

Modelling and Simulation and Capability Engineering Process

Marielle Mokhtari[†], François Bernier[†], Mario Couture[†],
Geneviève Dussault[†], Claire Lalancette[†], Sylvia Lam[‡], Michel Lizotte[†]

[†]Defence R&D Canada - Valcartier, System of Systems Section,
2459 Pie-XI Blvd North, Val-Bélair, QC, G3J 1X5, Canada

[‡]Defence R&D Canada – Ottawa, Future Forces Synthetic Environment Section,
3701 Carling Avenue, Ottawa, Ont., K1A 0Z4, Canada

Marielle.Mokhtari@drdc-rddc.gc.ca

ABSTRACT

The Department of National Defence and Canadian Forces are currently implementing Capability Based Planning (CBP) as a core element of their overall business process. According to CBP, once a capability is defined, it must be both properly engineered and managed. To this end, the Collaborative Capability Definition, Engineering, and Management (CapDEM) project aims at defining Capability Engineering (CE) and validating the discipline (through the Capability Engineering Process - CEP) in the Canadian defence context, including collaboration with various DND and industrial stakeholders. This paper provides a preliminary discussion on the role of Modeling and Simulation (M&S) in the context of the CE-CEP. With the combination of a collaborative engineering environment and a robust suite of M&S tools, CE-CEP promote simulation-based acquisition and facilitate information sharing and collaboration among the participants involved in the acquisition process.

1.0 INTRODUCTION

The Department of National Defence and Canadian Forces (DND/CF) are in the early stages of fundamental changes in their strategic planning and management approach. These changes are driven by new world realities and by the imperatives of the Revolution in Military Affairs [Sloan, 2000], which is affecting CF as the ones of all allied nations. The impact of this new reality in the military world is the shift from the old stovepipe bottom-up threat-based planning to the top-down Capability-Based Planning (CBP) [DND/CF, 2002]. This new approach has to allow the acquisition of systems by emphasizing on integration, option analysis, and on trade-off analysis between acquisition projects. It has to lead to identify optimum investment strategies. To support the new capability-based approach, DND/CF have started to introduce in the last four-five years a number of initiatives [Sweetnam, 2004]. These initiatives aim at bringing new tools, frameworks and processes aiming to help DND/CF senior managers in their planning and management activities.

In the context of the Canadian Collaborative Capability Definition, Engineering and Management (CapDEM) project, the acquisition cycle is one area where the current processes and decision-making are being examined to better understand the situation and propose a Capability Engineering Process (CEP) [CapDEM, 2003]. The CapDEM project, taking its origin from [Walker, 2002], aims at specifying capability engineering (by defining and refining the CEP) and validating this discipline in the Canadian defence context, in collaboration with a wide range of DND and industrial community stakeholders.

Modelling and Simulation and Capability Engineering Process

As illustrated in Figure 1, the current DND/CF acquisition process requires on average more than fifteen (15) years to deliver the Final Operational Capability (FOC) for major acquisition initiatives (as opposed to ten (10) years to deliver the Initial Operational Capability (IOC)).



Figure 1: Current DND/CF acquisition process delivery timeframe (in months)

The Advisory Committee on Administrative Efficiency [ACAE, 2003] has proposed some changes in order to shorten the acquisition cycle by about thirty percent (30%), in order to deliver an IOC within a 6.5 years timeframe and reduce the overall delivery life cycle to 10-12 years. It is believed that the new capability-based acquisition process will play a major role in achieving this objective. With an efficient use of Modelling and Simulation (M&S) tools and processes, CEP should provide a core process to support DND/CF in delivering new or updated capabilities in less time with reduced cost and risk. The new acquisition process will bring many changes in the way people, processes and material collaborate in order to create, transform and exchange information throughout the acquisition life cycle. Some of these challenges are: capability-based approach; exploding complexity; broad range of missions; new / uncertain threats; coalition / joint perspective; System of Systems (SoS) perspective (requires the development of a high degree of interoperability within existing and new systems); distributed collaborative development environment; joint development and test environment; and efficient and secure sharing of products, models, simulations and other related information among distributed participants.

