources. Going forward, the provision of a more complete training programme with suitable materials will be essential to ensuring the appropriate depth and breadth, the ability to adapt to individual needs, as well as affording more flexibility and realism in terms of delivery.

As discussion points, consider the following issues in terms of audience focus and relevance within Exercise Gamma.

- Scheduling changes negatively impacted the planned training. Specifically, while the initial training plan was appropriate, the CET delayed the beginning of the Elaboration Stage by three months, resulting in the need to modify the training plan to ensure timely delivery (in accordance with the PLA). Even so, the CET received Elaboration Stage training almost a month prior to its actual start, resulting in recall difficulties. Correspondingly, a noticeable change in CET sentiment was detected (i.e., very enthusiastic after training, less enthusiastic at the focus group).
- For Exercise Gamma, the training component was modified to be more hands-on, resulting in more engaged participants, increased questions, and improved training dynamics. Some training sessions, however, were still not particularly participatory (notably, the Process training).
- The CET's preference was for more context specific training, applied relative to tasks that specific roles had to perform, including what tools and how they would be used for those tasks. Some individuals wanted 'fill in the blank' training, while yet others advocated the addition of case studies.
- There was a need to establish and maintain 'situational awareness' for the CET in terms of the process at every training session (i.e., provide a global overview – "where we are; what was done; what's coming next"). That is, there was a need to identify and reinforce a linkage between what the CET was doing and the 'big picture' (i.e., capability gap). Indeed, despite the effort to do so, the Inception Stage and associated training failed to convey that perspective; that is, the CET was trained on the 'big picture', but they did not identify with it. Maintaining this linkage was further challenged by the use of an evolving process (including late workflow availability). While such a developmental issue will lessen over later applications of the approach, the question remains how to suitably communicate such information in a way that will be meaningful to a typical CET (e.g., how to order, organize and present the material, be it by stage, phase, artefact, business practice, etc.).
- The CET was sometimes too focused on changing the tool to meet their mindset instead of thinking of how to solve the problem using the tool as provided[22]. This conflict related to training in the need for broad understanding to avoid 'tunnel vision' and the propensity to inappropriately customize approaches and representations such that they don't inadvertently become constraints (i.e., suitable levels of abstraction are required).
- The CET needed to be better informed in terms of information collection not only for purposes of process integration (as mentioned earlier), but also for the identification of personnel and the training required. The tools to collect such information (e.g., enterprise architecture support), as well as how to organize it (e.g., coaching on information/document organization) were the subject of concern.
- Perception, scheduling and attempts to leverage training sessions designed for other initiatives negatively impacted the training reality. Specifically, the planned training for the Materiel axis was not completed, nor was appropriate training achieved. Due to scheduling pressures and the desire "to get going", certain training components were cancelled. Further,

[22] In reality, both directions need to be considered.

the perception of the CEE as being 'just software' resulted in overconfidence and a lack of focus by some individuals. Further, the attempts to leverage (i.e., 'piggyback') training sessions designed for other initiatives (such as DoDAF training) resulted in a range of availability, focus and content suitability issues. Future training must guard against these kinds of misconceptions as part of facilitating an appropriate balance in training between axes.

5.2.2 Evaluation Team

The Evaluation Team was generally well-regarded by the CET, particularly in terms of being "very responsive" to their questions and issues. Conversely, the CET did not appreciate the Evaluation Team's style of interaction, in which feedback often was given via prompting the CET with guiding questions as part of having the CET address its own issues ("don't answer a question with a question"). While the approach taken by the Evaluation Team was primarily to avoid undue interference in the evaluation by being too prescriptive, the CET had a difficult time appreciating that perspective.

Another source of consternation was the nature and purpose of the Evaluation Team, such that there was confusion over its role well into the execution of the exercise (i.e., early on into December). In particular, the term 'Evaluation Team' caused discomfort as the CET did not feel they knew what was being evaluated. In particular, the CET was concerned that their performance was being assessed (in terms of correct application of the CapDEM approach). In actuality, the Evaluation Team was assessing the CET's experience in applying the CEP using the CEE. In this sense, the CET was a 'Subject Team' for characterizing their experience from the CapDEM point of view, not whether the CET was right or wrong in their actions. Unfortunately, the CET had difficulty accepting that perspective; further, they also found it difficult to disassociate between the same individuals serving both as advisors as well as evaluators. Indeed, at one point the CET Lead did state he was not sure why certain persons were in the room; hence, role clarification was a crucial issue, illustrating the need for a clearer separation of "who does what", both inside and outside the CET structure itself. Going forward, this issue will diminish as the evaluator role will be transition to (i.e., be subsumed by) an advisory and coaching function (i.e., a support team across all axes to facilitate training, coaching and problem solving; to assist at the administration/analyst interface (e.g., data modelling) and assist/work with the CET coordinator).

Despite those concerns, an essential function of the Evaluation Team within Exercise Gamma was to provide coaching services to the CET. Indeed, the CET identified coaching as critical to their success ("it's a requirement"). Accordingly, three important aspects of coaching became evident:

- **Appropriate and suitable roles.** There needs to be clearer separation of "who does what" such that the CET found it confusing when the same person would play several different roles. Specifically, the small group of people involved in the exercise often had to perform multiple roles and functions, simply due to personnel logistics and resource availability. This concern would be moderated over time as the evaluation function is lessened (see above) and a broader base of SMEs and personnel become available as the approach becomes more ingrained within the department. Additionally, the provision of facilitators during meetings and other working sessions was noted as potentially helpful (although it was

unclear to what degree they were necessary, how they would have been used and how they would differ from topic-specific SMEs).

- **Suitably skilled personnel.** Suitable training staff (i.e., people that know how to train) must be involved in the preparation and delivery of the various training elements. Similarly, coaching should be provided by experienced persons, not simply using external contractors/developers to provide context-independent training.
- **Style and degree of interaction.** The CET preferred a style of coaching that was both pro-active and offered immediate adjudication. They wanted the coaches to help frame the meetings, to be actively involved in them, as well as to give near immediate feedback (i.e., come back with answers within or shortly after the meeting). While the original coaching style was not as expected, actions taken by the Evaluation Team (early in 2007) to change the style and availability of coaching appeared to be successful. Specifically, a variety of circumstances allowed a limited degree of 'co-coaching' (i.e., one-on-one coaching), specifically in terms of the Process axis (the rationale for more coaching being the lack of process maturity). Such an approach was found to be efficient, facilitating the finalization of the documentation as well as enabling access to a CEP version that was still under construction; it also improved contact between the CET and the Evaluation Team, helping to appreciate the other team's perspectives (including ongoing work and the 'big picture'). Such an approach, which was akin to embedding a per-axis SME within the CET, was resource intensive while still being perceived as insufficient. Hence, there was a need for more substantial coaching in each axis (not just for Process) as well as in the across-axes domain; that is, there needed to be 'joint' coaching in which the interaction between axes and how they would work together for specific tasks and specific points in time (versus in general) would be covered. Such coaching would help the CET understand and achieve a tighter integration between the axes, a key tenet of the CapDEM approach.

6 Conclusion

Despite the challenges encountered during Exercise Gamma, including its unplanned schedule extension and lack of process iterations, the exercise was still considered a success by both the Evaluation Team as well as the CET. Indeed, the identification of many of those challenges was the primary purpose of the exercise itself.

6.1 Report Summary

Exercise Gamma provided the opportunity for a CET constituted from actual departmental personnel to apply the CapDEM approach on a real departmental scenario. This enabled the Evaluation Team to obtain a significant amount of data and insight with respect to the CapDEM approach. In addition to brief per axis summaries, Table 5 provides a synopsis of Exercise Gamma's intended goals, scope, outputs and outcomes as compared to how they were realized within the actual exercise. It is important to note that the level of realization is not an indication of merit or importance in the conduct of the exercise; rather it indicates the degree to which a particular aspect was addressed, regardless of reason or extenuating circumstance. Further, in terms of 'Outputs and Outcomes', many useful observations and lessons learned were obtained outside the originally intended measures; consequently, their actual value is not represented in the table, as such measures reflected more on the reality of exercise execution and less on those outlined in the exercise's original design.

Table 5: Exercise Gamma – Realization of Original Design

Aspect		Description	Realization
Goals	**Overall**	• Test and evaluate the CET, CEP and CEE as applied to a realistic problem provided by an external client.	HIGH
		• Ensure the necessary people, process and materiel can address a 'real world' problem when being executed by an appropriate real-world client group.	MEDIUM/HIGH
	People	• Test and evaluate the final iteration of the CET.	MEDIUM/HIGH
		• Put forward best practices and lessons learned for a comprehensive Team Charter, including the proper identification of roles and responsibilities, dynamic teamwork and collaboration practices, and effective team communication practices and mechanisms.	MEDIUM
	Process	• Test and evaluate version 4 of the CEP, including its complete set of activities and deliverables.	MEDIUM/HIGH
	Materiel	• Test and evaluate the revised CEE.	MEDIUM/HIGH

		• Investigate and determine a reasonable list of functionalities (required, preferred and optional) for CEE institutionalization.	MEDIUM
Scope	**Overall**	• Seven month duration.	LOW
		• 'Real world' scenario.	HIGH
	People	• Complete team size.	LOW
		• DND clients from more than one organization.	HIGH
	Process	• Complete each CEP v4 deliverable.	HIGH
		• Complete each CEP v4 task and iterate as mandated by the process.	LOW/MEDIUM
	Materiel	• Fully exploit CEE functionalities in performance of their tasks.	LOW/MEDIUM
Outputs and Outcomes	**People**	• Complete the Team Charter, incorporating roles and responsibilities, as well as teamwork and collaboration principles for the CET. • Put forward recommended best practices for initiating a successful CET. • Link successful team dynamics with CEE (e.g., ACCESS Labs and Livelink) for enhanced communication practices.	LOW/MEDIUM
	Process	• Ensure the CET clearly understands CEP processes. • Ensure the CET clearly understands CEP deliverables. • Identify documentation weaknesses (process and deliverable templates) to facilitate application during institutionalization within the DND/CF. • Identify training weaknesses to be addressed when providing future training to DND/CF personnel. • Identify metrics to measure and facilitate continuous improvement of the CEP. • Identify critical factors for successful implementation of the CEP.	MEDIUM/HIGH

	Materiel	• Provide a user-validated list of mandatory/preferred functionalities to fully enable the CEP and facilitate collaboration inside the CET. • Refine and validate the existing workflow between the various tools. • Provide an updated and expanded database of 'Frequently Asked Questions' (FAQ), 'Tips & Tricks' and lessons learned.	LOW/MEDIUM

People. In terms of the People Axis, this exercise reiterated the importance of CET composition and structure, including the delineation and maintenance of roles over the course of the effort. Related themes of team charter utility, communication and collaboration along with the importance of team leadership also emerged. Other themes included the need for appropriate and dedicated personnel, expertise integration and ensuring alignment between the CET and CEE.

Process. In terms of the Process Axis, this exercise highlighted the need to address linkages between the CEP and external processes (such as CBP), address CEP lifecycle clarity, alternative specifications, workflow definitions (i.e., process flow), as well as its linkage to the CEE and information management. Process variability, benchmarking and applicability were also highlighted. Various documentation issues as well as the need for further analysis in terms of the relationship between requirements, operational and SoS architectures were also highlighted.

Materiel. In terms of the Material Axis, this exercise confirmed the difficulty inherent to distributed configuration management and support across organizations with different network infrastructures which are not fully interoperable. Moreover, various components of the CEE had unanticipated technical and personnel issues. The key issues of understanding and usability, functional grouping and alignment, information and knowledge, logistics, personnel, and technology, facilities and infrastructure were discussed. Infrastructure provisioning and management, secure distributed collaboration, information management, workflow, external interface alignment to other axes, expertise integration, understanding and usability, as well as the expansion of the technology/capability base were highlighted.

6.2 Highlighted Recommendations

The presentation and detailed discussion of the observations, experiences and lessons learned within Exercise Gamma have already been presented earlier in this report (see Sections 4 and 5). This section now highlights a selection of recommendations abstracted from those earlier discussions.

6.2.1 People

Mandate use of the team charter. As part of maintaining a cohesive and functional CET with an effective understanding and fulfillment of its roles by the appropriate individuals, there must be a more defined link between the team charter and the day-to-day governance and functioning of the CET. To provide and maintain such linkage between the team charter and the day-to-day

governance and functioning of the CET, there needs to be less dependency on team volition to use the charter with its use being mandated and it serving as a practical and authoritative guide, not an ancillary 'good practices' reference. Such functioning includes the alignment of roles and individuals to specific parts of the process (CEP) as well as the technological environment (CEE).

Utilize appropriately designated and dedicated personnel. The CET must be composed of suitably skilled and interested individuals who are appropriately available and in sufficient number according to the requirements of the CE effort. Focus on the effort is important to ensure consistent availability with fewer conflicts in terms of time and accessibility for the variety of tasks required of an individual's role, be it from training and interaction with SMEs to the application of the process and the informed use of the various support technologies. Hence, the participating individuals need to be dedicated to the CET and not divided between multiple jobs. Aptitude and expertise, combined with availability and appropriate role assignments, are key elements of a successful CET. Conflict with other outside job or career interests as well as having to perform too many roles (i.e., wearing too many 'hats' within the CET) results in role confusion and creates uncertainty in terms of importance and priorities that can impact the rest of the team in the performance of their roles and in their interactions with fellow CET members. The effect of arbitrarily altering specified positions and role assignments can have (and has had) negative downstream effects, including intra-team personnel conflicts and a lack of effective work activities due to misperceptions of competency, importance and relevance.

Integrate expertise within the CET. As part of enabling a self-sufficient CET that does not solely depend on outside knowledge for routine tasks such as process application and tool usage, the CET needs to have resident expertise not only on the problem space being addressed, but also in terms of the CE construct. For example, having integrated CET knowledge would be useful for team management, including a more 'natural' use of the team charter. Knowledge of the CEP would help the members not only see the 'big picture' of the effort, including how the parts support and facilitate each other, but also help in the performance of specific tasks. For the CEE, a means for enabling and advocating suitable use of the CEE should be made integral to the CET, either by a dedicated CEE-focused team member, or through multiple team members whose CEE-focused responsibilities and skills are stringently incorporated into their role definitions (a potential use of the Team Charter).

Constructively manage CET roles. As part of ensuring a functional effort, the roles on the CET must be managed in a concerted, clear and transparent manner. That is, the CET must not be left to flounder or its structure be changed in an ad hoc fashion (i.e., 'on a whim'). For example, CET members need to fulfill their roles for the duration of the effort, rather than change (i.e., take on or drop) responsibilities without appropriate consideration of wider implications. Indeed, to ensure cohesive CET behaviour, it is important not to create confusing functional overlap (i.e., ensure well-delineated responsibilities) or distract members through interpersonal issues (e.g., 'turf war') that can have adverse effects on collaboration and team dynamics; see 'Utilize appropriately designated and dedicated personnel' above. As mentioned, the use of the Team Charter would serve as a mechanism to achieve this end, as would embedding knowledge of the People Axis issues within the CET. Further, aside from the management of core CET roles, it is important to clarify the intent of CET support roles**.** For example, CET concern over single individuals serving the combined roles of evaluator, advisor and coach role was a distraction. Part of this diversion was due to functional overlap combined with a lack of clarity with respect to the purpose of particular roles (specifically, the evaluator role) as well as being unclear (and

comfortable) asking for help from the same individuals (in their advisory and coaching capacities). While the role of evaluator will diminish as it is transitioned to (i.e., subsumed by) an advisory and coaching function (i.e., a support team across all axes to facilitate training, coaching and problem solving), the need to know 'who to go to' will remain, as will the need to facilitate good working relationships. Undoubtedly, any embedding of expertise within the CET (see above) will assist in meeting this goal. Further, ensuring appropriate inter-role linkage will help facilitate smooth work practices (for example, assisting at the administration/analyst interface (e.g., data modelling) and abetting the CET coordinator). Moreover, the selection and continued availability of a suitably skilled CET Lead (i.e., Project Manager (PM)) is fundamental to ensuring these issues can be addressed in an appropriate and timely manner.

Increase and clarify alignment between CEE and CET. The common theme of 'technological trepidation' both inside and outside of Exercise Gamma further necessitates an effective bridging between the People and Materiel axes. Attaining this connection requires stronger and more readily identifiable cohesion between the two axes combined with a clearer delineation of personnel with respect to the technology they need to use. Further, a stronger support capability to assist in problem areas is required. Hence, a means for enabling and advocating suitable use of the CEE is necessary to facilitate its effective use by the CET. Achieving clear alignment to and effective usage of the CEE affects both the team as a whole, as well as individual members. Notably, the performance of other team members can influence interactions between fellow CET members, thus impacting team dynamics and consequently, the efficacy of their teamwork and collaboration. Consequently, both aptitude and expertise along with availability and appropriate role assignment must be considered as part of achieving this alignment. To that end, one way of improving the alignment between the CEE and CET is to embed expertise on the environment within the team structure (as described above). By doing so, the increased self-confidence enables the CET to effectively and assuredly use and explore novel application of the tools at their disposal. Consequently, they are able to function more independently and not require continuous interaction with outside expertise, which could excessively disrupt their workflow. Rather, the team would benefit from increased self-sufficiency and higher productivity.

6.2.2 Process

Formalize identifiable linkages between CEP and CBP. Despite the existence of linkages between CBP and the CEP used within Exercise Gamma, they were not easily identified by the CET members. As a result, there was ongoing apprehension by the CET as to how to proceed in a coordinated manner that respected both processes. Consequently, future CEP versions must formalize such linkages and make them more easily identifiable. Clarifying the connectivity between both processes is important to ensure both real and perceived linkage issues are addressed and will be an important part of facilitating its introduction to process newcomers. More effective training and a larger and broader user base combined with increased experience and heightened expertise will also assist with this issue. Furthermore, when the development and utilization of the process become under the purview of a single organization (i.e., CFD), synchronization between the processes will undoubtedly become more straightforward.

Clarify CEP lifecycle and progression. While key aspects of the CEP include its iterative, incremental and multi-stage design, understanding how such characteristics interrelate has proven a challenge for various CETs, including Exercise Gamma's. Confusion over which construct was which and how they related to each other was encountered; the notion of performing the entire

series of stages within each iteration was an example of such a misunderstanding. Going forward, clarity of the CEP lifecycle, including construct relationships and progression between them must be more clearly communicated; for example, the difference between iteration vs. stage and their relative progression. In the broadest sense, the CET needs a clear understanding as how to execute, manage and understand stages in an iterative and incremental manner. More effective training, enhanced documentation, increased experience and heightened expertise will further reduce the impact of this issue.

Provide alternative CEP specifications. As with many processes, the specification of the process can significantly impact how easily it is understood and followed. With the CEP, there was a broad consensus that the provision of complementary specifications, specifically the use of deliverable-centric and task-centric methods, would be important to fostering greater understanding and acceptance of the process within the department. Notably, however, one of the challenges of such a dual-pronged approach is the need to maintain coordination and consistency between them.

Ensure workflow independence. One of the challenges in applying a novel process is to achieve understanding and acceptance (i.e., buy-in) by its practitioners and relative to its supporting technologies. Doing so while avoiding instance-specific explication and maintaining sufficient independence to enable broad and diverse application is even more challenging. Workflows should be specified suitably orthogonal to (i.e., independently of) the specific problem and technical environment; however, for ease of use, they must be linked in an illustrative (normative) manner to the CEE to better enable CET understanding.

Clarify CEP and CEE linkage relative to information management practices. The linkage and mutual influence amongst information modelling, tool input and output, process input and output (i.e., deliverables) and their specification relative to each other needs considerable forethought and appropriate structuring in order to facilitate productive process application through the effective use information management and the various CEE tools. To date, this has been a problem as neither tool or information management (structuring) knowledge was sufficient within the CET. A more well thought-out approach and the formalization of these topics as an essential part of the training programme would prove useful going forward. As mentioned under the People discussion above, the potential embedding of such expertise within the CET would be advantageous. Notably, well-founded information structuring and management principles need to be applied and serve as the basis for well principled exploration of (and deviation from) both the CEE and the CEP once comfort and understanding of the fundamentals are established.

Investigate deliverable benchmarking and applicability to decision making. Further investigation as to the merit of creating benchmarks for deliverable completion and how to provide guidance in support of such benchmarking remain open questions. While illustrating the potential of architectures and capability engineering within the force development process, Exercise Gamma's CET was not able to make solid conclusions about their applicability within the decision process. Given the novelty across the breadth of the exercise (e.g., new CET membership, revised process, and revised/realigned CEE) this is a realistic outcome that serves as an appropriate basis for additional departmental evaluation.