This article provides a preliminary discussion on the role of M&S in the context of the CE-CEP. The first section presents the CEP as expressed at the present time. The second section is dedicated to the link between the CEP, embedded in the acquisition process, and M&S. With the combination of a Collaborative Engineering Environment (CEE) and a robust suite of M&S tools, CEP promotes Simulation-Based Acquisition (SBA)¹ and facilitates information sharing and collaboration among the participants involved in the acquisition process. M&S encompasses a very large number of tools and technologies that can be exploited throughout the capability life cycle. It is not within the scope of this paper to provide a comprehensive tool survey. Finally, the paper suggests some recommendations to further define the role of M&S in CE-CEP.

¹ SBA is defined as “an iterative, integrated product and process approach which capitalizes on the collaborative use of a robust suite of M&S tools by both the DND/CF and industry to ensure that the operator's materiel needs are satisfied. It is an acquisition methodology that can be applied to both *off-the-shelf* or *to-be-developed* equipment and systems. It involves the application of M&S across all functions and program phases, including identifying the required capability; preparing requests for proposal and evaluating bids; designing, developing, or modifying models or equipment; testing and evaluating the proposed solution; training operators; and ultimately, disposing of the system. The overall objective is to reduce acquisition time, resources, and risk.” [DND/CF, 2000]

2.0 CAPABILITY ENGINEERING PROCESS (CEP)

The CEP is an iterative and incremental process starting from capability shortcomings and finishing with a set of investment options and a recommendation which will provide senior DND/CF personnel with relevant information for enhanced decision-making capabilities.

2.1 Iterative and Incremental Meta-Process

To develop the CEP, the CapDEM CEP team has put forward the Iterative and Incremental Meta-process (I2M) applying lessons learned from system and software engineering [Lizotte *et al.*, 2005]. Figure 2 introduces I2M which starts with a familiarization step (DISCOVER) followed with a repetition of the following cyclic steps: looking at the current situation (GRASP), identifying the needs (SCOPE), developing the process (DEVELOP), and evaluate it (EVALUATE). All cycles except the first one, have two effects: (a) correcting content of the previous cycle, and (b) adding content e.g. giving a precise deliverable template detailing an outline of content provided in the previous version. After some cycles, the team will recommend an implementation strategy.

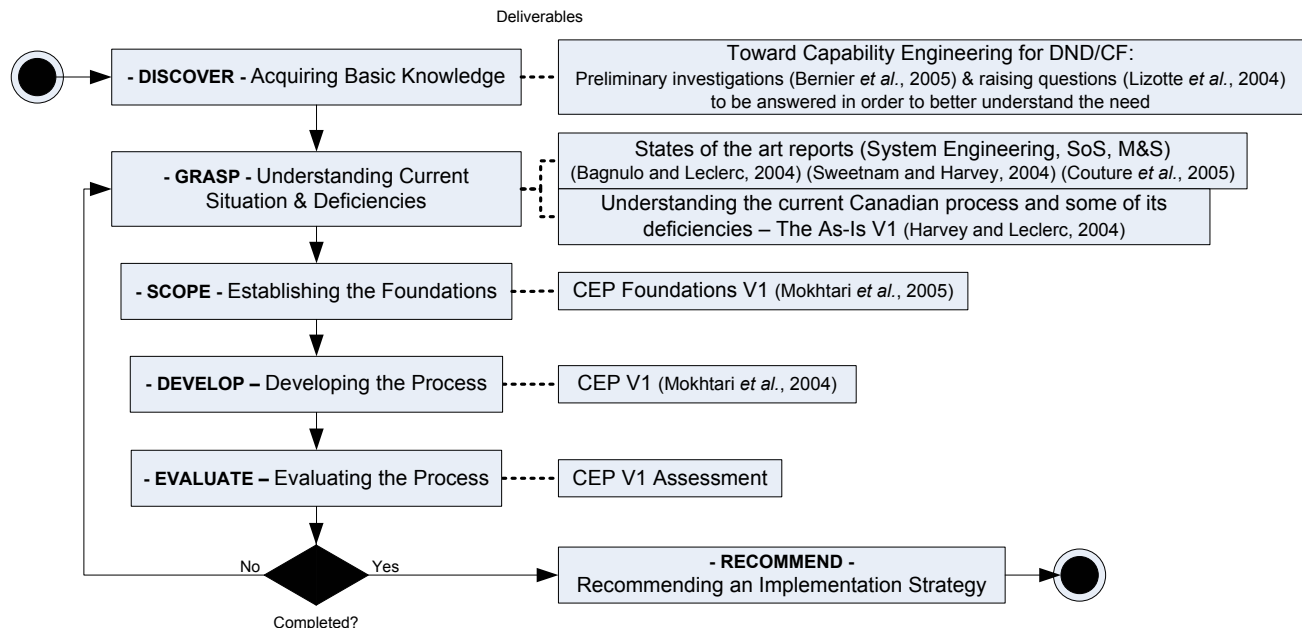


Figure 2 – CEP and iterative and incremental meta-process activity diagram

2.2 An overarching process

In order to help DND/CF deliver new or enhanced capability better, faster and cheaper, the CEP aims, through the use of system engineering processes, at analysing, defining, developing and monitoring the engineering solutions. The CEP is initiated with the identification of a prioritized capability deficiency at the CBP level, and ends with the definition of a set of viable investment options and a recommendation aimed at providing the DND/CF managers and decision-makers to rectify the deficiency. These options are expressed in terms of

PRICIE² elements, risk, schedule, performance and costs. Figure 3 positions the CEP as an overarching process linking the CBP activities and the individual materiel acquisition and non-materiel solution project activities. Following key elements summarize this figure:

- **Single Capability:** CEP focuses on a single capability while CBP focuses on a set of capabilities;
- **Triggering Event:** CBP triggers a CEP instance through a decision at the JCRB/JCAT³ level;
- **Concurrence:** Multiple CEP instances can execute in parallel;
- **PRICIE Solutions:** A solution may involve any combination of the PRICIE components i.e. not limited to acquisition-based projects;
- **Multiple Systems:** Multiple systems (a SoS) can be involved in one capability;
- **System Sharing:** A system can be involved in one or more capabilities;
- **System Feedback:** The CEP gets feedback and project status information (monitoring) from various materiel acquisition projects including non-materiel solutions;
- **CBP Feedback:** The CEP communicates to the CBP the potential capability investment options; and
- **CBP Control:** CBP controls the CEP through appropriate decision gates.

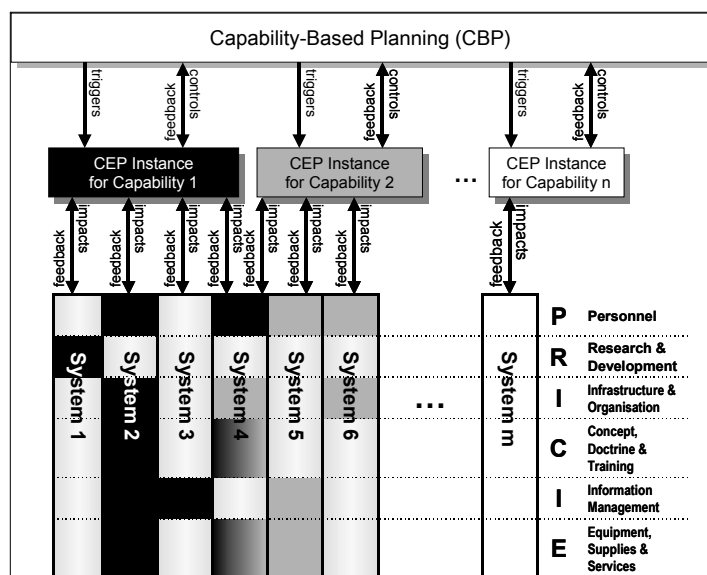


Figure 3 – CEP as an overarching process

The investment options are the result of the execution (1) of management processes used to plan, assess and control a CEP instance and (2) of engineering processes used to analyse the deficiency, develop investment options and recommend an integrated operational and system of systems architecture with regard to the capability deficiency being addressed. There is continuous interaction and feedback between these processes.