Follow the process and accept its variability. Within the various applications of the process, there have been and will always be natural variation in the conduct of the CEP, in part due to its

descriptive rather than prescriptive specification. The amount of variance in Exercise Gamma, however, was regarded as atypical of that going forward, assuming increased process maturity and practitioner experience. To that end, it will be important to properly control process evolution during its application (i.e., avoid utilizing multiple versions of the process within a single instance). Furthermore, it will be important to limit premature workflow customization, so as to prevent unnecessary divergence from recommended practices. That is, it will be important to ensure that practitioners know and utilize 'the basics' first.

6.2.3 Materiel

Ensure reliable infrastructure provisioning and management. A significant issue experienced within Exercise Gamma was the use of multiple and independently managed networking and computing infrastructures (specifically, the DRENet, the DWAN and the Internet). While this situation was an artefact of TDP reality, it was an unremitting source of user difficulties and technical challenges, which grew each time the exercises' participants became broader. As detailed previously, typical difficulties included unplanned and/or unannounced network policy changes that adversely affected the remote use of tools outside of the host network. Consequently, the ability to work (i.e., utilize the CEE) on the host network would eliminate the myriad of cross-network issues. While external access to the CEE remains desirable, the variety and configuration of access points needs to be limited and well-controlled as a matter of pragmatism (such as the ability to technically support and manage only a certain number of configurations). Further, security and classification issues will need to be more deeply considered relative to the provision of potential end points (see below). Moreover, short of providing cross-infrastructure service level agreements which include a means for suitable notice and redress of infrastructural changes, the CEE should exist on, be managed and supported by a single network infrastructure (not precluding differences due to security classification).

Investigate requirements and alternatives for secure distributed collaboration using non-homogenous environments. Further study is required as to the means to enable and support different internal and external configurations of the tool environment(s) relative to security and classification issues. One example is whether and in what manner external access to a classified CEE and/or the classified ACCESS Lab would be viable. The value of said functionality (which could be described as a secure collaborative VPN environment) is anticipated to be markedly increased should CEE use become commonplace given the institutionalization of the CapDEM approach (based on the increased frequency, distribution and significance of such requests). A further issue to be addressed is whether or not and to what degree multiple external configurations could be made available at the same time, independent of the local configuration of the host CEE. Based on the initial design, it is anticipated that further study and re-engineering would be required to address this additional requirement.

Increase focus, expertise and alignment in terms of information management and associated technological capability. Despite a significant emphasis on information availability, creation, storage and access as part of applying the CEP, there were considerable challenges in providing a clear, flexible, extensible, scalable, comprehensive and understandable means to use, link and describe information that was amenable to CET usage, CEP application and CEE representation. Underlying this situation was a lack of suitable CET expertise, SME availability and a variety of technical and operational issues. The team's conceptual understanding and approach to information management, along with the pragmatics of its implementation, were problematic and

did not align with the need for the variable levels of granularity and composability required to meet the criteria identified above. Indeed, their achievement requires a systematic level of integration and interoperability between the axes in order to clearly identify role and technology alignment to (i.e., responsibility for) a given artefact; the identification of relevant process elements (be it deliverables, workflows or portions thereof) and how they are linked to (i.e., modelled, represented and processed within) the CEE also require a comprehensive and scalable approach. Such malleability requires a shift away from the 'shared file/network drive' paradigm towards the use of composable information architectures. As part of such a migration towards information management and eventually towards the goal of knowledge management, increased expertise from a variety of information and technology fields will be required (potentially including DRDC scientific, knowledge management and IT communities). Notably, many of these resources were not available during the exercise; however, as the CapDEM approach becomes increasingly part of departmental practices, achieving such linkages will presumably be less difficult.

Facilitate workflow independence. As with the application of a novel process, one of the challenges in using a collection of unfamiliar technologies is to achieve understanding and acceptance (i.e., buy-in) by users. Achieving this goal while avoiding instance-specific explication and maintaining sufficient abstraction to enable broad and diverse application is even more challenging. As part of moving towards composability and conceptual interoperability [16], workflows need to be specified suitably orthogonal to (i.e., independently of) the specific problem and technical environment. While the workflows must be linked in an illustrative (normative) manner to the CEE, as part of facilitating learning and providing a baseline for initial use, such linkages must not be done so as to create unnecessarily restrictive limits or dependencies as each of the axes mature and change over time. Facilitating workflow independence from a CEE perspective is necessary to complement the process-centric workflow independence (mentioned above). This decoupling of logical (process) vs. physical (technological) workflows creates a more granular (and therefore flexible and more adaptable) way to repurpose and realign the 'what' from the 'how'. As with the notion of alternative process specifications (detailed above), such an approach can assist in the delineation of responsibilities, therefore informing CET membership relative to different process and technology skills.

Increase support for interfaces to external processes. In support of the process goal of clearer linkage to external processes (e.g., CBP, upper management, chain of command, etc.), there is a need to investigate the technological requirements and implications of linking CEE systems to those used by external processes. That is, this issue speaks to the need for technological support along the CEP's interface to other departmental processes. Within Exercise Gamma, the collection of information in terms of input from organizational levels above the CET was difficult. This difficulty led to the request for tools to facilitate the crossing of organizational boundaries; for example, the use of an enterprise architecture tool to assist in obtaining and organizing system attributes. In working towards this capability, clearer identification of relevant organizations, processes and systems needs to be provided, while issues of representation, compatibility, security and access (e.g., permissions) also need to be considered (again, related to the notion of conceptual interoperability [16]). While such functionality was not within the scope of this effort, it obviously needs future consideration as the CapDEM approach becomes part of the broader capability management domain. Notably, addressing this need will also be easier given the adoption of the above information management recommendations.

Clarify CEE support for information management practices. As discussed previously, the confluence of information modelling, tool input and output, process input and output and their use relative to each other needs considerable forethought in order to facilitate productive process application. In terms of the CEE, appropriate structuring and use of information management principles applied at the interface between the axes require the CEE to provide a composable interface (as discussed above in terms of workflow independence). To date, neither tool nor information management (structuring) knowledge was sufficient and/or available, resulting in very superficial interaction with the technological environment and its information handling abilities. Well-founded information structuring and management principles need to be applied and serve as the basis for well principled application of the CEE. Again, the availability of such expertise within the CET would be advantageous.

Increase and clarify alignment between CEE and other axes. Circumventing missteps in the application of the CEE is a key element in the CET being able to function more independently and avoid excessive workflow disruptions due to interaction with outside expertise. Ensuring appropriate technical propensity along with a balance of technology cohesion and delineation relative to the other axes would be part of achieving clear alignment to (and effective usage of) the CEE both by the team as a whole, as well as by individual members. Further, the performance of individual team members can influence member interaction, therefore impacting team dynamics and consequently, the efficacy of their teamwork and collaboration. Consequently, the resulting impact on both individual and team-wide self-sufficiency and productivity can significantly impede or advance the broader engineering effort. Indeed, such clarity would reduce the potential of inappropriate technology application, along with helping to focus the selection of useful and forward-looking technologies.

Integrate CEE expertise within the CET. The availability of CEE expertise within the CET is useful not only to assist in tool application and information management issues (as discussed above), but also to facilitate advocacy of suitable usage, awareness of potential application and/or which pitfalls to avoid (i.e., provide mentorship and coaching). Achievable through a number of possible CET configurations (see People section above), it is notable that complementary resident expertise in terms of the CE construct would aid in creating a holistic understanding and reduce the potential for technological silos (such as the knowledge of a particular software but not aware of its implications within the broader technological environment or the engineering effort itself).

Promote increased understanding and usability. The themes of understanding and usability underlie many of the issues that affected the CEE during Exercise Gamma. In particular, a lack of understanding in terms of how to use particular tools as well as how to use them in conjunction with each other exacerbated the level of difficulty experienced. By addressing the above issues of expertise integration and improved clarity/alignment, individual members can be more focused on relevant tools and process concerns (i.e., their efforts will be less ‘scattered’). Additionally, such clarity will enable more focused provision of training, mentoring and coaching, along with a stronger ability to target problematic areas in terms of technical support and the evolution of the CEE.

Expand technology and associated capability base. In line with the evolution of the process and the user community that will be conducting the Capability Engineering effort, there is a need to explore alternative and developing technologies (including disruptive technologies) as part of providing an innovative and creative engineering environment that will continue to support the

changing needs of the department, participating staff (e.g., scientists, engineers, SMEs, uniformed members) and the advancing technological landscape. Such a 'technology watch' is necessary as part of addressing the breadth and depth of tool functionality that corresponds to an evolving user base, their expertise/advice and with the need grow beyond the typical toolset.

6.2.4 Training

Provide a suitable training programme. To enable a sufficiently capable and serviceable curriculum for Capability Engineering and the CapDEM approach, a complete self-contained training programme is required. Such a training programme will require useful instructional materials and suitable instructors, offering both appropriate depth and breadth, the ability to adapt to individual needs, as well as affording more accessibility, flexibility and realism in terms of delivery. Within the evaluation exercises, the ability to provide suitable training was already constrained and personnel availability already made scalability an issue. Consequently, the use of governmental training mechanisms, such as the Canada School of Public Service (CSPS), is suggested to address the above concerns, most notably that of scalability and resource constraints. The independence and separation of the training personnel from the CET and its support staff would help address the issue of functional overlap and the perception of evaluation in cases where coaching and other 'on the job' facilitation is required. Similarly, the development of an electronic online tutorial system is recommended as a complement to initial training efforts, both as a compendium and as the basis for follow-on reference and individual self-help retraining.

6.2.5 Other

Ensure clear, accessible and reliable logistics support. Within Exercise Gamma, logistical issues detracted from CET focus and CEE application. To mitigate these issues going forward, clearly identified and reliable logistic support are required, including the need to ensure environmental and infrastructural readiness in a more reliable and timely manner. The concerns regarding facilities (e.g., lack of classified work places, network availability, etc.) speak to the larger issue of exercise logistics and the logistics of applying the CapDEM approach. While these two issues intersect, it is important to realize they were not the same and will naturally differentiate going forward. That is, it is anticipated that future applications of Capability Engineering as an institutionalized (i.e., operational) departmental process will facilitate easier logistical support.

6.3 Concluding Observations and The Way Ahead

Applying a system engineering approach at a capability level is new to the Department of National Defence and its constituent organizations. Thus it will continue to require further improvement through experimentation and application. In addition to becoming knowledgeable in the practice of CE, it is anticipated that the construct will require continuous improvement as it evolves into its niche within the force development community. Challenges will include institutional resistance to change (e.g., legacy of environmentally-aligned stovepipes, 'not-invented-here' syndrome), and the availability of knowledgeable personnel that can be fully dedicated to applying the approach.