² DND acronym for Personnel, R&D/Ops Research, Infrastructure & Organization, Concepts, Doctrine & Collective Training, Infrastructure, Equipment, Supplies and Services.

³ Joint Capability Requirements Board/Joint Capability Assessment Team

Then outputs are progressively elaborated as the CEP progresses. Key elements of an option defined by the CEP are:

- **Incremental Delivery:** The CEP may provide incremental implementation plans in its investment options to progressively correct the capability deficiency over time. The number of increments from one option to another may vary;
- **System Life Cycle:** Multiple systems (a SoS) can be involved in one capability, each being at different stages of their respective life cycle; and
- **System:** A system is a global unit organized into relationships between process, people and materiel (including facilities, software ...) to satisfy a stated need.

3.0 CEP AND M&S

CEP promotes SBA concepts, which exploit M&S across all acquisition functions and program phases, in order to support enterprise-wide electronic interactions and information sharing through the means of Distributed Product Descriptions (DPDs) supported by a CEE. DPDs are stored in a central repository accessible from the CEE to all participants involved. Although a DPD is composed of multiple data dimensions, such as requirements, design specifications, costs, performance, manufacturing, test and evaluation scenarios and logistics, it appears to all participants as a logical unified product representation [Eirich *et al.*, 2002]. Import/export tools and Data Interchange Formats (DIFs) are provided by the CEE to allow information exchanges between the central repository and the users.

In a similar fashion as the one described by [Eirich *et al.*, 2002], the CEE would store the representation of DND/CF military combat system designs as well as representations of threats systems, operating terrain and environmental conditions, and alternative scenarios to be simulated. The CEE would also promote the sharing of a distributed M&S Resource Repository (MSRR) to allow “an integrated use of M&S tools across the individual environments from the initial phases of concept development through their exploitation throughout the life cycle of any military capability” [Pogue and Vallerand, 2003]. [Eirich *et al.*, 2002] also mentioned that “A DPD must maintain coordinated system design (structural) and behaviour (performance) views, must be able to incrementally reflect changed performance parameters in response to design changes, and must address the performance impacts on coordinated combat operations due to changes in any one of the combat system platform design (including the effects of combat damage or component failures)”.

Furthermore, the CEE infrastructure would support CEP within the acquisition phase as well as other capability-based activities where M&S tools and processes are involved (e.g. capability-based planning, CD&E, R&D and Maintenance and Support) [Pogue and Vallerand, 2003].

CEP promotes also a spiral development approach which allows architecture, design, construction, verification, implementation and trade-off studies to be performed at each phase of the process through “virtual system life cycles”. The wheel is spun quickly within each phase in order to obtain a continuous increase in the level of details and fidelity of the DPD being developed to address the capability deficiency. For each cycle, each activity is addressed at a different level of detail to mitigate risk and ensure achievability of the whole solution [CapDEM, 2003]. Therefore, the transition from an executing phase to the next one happens when the level of risk is within the desired boundaries (cost, time and performance).

The development of an evolving DPD becomes possible through M&S⁴ which provide the necessary tools and processes to virtually assess the effort to develop, deploy and support a new capability as it matures across each phase of the acquisition process. This development approach replaces the traditional « design, build, test, fix procedure » by a « design, simulate, fix, build procedure » which greatly contributes to reduced risk and cost [NMSG, 2001].

As a full capability is often delivered incrementally during the acquisition process, spiral development would also be effective to allow on-going introduction of updates and enhancements between the phased deliveries. Again, this approach can significantly reduce inherent risks and optimize the overall capability being deployed. Low fidelity models and simulations created in the early phases of acquisition, along with the DPD stored in the shared knowledge repository, would naturally evolve⁵ in a consistent way throughout the process. As the CEP will be involved early, it will play a particular role in establishing the degree of fidelity of the models and simulations to develop.

3.1 Benefits expected

Within the acquisition process, SBA acts as a vehicle to effectively coordinate the use of M&S to create a synthetic environment for concept development, experimentation, acquisition, test and training [Eirich *et al.*, 2002] and enables Integrated Product and Process Development (IPPD) across the entire life cycle. Models and simulations can be re-used, integrated or linked together in order to meet the respective needs of the different acquisition phases.

Some of the main benefits expected from M&S are as follow [DND/CF, 2000]:

- **Information Credibility:** When involved in the very early stages of acquisition (including CEP), M&S can add to the completeness and the credibility of the information associated with the options presented to the decision makers. It allows an in-depth look at issues related to requirements and design, functionality, manufacturing, training, life cycle support, etc. of a system. Various aspects of a capability can be simulated to help better estimate performance, effectiveness, potential problems, costs and risks. M&S allows the requirements definition process to be iterative which can help gather more complete, accurate and credible information early in the acquisition process.
- **Concurrent Processing:** Early M&S involvement in the acquisition process also allows addressing multiple PRICIE issues concurrently. As an example, training programs can be developed and tested out in virtual environments before new systems or equipments get delivered to the users. This not only allows minimizing the time to deploy the new equipment or system but it also helps future users build greater confidence.
- **Contracting:** In its ability to allow multiple and complex option analysis, M&S can greatly help to evaluate the cost effectiveness of various solutions, thereby decreasing the time required to develop a Statement of Operational Requirements (SOR), and eventually the associated statement of work. Through the mean of its CEE, DND/CF believes it can work more closely with the manufacturing industry when performing requirements definition and functional analysis. As some related M&S

⁴ Among others, models and simulators are used with other tools within a synthetic environment. All of these tools contribute to feed the central repository.

⁵ This is a general tendency. Within the CEP, the risk levels will dictate the degree of fidelity of the models and simulations that need to be developed.

activities could be conducted jointly in a collaborative environment, it is anticipated that better requests for proposal would be developed and issued faster.

- Test and Evaluation:** M&S can strongly contribute in cutting down the costs associated with physical prototypes as various physical tests can be conducted in synthetic environments instead. Although physical tests will still be required, their objective will mainly be to validate the models developed. Once models have been validated, numerous virtual simulations can be executed at a fraction of the time and costs required to perform multiple physical tests. “Additional benefits include the elimination of risks associated with safety hazards and the protection of the environment. Simulations can also help focus the test effort on the critical evaluation areas, thereby avoiding unnecessary physical testing. As well, testing in a virtual environment permits parallel, rather than sequential testing. All these possible benefits in the realm of test and evaluation permit the fielding of materiel at a faster and potentially cheaper rate.” [DND/CF, 2000]

Table 1 was extracted from [NMSG, 2001] and slightly modified to use the naming convention used in DND/CF for the acquisition phases. It summarizes how SBA, through the use of M&S, can provide benefits to the first phases of the acquisition life cycle where CEP activities take place.

Table 1: Applicability of M&S through the acquisition phases

PHASE OF LIFECYCLE	APPLICATION OF M&S	BENEFIT
Identification of existing shortcomings <i>(Pre-acquisition)</i>	Represent existing systems and test for a shortcoming in capability. Demonstrate the consequences of the shortcoming in capability.	Early and accurate assessment of capability shortcoming.
Concept, Development and Experimentation (CD&E) <i>(Pre-acquisition)</i> Identification	Demonstrate new concepts, including modes of operation, and assess modified or new equipment in future operational scenarios. Construction and presentation of robust business case.	Facilitates investigation of concepts including assessment of operational effectiveness (in conjunction with pre-existing systems). Enables feasibility assessment of concepts. Provides a mechanism to demonstrate SOR.
Identification Option Analysis	Demonstrate high-level system solutions including performance, logistics and through life costs. Facilitate refinement (de-risking) of concepts.	Enables assessment of capability over varied operational scenarios. Enables concept to be evaluated in an operational environment. Facilitates the refinement of the SOR.