As expected for any new approach, concerns arise over its complexity, duration and which of its elements are truly essential to supporting the needs of the relevant decision makers. Efficient and effective team generation with effective training and tools continues to be recognized as a required area and warranting further improvement. Furthermore, the level of detail and volume of analytical products required to satisfy capability level decisions remains an ongoing question that may not be completely answered until a use case is transitioned into implementation via the capability production domain.

This exercise was the first attempt to implement the Capability Engineering process across the broader enterprise. While the participants were generally satisfied with their work, they did not reach a sufficient level of knowledge enabling them to properly evaluate the usefulness and adequacy of their work, therefore limiting their ability to evaluate Capability Engineering and the CapDEM approach as a larger whole. In general, the exercise can be considered a success, such that most of these elements were addressed while offering important insight into the day-to-day challenges affecting its institutionalization. Further, they will serve as important input to organizations applying the approach in the future. It is also important to note that the various efforts to advance the CapDEM approach occurred at the same time when the capability planning, management and production domains were being defined for the first time. As with other departmental concepts like capability roadmaps, the continuous, iterative and incremental improvement of the capability engineering construct will also be required, thus ensuring the need to couple its evolution with an ongoing evaluation strategy.

Based on the evaluation efforts to date, critical success factors for the application of Capability Engineering include the following: commitment by DND/CF executives to realize all portions of the Capability Engineering construct; creation of specially trained ‘CE officers’ to effectively enable institutionalization and continuous improvement; direct involvement of the operational community into solution development in order to provide operationally acceptable options; commitment and participation of relevant capability implementers in order to assess option feasibility; and the availability of appropriate support and resources for the people and the technical environments employed in making Capability Engineering a reality.

Lastly, while this exercise was done within the Department of National Defence, it is quite reasonable to believe that the findings and conclusions will be applicable to any large enterprise willing to shift toward Capability Engineering and the CapDEM approach.

References

[1] Robbins, W., Waruszynski, B., Lalancette, C., Lizotte M. and Nécaille, C. *CapDEM Evaluation Strategy: Integrating People, Process and Materiel*, Defence R&D Canada – Valcartier, DRDC Valcartier TM 2005-164, 2005.

[2] Lalancette, C., Lizotte, M., Nécaille, C., Robbins, W. and Waruszynski, B. *CapDEM Exercise Alpha: Detailed Work Plan*, Defence R&D Canada – Valcartier, DRDC Valcartier TN 2005-258, 2005. Internal publication.

[3] Lalancette, C., Lizotte, M., Nécaille, C., Robbins, W. and Waruszynski, B. Advancing the Canadian Capability Engineering Approach, in Proceedings of INCOSE 2006 Symposium, Orlando, FL, July 2006.

[4] Lalancette, C., Lizotte, M., Nécaille, C., Robbins W. and Waruszynski, B. *CapDEM Exercise Alpha: Results and Discussion*, Defence R&D Canada – Valcartier, DRDC Valcartier TM 2007-080, 2007.

[5] Robbins, W., Waruszynski, B., Lalancette, C., Lizotte, M. and Nécaille, C. *CapDEM Exercise Beta: Detailed Work Plan*, Defence R&D Canada – Ottawa, DRDC Ottawa TN 2005-244, 2005. Internal publication.

[6] Lalancette, C., Lizotte, M., Nécaille, C., Robbins, W. and Waruszynski, B. Capability Engineering: Learning from Practice, in Proceedings of INCOSE 2007 Symposium, San Diego, CA, June 2007.

[7] Robbins, W., Waruszynski, B., Lalancette, C., Lizotte, M. and Nécaille, C. *CapDEM Exercise Beta: Results and Discussion*, Defence R&D Canada – Ottawa, DRDC Ottawa TM 2009-252, 2009.

[8] Lalancette, C., Lizotte, M., Nécaille, C., Pagotto, J., Robbins, W. and Waruszynski, B. *CapDEM Exercise Gamma: Detailed Work Plan*, Defence R&D Canada – Ottawa, DRDC Ottawa TN 2007-207, 2007. Internal publication.

[9] Lalancette, C., Lizotte, M., Nécaille, C., Robbins, W. and Waruszynski, B. Capability Engineering within Canadian Defence: Experimentation and Lessons Learned, in Proceedings of INCOSE 2008 Symposium, Utrecht, The Netherlands, June 2008.

[10] Pagotto, J., Robbins, W., Waruszynski, B., Hales, D., Lalancette, C., Lizotte, M., Nécaille, C., Lam, S., Youssef, R., Pogue, C. and Poursina, S. Collaborative Capability, Definition, Engineering and Management Summary Report: CapDEM TDP Capstone – Summary of Studies 2003 – 2007. DRDC Ottawa Technical Report 2009-292, 2010.

[11] Waruszynski, B. *Joint Fires Support Team Dynamics — Fundamentals for Successful Team Performance*, Joint Fires Support Team Workshop, Kingston, Canada, September 2006.

[12] Lizotte, M., Necaille, C. and Lalancette, C. *Capability Engineering for Strategic Decision Making*, in Proceedings of INCOSE 2006 – the Sixteenth Annual International Symposium of the International Council on Systems Engineering, Orlando, FL, July 2006.

[13] Robbins, W., Lam, S. and Lalancette, C. *Towards a Collaborative Engineering Environment to Support Capability Engineering*, in Proceedings of INCOSE 2005 – the Fifteenth Annual International Symposium of the International Council on Systems Engineering, Rochester, NY, July 2005.

[14] Purcell, D. Capability Engineering Proof of Concept Trial: Findings and Recommendations. PLA Signatory Briefing. May 2007.

[15] S. Lam, S. Poursina and T. Spafford. *An Overview of the CapDEM Integrated Engineering Environment*, Defence R&D Canada – Ottawa, DRDC Ottawa TM 2005-118, 2005.

[16] http://en.wikipedia.org/wiki/Conceptual_interoperability. March 2011.

Annex A First Focus Group

A.1 Questionnaire

Focus Group Discussion Guide

Exercise Gamma: Solving a Real Problem

Exercise Gamma is intended to be a complete "3rd party" functional test and evaluation of CapDEM's CEP, CET and CEE axes. Based on a realistic problem definition, Exercise Gamma shifts emphasis towards external groups being able to address their problem using the CapDEM approach. The CET will be composed of individuals from relevant client groups. The primary goal of this iteration is to test and evaluate the CEP via an instance based on Force Planning Scenario 2.

To help understand how Exercise Gamma is progressing after completing the Inception Stage, 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, training and Evaluation Team.

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

The CE Initiative – Inception Stage

Objectives

The main goal of the Inception Stage is to establish the scope and boundaries of the capability need, establish the engineering team, obtain approval on the CE initiative mandate, team resourcing, plans and budget. The objectives include:

- Confirm CE initiative mandate and establish core engineering team members;
- Establish CE initiative management plans and budget, and finalize engineering team resourcing;
- Establish CE initiative engineering and management environments;
- Gather information on existing operational and SoS architectures delivering the capability; and
- Understand the strategic context, the high-level operational concepts as well as needs and constraints.

Essential Activities

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

- Preliminary analysis of the capability and stakeholders needs to establish the CE initiative mandate;
- Selection of core CET members;
- Confirmation of CE initiative mandate;
- Tailoring of the standard CEP activities to the specific nature of the CEP mandate, the capability to be addressed, and the stakeholders involved;
- Finalization of CET resources including Operational and PRICIE representatives;
- Establishment of CE initiative engineering and management environments, including the requesting and approval of required resources, infrastructures and tools;
- Establishment of the CE initiative execution schedule, including the detailed scheduling of the Inception Stage and subsequent iterations;
- Preparation, validation, approval and publishing of CE initiative mandate, management plans and budget;
- Amendment and acceptance of Team Charter;
- Preparation and holding of the kick-off meeting;
- Collection of relevant information;
- Analysis of strategic factors, and identification of high-level needs and constraints based on deductions;

- Definition and prioritization of key decision criteria (cost, schedule, risk, performance);
- Drafting of the operational concept graphic;
- Ongoing enforcement of CE initiative assessment and control activities;
- Configuration and verification of the CEE;
- Preparation and delivery of initial training sessions on all axes.

Deliverables

The major deliverables to be available at the end of the Inception Stage are:

- Engineering Management Plan – Release 1 (external release) including CE initiative mandate, overall plans and detailed plan of the Inception Stage;
- Strategic Context Analysis – Release 1 (external release);
- Operational Architecture – Draft (operational concepts).

Milestone

At the end of the Inception Stage, the initial CE initiative management plans and budget shall be approved and there should be a common agreement and a shared understanding of strategic factors, high-level needs as well as the constraints and key strategic decision criteria.

At this point, if the objectives are met, then the Comprehension Stage can commence.

Focus Group Questions
Inception Stage

GENERAL

1. Overall, how would you assess your participation within the Inception Stage?
2. Overall, how would you assess your achievement of the objectives within the Inception Stage?

PEOPLE

3. Please identify any issues that you may have encountered with the specified roles and responsibilities of the CET.
4. How would you describe the level of Team Leadership (Team Leader and Sub-Team Leaders) within the CET?
5. Please describe how you incorporated the principles of teamwork and collaboration within the CET.
    a. Describe how the team worked together to produce the deliverables.
    b. Did you employ teambuilding exercises with the CET throughout the past several weeks?
6. Please describe how the Team Charter has been employed in your team?
    a. What elements of the Team Charter have been useful?
    b. What elements of the Team Charter could be improved?
7. Please describe how the CET communicated to ensure an integrated collaborative approach.

PROCESS

8. Please identify any process strengths and/or weaknesses regarding the Inception Stage that would facilitate its application?
    a. What would you suggest to ease this stage? *Examples of improvement are: enhance description of existing activities, remove or add activities, templates, etc.*
    b. Were the activities pertinent to the stage?
    c. Were the proposed steps coherent?
    d. Was the ordering of the steps/activities coherent?
    e. What activities were done effectively? Why?
    f. What activities were missing?
    g. Were the activities well-described and understandable?
9. As a team, or as an individual, how would you assess your understanding of the CEP deliverables?
10. Please identify any documentation strengths and/or weaknesses (including deliverable templates, online documentation, etc.) that would facilitate application in subsequent iterations.

MATERIEL

11. Please describe your experience with using the current CEE in helping you go through the activities of this iteration.
12. Please describe the tools and how they were used to produce the deliverables.
13. Please describe your experiences with respect to the use of the ACCESS Labs (both at CORA, Shirley's Bay).
14. Please describe the CEE functionalities that helped facilitate team collaboration.
    a. What would likely help in the future?
15. Please describe the CEE functionalities that helped facilitate communication within the CET.
    a. What would likely help in the future?