PHASE OF LIFECYCLE	APPLICATION OF M&S	BENEFIT
Definition	<p>Demonstrate the proposed options and down select the options for preparation of the Request For Quotation (RFQ).</p> <p>Establish the credibility of potential suppliers.</p> <p>Define the facilities to be used to evaluate the solutions offered in response to the RFQ.</p> <p>Support system design of the solution and the risk mitigation of the estimates used for the response to the RFQ.</p>	<p>Supports continued down selection of the options.</p> <p>Develops an objective base for the assessment of potential suppliers and the assessment of their performance to deliver an acceptable solution ready for in-service use.</p> <p>Defines the facilities and criteria that will be used to assess the acceptability of the equipment/non-equipment solution.</p> <p>Facilitates consideration of the options for supplying training, Mission Rehearsal & Planning (MR&P) facilities to meet the required in-service date.</p>
Implementation	<p>Support system design throughout the system and detailed design phases.</p> <p>Enables informed overview of the equipment manufacturing process.</p> <p>Provide a reference system for continuous monitoring of the key requirements included in the RFQ.</p> <p>Supports the test and integration of the solution by providing a comprehensive basis for fully exercising the design and ensuring that it meets the customer's requirement.</p>	<p>Provides a basis for monitoring the development, manufacture, test and integration of the selected solution as it progresses through the manufacturing phase.</p> <p>Support design & contract reviews.</p> <p>Enables assessment of the Training and MR&P facility and consideration of the implementation options.</p> <p>Provides a basis for monitoring the development, manufacture and test of the Training, MR&P facilities.</p> <p>Provide the test and demonstration environment for acceptance of the equipment and associated Training, MR&P facilities.</p> <p>Facilitate assessment of the methodology for introducing the equipment into service.</p>

3.2 Benefits from early involvement of M&S in the acquisition life cycle

The primary objective of M&S is to provide tools and processes to better leverage risk throughout the acquisition process. In order to obtain the most benefits, M&S activities must be planned early in the process and properly managed across the different acquisition phases. This requires up front investment in terms of hardware and software infrastructure as well as direct and indirect resources and knowledge to efficiently plan, conduct, support and manage M&S activities. The diagram in Figure 4, although not based on definitive numbers and outcomes, illustrates how (major and large) acquisition projects can benefit from the introduction of M&S at an early stage. Again, the figure's objective is only to show differences in the risk mitigation from using or not using M&S [NMSG, 2001]. It should be noted that most of the benefits generated by the use of M&S during the CEP would only be observed in the subsequent phases of the acquisition process.

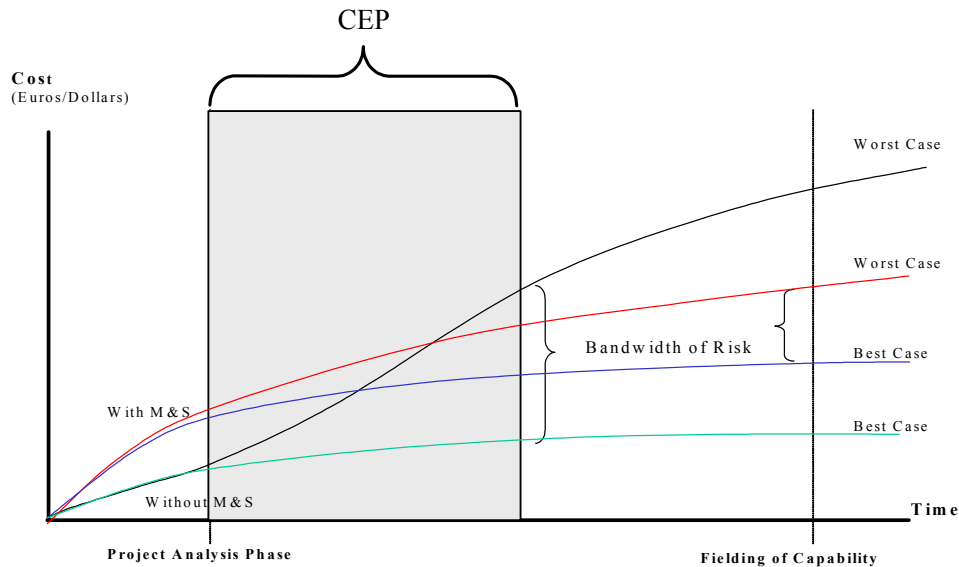


Figure 4: Justification for investment in M&S for acquisition projects

4.0 CONCLUSION

The CEP is one of the CapDEM project expected outcomes aimed at efficiently integrating M&S and system engineering processes to optimize how DND/CF military capabilities are delivered better, faster and cheaper. Since the CEP definition is at an intermediate stage, this paper may be considered as a first step in defining the link between M&S and CEP. As the CEP matures, the role of M&S should progressively be refined as well. Furthermore, as the DND/CF intention is to globally manage M&S across the entire acquisition life cycle, through the “institutionalization” of SBA [DND/CF, 2000], the role of M&S in the CEP will need to tie to the global M&S strategy. Once this global strategy is defined, it should encompass in more detail how the common synthetic environment framework and the shared distributed MSRR will be developed within DND/CF, in order to promote re-use and consequent efficiencies “across the board” [Pogue and Vallerand, 2003].

In order to efficiently implement the notion of collaboration and sharing across the life cycle, there is a great need to define how M&S activities, and its relevant data, must transit from one phase (or process) to another. The objective is to maximize benefits from M&S within the capability life cycle as a whole as well as within each individual phase. M&S implementation details across the capability life cycle will particularly be defined as the IPPD and the CEE concepts are integrated into the capability acquisition process. The anticipated benefits from the use of M&S will mostly be observed in the subsequent phases of the CEP until the capability life cycle has been completed (disposal). Therefore, the M&S resource investment required to implement a specific simulation support plan will need to take into account all the activities involved in a capability life cycle (definition, development, training, sustain and disposal).

As for candidate M&S tools to support the CEP, the tools selection cannot happen without considering the greater framework within which they will be deployed. This document does not go into any detail on the supporting technologies and processes that will allow M&S tools to work effectively within the CEP. Current

Modelling and Simulation and Capability Engineering Process

trends such as collaboration, interoperability, MSRRs, data standards, interchange formats, HLA and the like should also be investigated further. These technologies, processes and standards will form the glue that will bind the suite of M&S tools together to achieve the objectives of the CEP.

From what has just been said, it is believed that the following elements represent valuable areas of opportunity to investigate in order to better define the role of M&S in CEP:

- Obtain the most recent DND/CF strategy and plans with regards to the implementation of SBA, IPPD and the CEE concepts to support the capability life cycle;
- Obtain the most recent DND/CF strategy and plans with regards to M&S planning, development, use and management enterprise wide;
- Once the CEP activities have been properly defined, upstream and downstream phases should be analyzed in order to identify common M&S objectives and define how they should be addressed. This will particularly help to better define how the simulation support plan should be developed and managed across the life cycle;
- Refine the role of M&S within the latest CEP definition within its global context; and
- Create a synergy with other DND/CF initiatives related to M&S use within the capability acquisition process.

5.0 ACKNOWLEDGEMENTS

The authors wish to acknowledge the significant contribution to this research, made by CGI Québec (Claude Drouin) and The HFE Group (Mike Wellwood).

6.0 REFERENCES

[ACAE, 2003] Advisory Committee on Administrative Efficiency, “Achieving Administrative Efficiency”, Report to the Minister of National Defence, 2003.

http://www.forces.gc.ca/site/Focus/AE/AEReportFull_e.pdf

[Bagnulo and Leclerc, 2004] Bagnulo, A., and Leclerc, J., “Systems Engineering - State of the Art Report”, Contract W7701-3-2621, 2004.

[Bernier *et al.*, 2005] Bernier, F., Mokhtari, M., Couture, M., Lizotte, M., Lemieux, F., Lam, S., Lalancette, C., and Dussault, G., “The Axes Guiding Development of a Capability Engineering Process”, in Proc. of INCOSE 2005, Rochester, NY, USA, July 10-14, 2005.

[CapDEM, 2003] DRDC Valcartier, CapDEM TDP fact Sheet IS-224-A, 2003-10.

http://www.drev.dnd.ca/poolpdf/e/162_e.pdf

[Couture *et al.*, 2005] Couture, M., Lizotte, M., Dussault, G., Mokhtari, M., Bernier, F., Lam, S., and Lalancette, C., “Capability Engineering Process within Canadian Defence: Some Engineering Issues”, in Proc. of INCOSE 2005, Rochester, NY, USA, July 10-14, 2005.