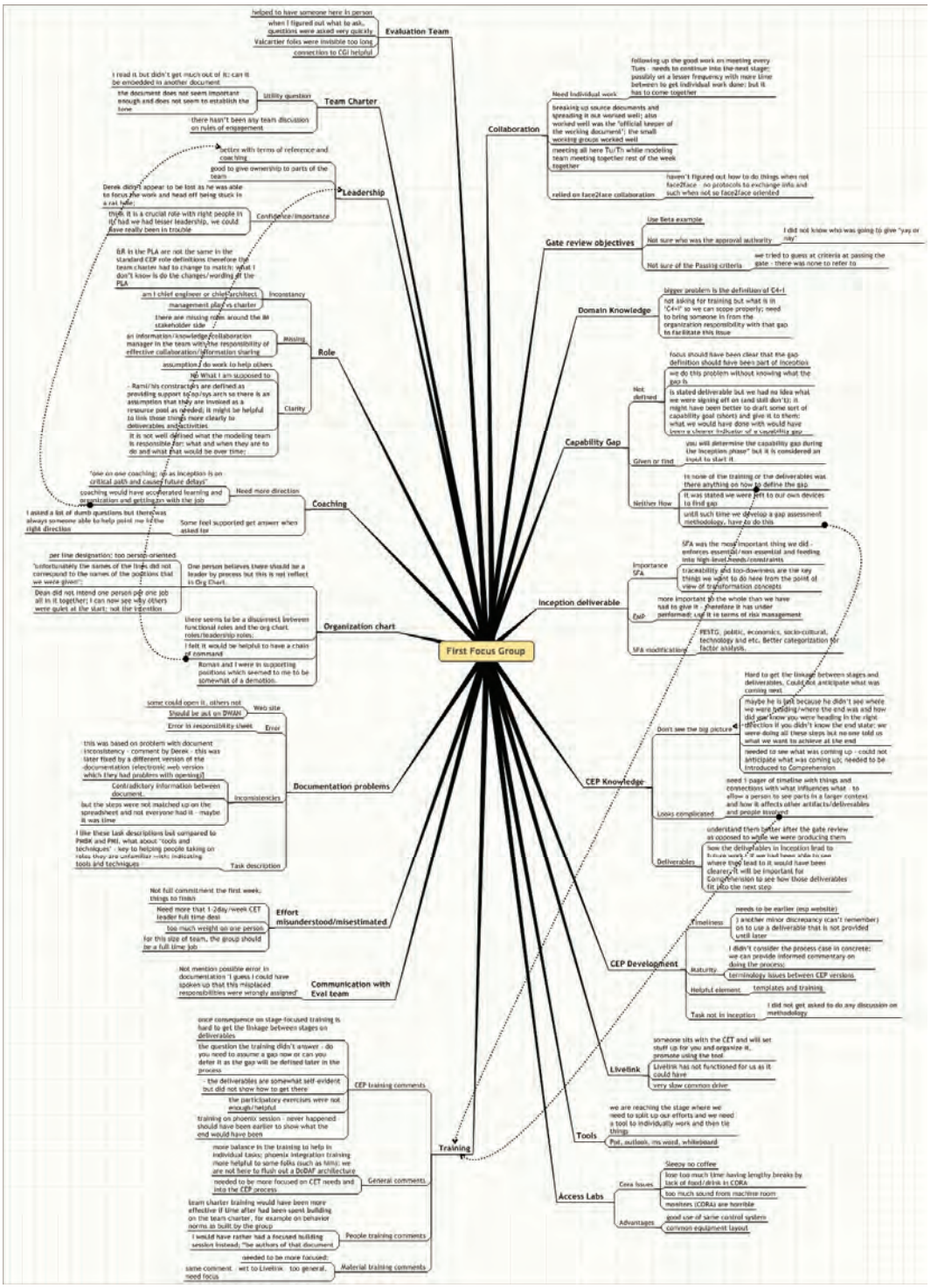
TRAINING

16. At this point in time, how would you describe the level of training for:
    a. Human dynamics
    b. CEP Inception and Comprehension Stages
    c. Tools
    d. Related topics (including Architecture)

EVALUATION TEAM

17. Please describe the level of support received from the Evaluation Team.
    a. What went well?
    b. What improvements, if any, would you recommend?

A.2 Mind Map


First Focus Group
Evaluation Team
helped to have someone here in person
when I figured out what to ask, questions were asked very quickly
Valcartier folks were invisible too long
connection to CGI helpful
Team Charter
I read it but didn't get much out of it: can it be embedded in another document
the document does not seem important enough and does not seem to establish the tone
utility question
there hasn't been any team discussion on rules of engagement
Leadership
better with terms of reference and coaching
good to give ownership to parts of the team
Derek didn't appear to be lost as he was able to focus the work and head off being stuck in a rat hole;
think it is a crucial role with right people in it; had we had lesser leadership, we could have really been in trouble
Confidence/importance
Role
BR in the PLA are not the same in the standard CEP role definitions therefore the team charter had to change to match; what I don't know is do the changes/wording of the PLA
am I chief engineer or chief architect; management plan vs charter
Inconstancy
there are missing roles around the IM stakeholder side
an information/knowledge/collaboration manager in the team with the responsibility of effective collaboration/information sharing
Missing
assumption I do work to help others
No What I am supposed to
- Rami/his contractors are defined as providing support to sys arch so there is an assumption that they are involved as a resource pool as needed; it might be helpful to link those things more clearly to deliverables and activities
it is not well defined what the modeling team is responsible for: what and when they are to do and what that would be over time;
Clarity
Coaching
"one on one coaching; so as inception is on critical path and caused future delays"
coaching would have accelerated learning and organization and getting on with the job
Need more direction
I asked a lot of dumb questions but there was always someone able to help point me in the right direction
Some feel supported get answer when asked for
Organization chart
per line designation; too person-oriented
"unfortunately the names of the lines did not correspond to the names of the positions that we were given"
One person believes there should be a leader by process but this is not reflect in Org Chart.
Dean did not intend one person per one job all in it together; I can now see why others were quiet at the start; not the intention
there seems to be a disconnect between functional roles and the org chart roles/leadership roles;
I felt it would be helpful to have a chain of command
Roman and I were in supporting positions which seemed to me to be somewhat of a demotion.
Documentation problems
some could open it, others not
Web site
Should be put on DWAN
Error
Error is responsibility sheet
this was based on problem with document inconsistency - comment by Derek - this was later fixed by a different version of the documentation (electronic web version which they had problems with opening?)
Contradictory information between document.
Inconsistencies
but the steps were not matched up on the spreadsheet and not everyone had it - maybe it was time
I like these task descriptions but compared to PMBK and PMI, what about "tools and techniques" - key to helping people taking on roles they are unfamiliar with; indicating tools and techniques
Task description
Effort misunderstood/misestimated
Not full commitment the first week; things to finish
Need more that 1-2day/week CET leader full time desi
too much weight on one person
for this size of team, the group should be a full time job
Communication with Eval team
Not mention possible error in documentation "I guess I could have spoken up that this misplaced responsibilities were wrongly assigned"
Training
once consequence on stage-focused training is hard to get the linkage between stages on deliverables
the question the training didn't answer - do you need to assume a gap now or can you defer it as the gap will be defined later in the process
- the deliverables are somewhat self-evident but did not show how to get there
the participatory exercises were not enough/helpful
CEP training comments
training on phoenix session - never happened should have been earlier to show what the end would have been
more balance in the training to help in individual tasks; phoenix integration training more helpful to some folks (such as NIH); we are not here to flush out a DoDAF architecture
needed to be more focused on CET needs and into the CEP process
General comments
team charter training would have been more effective if time after had been spent building on the team charter, for example on behavior norms as built by the group
I would have rather had a focused building session instead; "be authors of that document
People training comments
needed to be more focused;
same comment - wrt to Livelink - too general, need focus
Material training comments
Collaboration
following up the good work on meeting every Tues - needs to continue into the next stage; possibly on a lesser frequency with more time between to get individual work done; but it has to come together
Need individual work
breaking up source documents and spreading it out worked well; also worked well was the "official keeper of the working document"; the small working groups worked well
meeting all here Tu/Th while modeling team meeting together rest of the week together
relied on face2face collaboration
haven't figured out how to do things when not face2face - no protocols to exchange info and such when not so face2face oriented
Gate review objectives
Use Beta example
Not sure who was the approval authority
I did not know who was going to give "yay or nay"
Not sure of the Passing criteria
we tried to guess at criteria at passing the gate - there was none to refer to
Domain Knowledge
bigger problem is the definition of C4-I
not asking for training but what is in "C4-I" so we can scope properly; need to bring someone in from the organization responsibility with that gap to facilitate this issue
Capability Gap
Not defined
focus should have been clear that the gap definition should have been part of inception
we do this problem without knowing what the gap is
is stated deliverable but we had no idea what we were signing off on (and still don't); it might have been better to draft some sort of capability goal (short) and give it to them; what we would have done with would have been a clearer indicator of a capability gap
Given or find
you will determine the capability gap during the inception phase" but it is considered an input to start it
Neither How
In none of the training or the deliverables was there anything on how to define the gap
it was stated we were left to our own devices to find gap
until such time we develop a gap assessment methodology, have to do this
Inception deliverable
Importance
SFA was the most important thing we did - enforces essential/non essential and feeding into high-level needs/constraints
SFA
traceability and loo-dowiness are the key things we want to do here from the point of view of transformation concepts
ExIP
more important in the whole than we have had to give it - therefore it has under performed; use it in terms of risk management
SFA modifications
PESTO, politic, economics, socio-cultural, technology and etc. Better categorization for factor analysis.
CEP Knowledge
Don't see the big picture
Hard to get the linkage between stages and deliverables. Could not anticipate what was coming next
maybe he is just because he didn't see where we were getting/where the end was and how did you know you were heading in the right direction if you didn't know the end state; we were doing all these steps but no one told us what we want to achieve at the end
needed to see what was coming up - could not anticipate what was coming up; needed to be introduced to Comprehension
Looks complicated
need 1 pager of timeline with things and connections with what influences what - to allow a person to see parts in a larger context and how it affects other artifacts/deliverables and people involved
Deliverables
understand them better after the gate review as opposed to while we were producing them
how the deliverables in Inception lead to future work ("if we had been able to see where they lead to it would have been clearer); it will be important for Comprehension to see how those deliverables fit into the next step
CEP Development
Timeliness
needs to be earlier (esp website)
) another minor discrepancy (can't remember) on to use a deliverable that is not provided until later
Maturity
I didn't consider the process case in concrete; we can provide informed commentary on doing the process;
terminology issues between CEP versions
Helpful element
templates and training
Task not in inception
I did not get asked to do any discussion on methodology
Livelink
someone sits with the CET and will set stuff up for you and organize it, promote using the tool
Livelink has not fucntioned for us as it could have
very slow common drive
Tools
we are reaching the stage where we need to split up our efforts and we need a tool to individually work and then tie things
Pod, outlook, ms word, whiteboard
Access Labs
Cora Issues
Sleepy no coffee
lose too much time having lengthy breaks by lack of food/drink in CORA
too much sound from machine room
monitors (CORAs) are horrible
Advantages
good use of same control system
common equipment layout

Annex B Second Focus Group

B.1 Questionnaire

Focus Group Discussion Guide

Exercise Gamma: Solving a Real Problem

Exercise Gamma is intended to be a complete "3rd party" functional test and evaluation of CapDEM's CEP, CET and CEE axes. Based on a realistic problem definition, Exercise Gamma shifts emphasis towards external groups being able to address their problem using the CapDEM approach. The CET will be composed of individuals from relevant client groups. The primary goal of this iteration is to test and evaluate the CEP via an instance based on Force Planning Scenario 2.

To help understand how Exercise Gamma is progressing during the Comprehension Stage, you are being asked to participate in this focus group session. This focus group will be asked a variety of questions (along with probing questions) to help the Evaluation Team assess the effectiveness of the three CapDEM axes and Evaluation Team.

As a reminder, the context for this discussion is the work accomplished since the Inception Gate Review and Focus Group until now.

Focus Group Questions
Mid Comprehension Stage

GENERAL

1. Overall, how would you assess your participation within the Comprehension Stage to date?

PROCESS

2. Given the CEP workflow for the Comprehension Stage (see slide), please answer the following.
    a. What tasks have you completed?
    b. How well have you completed them?
    c. How closely did you follow the workflow as presented?
    d. Did you augment the workflow? If so, how?
    e. Was the ordering of the tasks coherent?
    f. Were the tasks well-described and understandable?
3. Please identify any documentation strengths (including deliverable templates, online documentation, etc.) that would facilitate application in subsequent iterations.
    a. What was your experience with the online CEP documentation (i.e., the web page)?
4. Please identify any documentation weaknesses (including deliverable templates, online documentation, etc.) that would facilitate application in subsequent iterations.
    a. If given the opportunity to improve a single aspect of the documentation, what would it be? And how?

MATERIEL

5. Please describe your experience with using the current CEE in helping you go through the activities and production of deliverables thus far.
    a. What tools worked as desired?
    b. What tools were not available/did not work as desired?
6. Describe your experiences in terms of exchanging information (work products) between tools (either as individuals or as groups of individuals)?
    a. Were there any interoperability problems? Were they solved?
    b. Were most issues addressed with technology or manual process?
7. Based on your experiences to date, what challenges and issues do you envision in a move to working at a classified level?
    a. In terms of information management?
    b. In terms of exchanging information?
    c. In terms of work environments?

PEOPLE

8. Please identify any issues that you may have encountered with the specified roles and responsibilities of the CET.

a. Were role names an issue (e.g., CET Coordinator)? If so, how?
b. What was your experience with contractor support to the CET?
c. To what degree did SMEs participate? What factors, if any, impacted SME participation?

9. At this point in time, how would you assess the leadership within the CET?
10. Please assess how well the CET communicated throughout the Comprehension Stage.
11. Please describe how you incorporated the principles of teamwork and collaboration within the CET.
    a. Describe how the team worked together to produce artefacts.

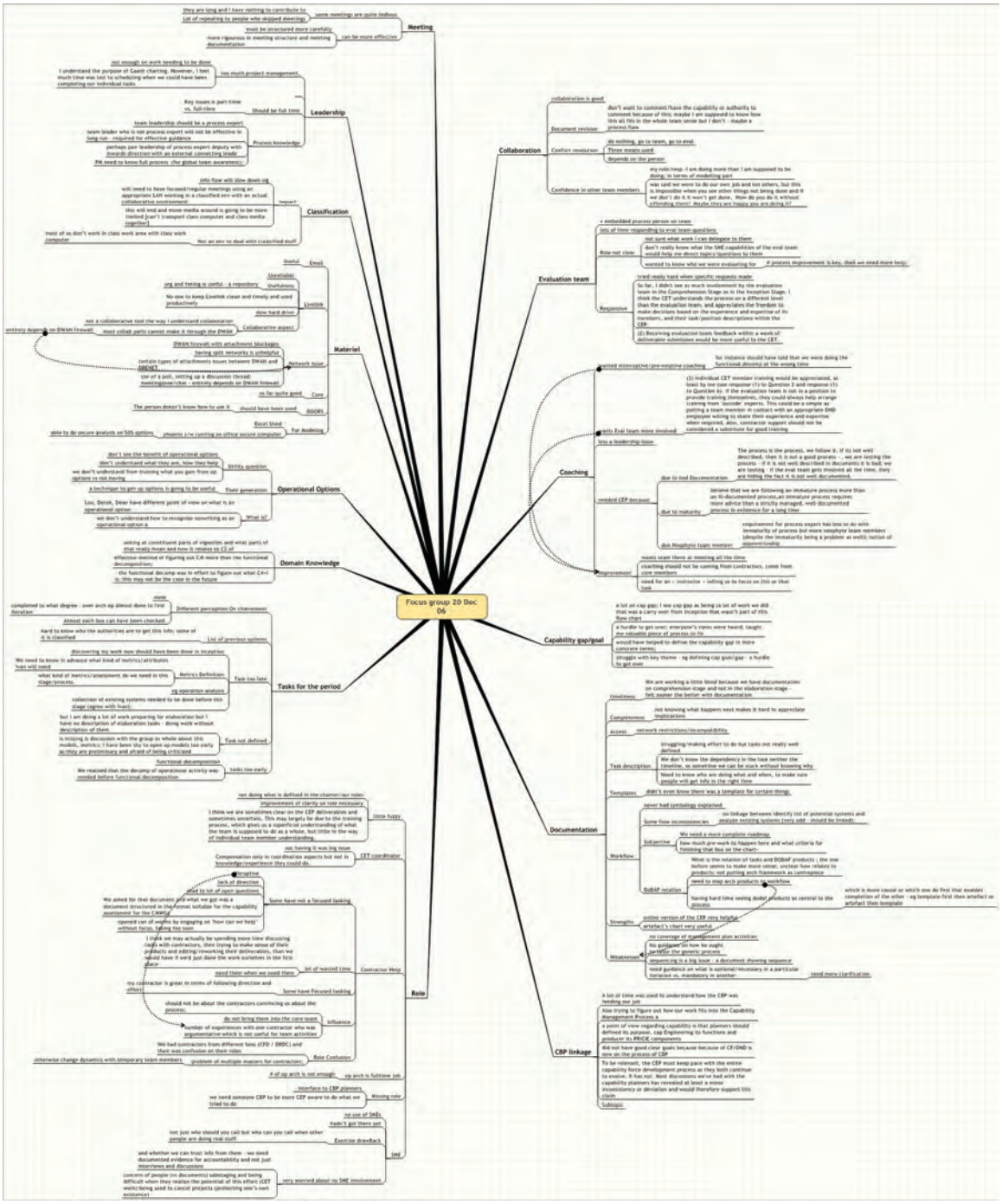
EVALUATION TEAM

12. Please describe the level of support received from the Evaluation Team.
    a. What went well?
    b. What improvements, if any, would you recommend?
    c. Is there a particular kind (style) of support you would prefer from the Evaluation Team?

PLA SIGNATORY REVIEW BRIEFING

13. How would you assess the PLA Signatory Meeting this past Monday, December 18, 2006.
    a. Do you feel Exercise Gamma is "on track"?
    b. What adjustments, if any, would you recommend?
        a. For example: issues of focus (content or approach), classification, industrial engagement/involvement, etc.

B.2 Mind Map


Focus group 20 Dec 06
Meeting
Leadership
Classification
Materiel
Operational Options
Domain Knowledge
Tasks for the period
Role
Collaboration
Evaluation team
Coaching
Capability gap/goal
Documentation
CBP linkage

Annex C Third Focus Group

C.1 Questionnaire

Focus Group Discussion Guide

Exercise Gamma: Solving a Real Problem

Exercise Gamma is intended to be a complete "3rd party" functional test and evaluation of CapDEM's CEP, CET and CEE axes. Based on a realistic problem definition, Exercise Gamma shifts emphasis towards external groups being able to address their problem using the CapDEM approach. The CET will be composed of individuals from relevant client groups. The primary goal of this iteration is to test and evaluate the CEP via an instance based on Force Planning Scenario 2.

To help understand how Exercise Gamma is progressing after completing the Comprehension Stage, you are being asked to participate in this focus group session. This focus group will be asked a variety of questions (along with probing questions) to help the Evaluation Team assess the effectiveness of the three CapDEM axes and Evaluation Team.

At this point, I would like to reiterate the background of the Comprehension Stage, including the objectives, main tasks and milestones.

The CE Initiative – Comprehension Stage

Objectives
The objectives of the Comprehension Stage are to develop and validate viable operational options, to identify and refine corresponding operational requirements, to develop trade study models and to identify a preliminary set of candidate SoS options.

Main tasks

- Analyze scenarios
- Outline operational options
- Refine operational options
  - Identify operational activity interfaces
  - Identify organizational composition
  - Perform operational activity decomposition
  - Analyse operational activity behaviour
- Assess operational options
- Analyze existing systems
- Identify potential systems
- Group and allocate systems
- Identify SoS options
- Refine CEDF Model & Performance parameter criteria

Milestones
At the end of the Comprehension Stage, a first set of viable operational options is approved, feedback is received on the set of preliminary SoS options and the work plan for the Elaboration Stage is approved.