[DND/CF, 2002] DND/CF, “Capability Based Planning for the Department of National Defence and the Canadian Forces”, 2002. http://www.vcds.forces.gc.ca/dgsp/00native/rep-pub/cbpManual_e.pdf

[DND/CF, 2000] DND/CF, “Creating the CF of 2020 – Concept Development and Experimentation and Modeling and Simulation”, Concept Paper by the Symposium Working Group, 1 Nov 2000.
<http://www.vcds.forces.gc.ca/dgsp/pubs/rep-pub/dda/symp/cde>

[DRDC, 2003] DRDC, “Project Implementation Plan - Collaborative Capability Definition, Engineering and Management (CapDEM) Technical Demonstration Project”, 5 May 2003, 49 pp.

[Eirich *et al.*, 2002] Eirich, P.L., Coolahan, J.E., and Purdy, E., “A Collaborative Environment Architecture for Future Combat Systems (FCS) Modeling and Simulation”, in GEIA 36th Ann. Engineering and Technical Management Workshop, CD-ROM, Snowbird, UT, 2002.
http://www.msiac.dmsi.mil/sba_documents/Collab%20Environment%20for%20FCS%20M&S.pdf

[Harvey and Leclerc, 2004] Harvey, G., and Leclerc, J., “DND Capability Decision-Making Process: The As-is”, Contract W7701-3-2621, May 2004.

[Lizotte *et al.*, 2005] Lizotte, M., Lalancette, C., Dussault, G., Lam, S., Couture, M., Mokhtari, M., and Bernier, F., “An Agile Meta-Process Producing a Deliverable-Centric Process”, in Proc. of INCOSE 2005, Rochester, NY, USA, July 10-14, 2005.

[Lizotte *et al.*, 2004] Lizotte, M., Bernier, F., Mokhtari, M., Couture, M., Dussault, G., Lalancette, C., Lam, S., and Lemieux, F., “Toward a Capability Engineering Process”, in Proc. of the 24th Army Science Conference (ASC’04), Orlando, FL, USA, November 29 - December 2, 2004.

[Mokhtari *et al.*, 2005] Mokhtari, M., Lizotte, M., Lam, S., Lalancette, C., Dussault, G., Couture, M., and Bernier, F., “Canadian Capability Engineering Process Foundations”, in Proc. of INCOSE 2005, Rochester, NY, USA, July 10-14, 2005.

[Mokhtari *et al.*, 2004] Mokhtari, M., Lizotte, M., Lam, S., Lalancette, C., Dussault, G., Couture, M., Bernier, F., Bagnulo, A., Drouin, C., Harvey, G., Leclerc, J., Sweetnam, P., and Wellwood, M., “Capability Engineering Process Version 1 (CEP V1) – Background and Overview”, Technical Memorandum TM 2004-426, 45 pages.

[NMSG, 2001] NATO Modeling and Simulation Group, “M&S Technology in Support of Simulation Based Acquisition (SBA)”, December 2001.

[Pogue and Vallerand, 2003] “A Conceptual Model of Military Capabilities and an Integrating Functional Architecture to Facilitate Military Capability-Based Planning”, in Proc. of Summer Computer Simulation Conference, July 20-24, Montréal, Qc, Canada, 2003.

[Sloan, 2000] Sloan, E., “Canada and the Revolution in Military Affairs: Current Response and Future Opportunities”, *Canadian Military Journal*, 2000.
http://www.journal.forces.gc.ca/engraph/Vol1/no3/pdf/7-14_e.pdf

[Sweetnam, 2004] Sweetnam, P., “Current DND Initiatives – Review”, Contract W7701-3-2621, 2004.

[Sweetnam and Harvey, 2004] Sweetnam, P., and Harvey, G., “System of Systems – State-of-the-Art Report”, Contract W7701-3-2621, 2004.

[Walker, 2002] Walker, R.S., “Towards Defence Capability Management: A Discussion Paper”, 2002.