Focus Group Questions
Comprehension Stage

GENERAL

1. Overall, how would you assess your participation within the Comprehension Stage?

PROCESS

2. Based on the work that you have carried out within the CET so far, how would you assess the CEP?
3. How would you assess the time that it took you to perform the tasks in the Comprehension Stage?
    a. Did you experience any difficulties with respect to completing the tasks? If so, can you describe these difficulties?
    b. Did you experience any delays with respect to completing the tasks? If so, can you describe what kind of delays?
4. Given the CEP workflow for the Comprehension Stage (see provided outline), please answer the following:
    a. What tasks have you completed?
    b. How well have you completed them?
    c. Was the ordering of the tasks coherent?
    d. Were the tasks well-described and understandable?
    e. How closely did you follow the workflow (as presented)?
    f. Did you augment the workflow? If so, how?
    g. Would a second iteration have influenced the outcome of this Stage? If so, how?
5. Please identify any process strengths (including deliverable templates, online documentation, etc.) that would facilitate its application in subsequent iterations.
    a. What was your experience with the online CEP documentation (i.e., the Web page)?
6. Please identify any process weaknesses (including deliverable templates, online documentation, etc.) that would facilitate its application in subsequent iterations.
    a. If given the opportunity to improve a single aspect of the documentation, what would it be? How would you improve it?

MATERIEL

7. Please describe your experiences with using the current CEE (mainly ACCESS Labs, Livelink, CORE, Phoenix, DOORS) in helping you to go through the activities and production of deliverables thus far.
    a. To what extent did you exploit the above tools?
    b. Which tools worked as desired?
    c. Which tools were not available/did not work as desired?
8. Describe your experiences in terms of exchanging information (work products) between tools (either as individuals or as groups of individuals)?
    a. Were there any interoperability problems? Were they solved?
    b. Were most issues addressed with technology or a manual process?

9. Based on your participation within the CET to date, have you experienced any challenges and/or issues in working at a classified level?
    a. In terms of information management?
    b. In terms of exchanging information?
    c. In terms of work environments?

PEOPLE

10. Please describe how you incorporated the principles of teamwork and collaboration within the CET.
    a. Describe how the team worked together to produce artefacts.
11. At this point in time, how would you assess the leadership within the CET?
12. Please assess how well the CET communicated throughout the Comprehension Stage.
13. Please identify any issues that you may have encountered with the specified roles and responsibilities of the CET.
    a. Do you feel that people carried out their roles and responsibilities adequately?
14. Please identify any issues that you may have encountered with: contactors outside the CET, Operational Reps and PRICIE Reps.
    a. What was your experience with contractor support to the CET?
    b. To what extent did Operational Reps participate?
        i. What factors, if any, may have impacted Operational Rep participation?
        ii. If they did not participate, do you feel that it would have been more beneficial should they have had participated?
    a. To what extent did PRICIE Reps participate?
        iii. What factors, if any, may have impacted PRICIE Rep participation?
        iv. If they did not participate, do you feel that it would have been more beneficial should they have had participated?

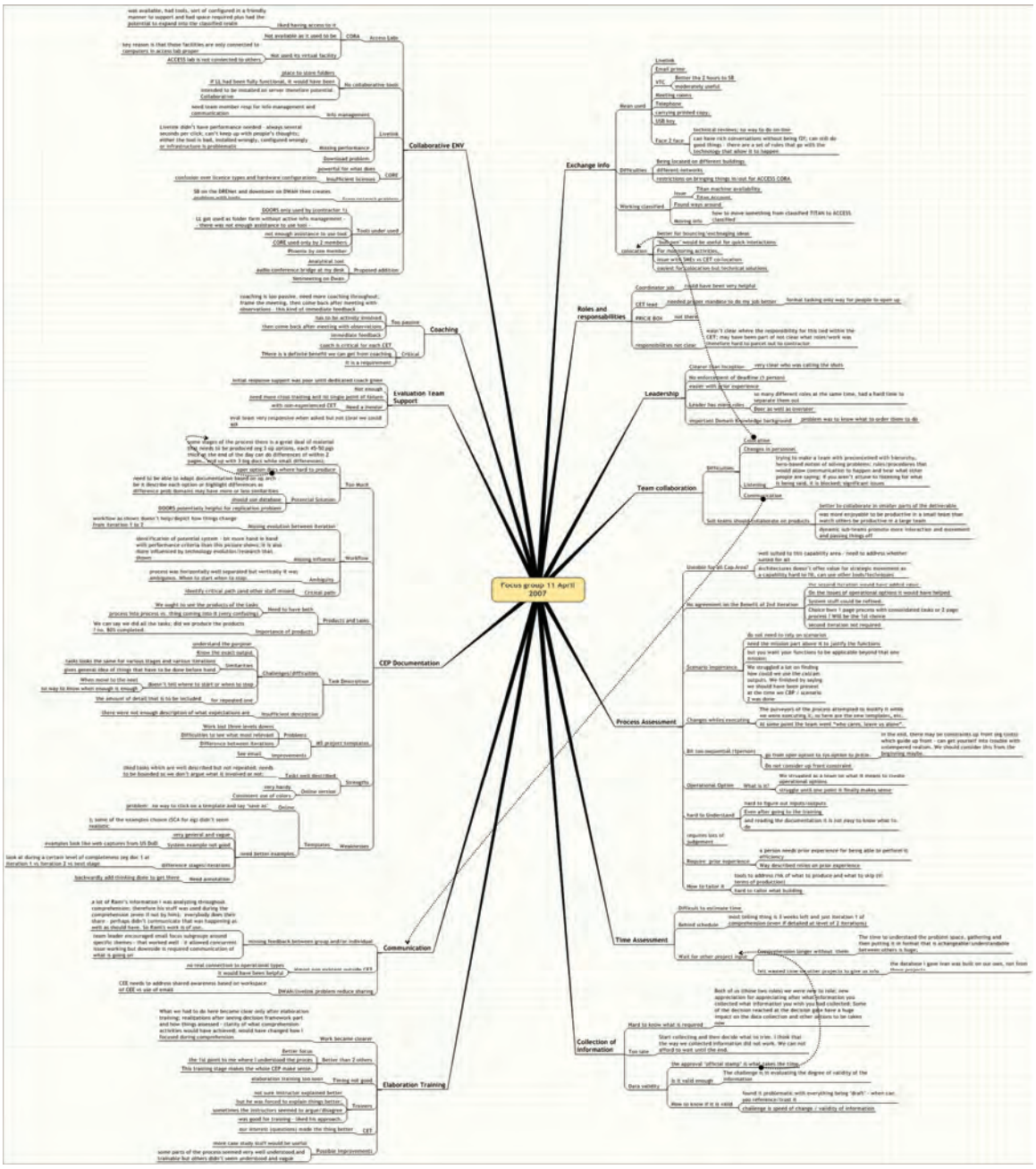
EVALUATION TEAM

15. Please describe the level of support received from the Evaluation Team.
    a. What went well?
    b. What improvements, if any, would you recommend?
16. How would you assess the level of coaching received since January 2007?
    a. What went well?
    b. What improvements, if any, would you recommend?

ELABORATION TRAINING

17. In comparison to previous training sessions (i.e., Inception and Comprehension stages), how would you assess the Elaboration training?
    a. What went well?
    b. What improvements, if any, would you recommend?
    c. Was the scheduling of the Elaboration training appropriate?
    d. Was the format for the Elaboration training appropriate?

C.2 Mind Map


Focus group 11 April 2007
Collaborative ENV
Coaching
Evaluation Team Support
CEP Documentation
Communication
Elaboration Training
Exchange info
Roles and responsabilities
Leadership
Team collaboration
Process Assessment
Time Assessment
Collection of information

This page intentionally left blank.

Annex D Fourth Focus Group

D.1 Questionnaire

Focus Group Discussion Guide

Exercise Gamma: Solving a Real Problem

Exercise Gamma is intended to be a complete "3rd party" functional test and evaluation of CapDEM's CEP, CET and CEE axes. Based on a realistic problem definition, Exercise Gamma shifts emphasis towards external groups being able to address their problem using the CapDEM approach. The CET will be composed of individuals from relevant client groups. The primary goal of this iteration is to test and evaluate the CEP via an instance based on Force Planning Scenario 2.

To help understand how Exercise Gamma is progressing after completing the Elaboration/Completion Stages, you are being asked to participate in this focus group session. This focus group will be asked a variety of questions (along with probing questions) to help the Evaluation Team assess the overall completion of Exercise Gamma.

Focus Group Questions
Post Elaboration/Completion Stage

GENERAL

1. Overall, how would you assess your participation within the CET since the last focus group?

People Axis

2. Please identify the main issues that you may have encountered within the CET.
    a. Team collaboration
    b. Team communication
    c. Roles and responsibilities
    d. Other issues

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. Stages
    b. Activities/tasks
    c. Iterations
    d. Deliverables

6. In general, how would you assess your level of satisfaction with respect to the completion of the deliverables?
    a. Did you recommend one option? If so, how did you come to a consensus on your recommendation?
    b. What is your level of confidence with respect to the recommended option [very confident, confident, somewhat confident, not confident at all]?
    c. What are the most relevant deliverables which you would recommend for the future?

7. Please describe the elements you would incorporate in the creation of the future "ideal" CEP.

8. Please describe what actions you would take to achieve (i.e., move towards) the realization of this "ideal" CEP.

Materiel Axis

9. Please identify the main issues that you may have encountered within the CEE.
    a. Functionalities
    b. Tools

c. Facilities
d. Connectivity and access

10. Please describe the elements you would incorporate in the creation of the future “ideal” CEE.

11. Please describe what actions you would take to achieve (i.e., move towards) the realization of this “ideal” CEE.

SUPPORT TEAM

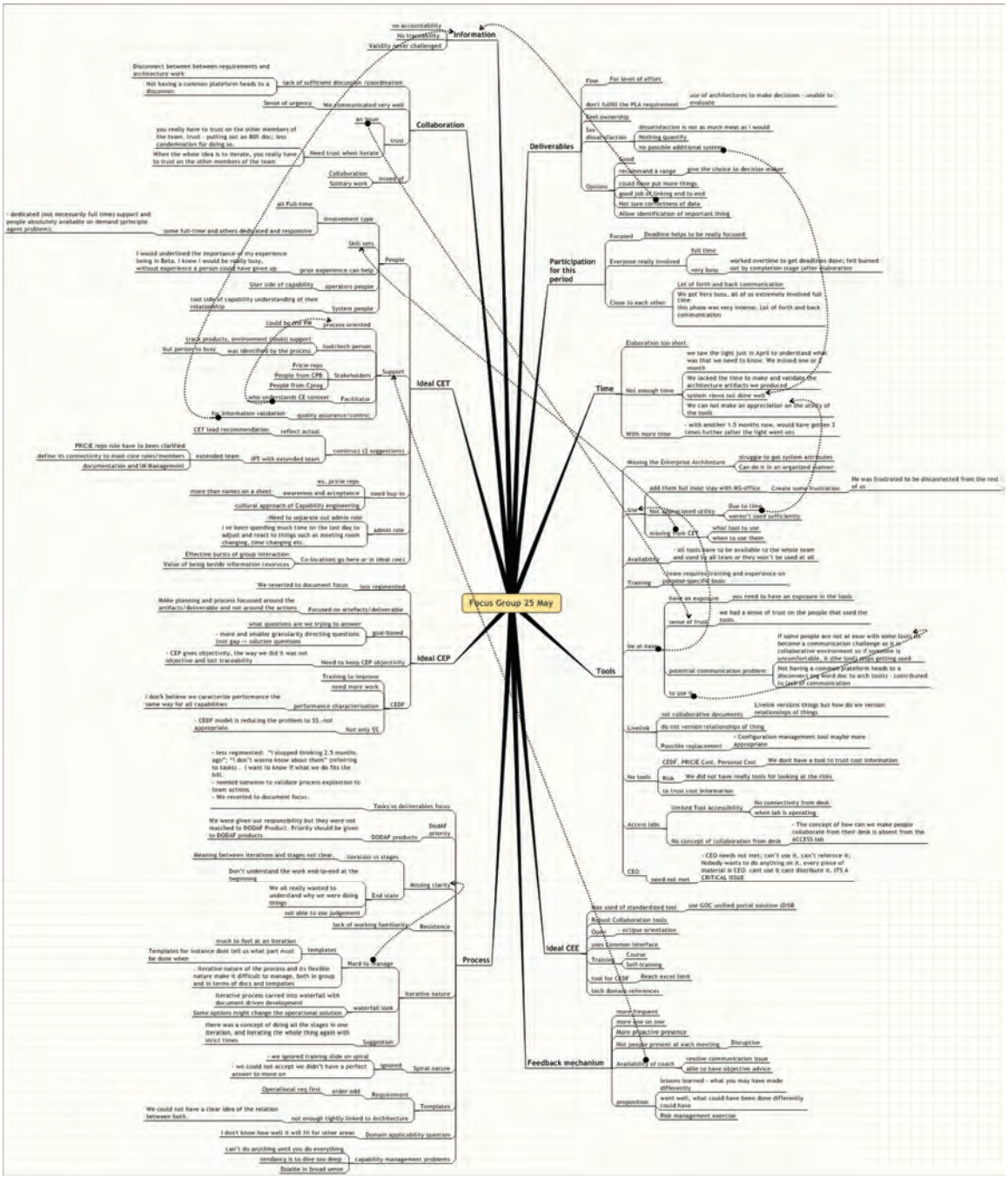
12. What kind of support would be required for future CET?
    a. Characteristics of a future support team.
    b. Functionalities

FUTURE FEEDBACK MECHANISMS

13. How would you assess the use of focus groups throughout Exercise Gamma?

14. Would you recommend any other feedback mechanisms? If so, which ones would you recommend?

D.2 Mind Map


Focus Group 25 May
Information
Collaboration
Ideal CET
Ideal CEP
Process
Deliverables
Participation for this period
Time
Tools
Ideal CEE
Feedback mechanism

List of symbols/abbreviations/acronyms/initialisms

ACCESS	Advanced Collaborative Capability Engineering Support System
ADM(IM)	Assistant Deputy Minister (Information Management)
aka	Also Known As
CAN/US	Canada/United States
CapDEM	Collaborative Capability Definition, Engineering and Management
CBP	Capability-Based Planning
CCA	Centre for Capability Analysis
CE	Capability Engineering
CEE	Collaborative Engineering Environment
CEO	Canadian Eyes Only
CEP	Capability Engineering Process
CET	Capability Engineering Team
CF	Canadian Forces
CFD	Chief of Force Development
CM	Configuration Management
CMSC	Capability Management Support Centre
CORA	Centre for Operations Research and Analysis
COS(IM)	Chief of Staff (Information Management)
COTS	Commercial Off-the-Shelf
CMWG	Capability Management Working Group
CSPS	Canada School of Public Service
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
C4+I	Command, Control, Communications, Computers and Information
DND	Department of National Defence
DoDAF	Department of Defence Architecture Framework
DRDC	Defence Research and Development Canada
DRDKIM	Director Research and Development Knowledge and Information Management
DRENet	Defence Research Establishment Network

DWAN	Defence Wide Area Network
ECS	Environmental Chief of Staff
EMP	Engineering Management Plan
NWP	Northwest Passage
IM	Information Management
IT	Information Technology
MSOC	Marine Security Operations Centre
PLA	Project Level Agreement
PM	Project Manager
PRICIE	Personnel; Research and Development; Infrastructure and Organization; Concepts, Doctrine and Collective Training; Information Management; Equipment, Supplies and Services
PSEPC	Public Safety and Emergency Preparedness Canada
R&D	Research and Development
SCA	Strategic Context Analysis
SFA	Strategic Factor Analysis
SME	Subject Matter Expert
SoS	System of Systems
TD	Technology Demonstrator
TDP	Technology Demonstration Programme
USB	Universal Serial Bus
VPN	Virtual Private Network
VTC	Video Teleconference

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (The name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Centre sponsoring a contractor's report, or tasking agency, are entered in section 8.)

Defence R&D Canada – Ottawa
3701 Carling Avenue
Ottawa, Ontario K1A 0Z4

2. SECURITY CLASSIFICATION (Overall security classification of the document including special warning terms if applicable.)

UNCLASSIFIED

3. TITLE (The complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title.)

CapDEM Exercise Gamma: Results and Discussion

4. AUTHORS (last name, followed by initials – ranks, titles, etc. not to be used)

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

5. DATE OF PUBLICATION (Month and year of publication of document.)

June 2011

6a. NO. OF PAGES (Total containing information, including Annexes, Appendices, etc.)

124

6b. NO. OF REFS (Total cited in document.)

16

7. DESCRIPTIVE NOTES (The category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

Technical Report

8. SPONSORING ACTIVITY (The name of the department project office or laboratory sponsoring the research and development – include address.)

Defence R&D Canada – Ottawa
3701 Carling Avenue
Ottawa, Ontario K1A 0Z4

9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.)

15as

9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.)

10a. ORIGINATOR'S DOCUMENT NUMBER (The official document number by which the document is identified by the originating activity. This number must be unique to this document.)

DRDC Ottawa TR 2011-044

10b. OTHER DOCUMENT NO(s). (Any other numbers which may be assigned this document either by the originator or by the sponsor.)

11. DOCUMENT AVAILABILITY (Any limitations on further dissemination of the document, other than those imposed by security classification.)

Unlimited

12. DOCUMENT ANNOUNCEMENT (Any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in (11) is possible, a wider announcement audience may be selected.))

Unlimited

13. ABSTRACT (A brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), (R), or (U). It is not necessary to include here abstracts in both official languages unless the text is bilingual.)

Exercise Gamma was designed to be a complete third-party test and evaluation of the Collaborative Capability Definition, Engineering and Management (CapDEM) approach. The primary goal of this final iteration of the CapDEM Evaluation Strategy was to test and evaluate the CapDEM approach using a 'real problem' based on a departmentally-defined scenario and executed by a team composed of DND/CF members. The intent was to validate the necessary people, process and materiel to address a 'real problem' while still enabling the observation and study of its application within an increasingly operational-like environment. As the third and final exercise, Exercise Gamma was the largest and most ambitious of the evaluation efforts, the result of gradual, controlled growth from one exercise to another, benefiting from the accumulated experience of the evaluation team along with its validated evaluation strategy. The exercise shifted away from incrementally controlled experimentation towards the reality of actual departmental clients applying Capability Engineering and CapDEM's ability to meet those needs. Accordingly, this report summarizes the results of Exercise Gamma which was undertaken to evaluate the three fundamental axes that compose the Capability Engineering (CE) construct (i.e., People, Process and Materiel). Specifically, the report outlines the conduct of Exercise Gamma, the results of observations and focus groups that were conducted throughout the exercise, and provides discussion and recommendations to consider in terms of the potential institutionalization of the CapDEM approach within the department.

L'exercice Gamma a été conçu pour être une épreuve et une évaluation tout à fait indépendante de l'approche axée sur la définition, l'ingénierie et la gestion collaboratives des capacités (DIGCap). L'objectif principal de ce dernier volet de la Stratégie d'évaluation de l'approche DIGCap consistait à mettre à l'essai et à évaluer cette dernière à l'aide d'un « problème réel » fondé sur un scénario défini par le Ministère, l'approche étant alors mise en œuvre par une équipe composée de membres du MDN et des FC. L'intention était de valider les personnes, le processus et le matériel nécessaires pour s'attaquer à un « problème réel », tout en permettant l'observation et l'étude de l'application du processus dans un contexte à caractère de plus en plus opérationnel. En tant que le troisième et dernier exercice, l'exercice Gamma a été le plus vaste et le plus ambitieux de tous les efforts d'évaluation; il résultait de la croissance graduelle et contrôlée s'étant produite d'un exercice à l'autre et il a bénéficié de l'expérience cumulative acquise par l'équipe d'évaluation et de sa stratégie d'évaluation validée. L'Exercice s'est éloigné des expériences progressivement contrôlées pour évoluer vers la réalité de véritables clients ministériels, en appliquant l'ingénierie des capacités et l'outil DIGCap pour répondre aux besoins de ces derniers. Par conséquent, le présent rapport résume les résultats de l'exercice Gamma, qui a été entrepris pour évaluer les trois axes fondamentaux du concept structurel de l'ingénierie des capacités (IC) : les personnes, le processus et le matériel. Le rapport décrit l'exécution de l'exercice Gamma et les résultats des observations faites pendant l'Exercice et des interventions des groupes témoins; il offre une discussion et des recommandations à étudier relativement à l'institutionnalisation éventuelle de l'approche DIGCap au sein du Ministère.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

CapDEM; Collaborative Capability Definition; Engineering and Management; Capability Engineering; Capability Management; Capability Based Planning; CBP; Evaluation Strategy; Exercise Gamma; Capability Engineering Team; CET; Capability Engineering Process; CEP; Collaborative Engineering Environment; CEE; Chief Force Development; CFD; Chief of Staff (Information Management); COS(IM); Assistant Deputy Minister(Information Management); ADM(IM)

Defence R&D Canada

Canada's leader in Defence
and National Security
Science and Technology

R & D pour la défense Canada

Chef de file au Canada en matière
de science et de technologie pour
la défense et la sécurité nationale

www.drdc-rddc.gc.ca