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Evolutionary Acquisition – A Complementary Approach to Capability Based Planning for the Delivering of Aerospace Power.

By /par

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ABSTRACT

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The Canadian Forces is in the process of acquiring nine new aerospace weapon systems over the next 20 years. Historically having taking an average of over 16 years to deliver a major defence capital project in Canada, one questions what should be the best method of ensuring the right capability is delivered to the right user in a timely manner. To address such a problem, the United States Department of Defense has adopted evolutionary acquisition as their preferred acquisition strategy for capital projects. Evolutionary acquisition is a strategy that develops and delivers new capabilities over time rather than in a single step, either via multiple spirals or increments, or both

The Canadian Forces has recently introduced the concept of capability-based planning as a methodology for strategic planning of future defence capabilities. It is a method of planning for future capability requirements that is functionally-based rather than threat-based.

This paper argues that evolutionary acquisition is an effective strategy in enabling the delivery of evolving operational aerospace capabilities and, as such, it is a complimentary acquisition strategy to the Canadian Forces' capability based planning methodology. This complementariness lies primarily in the shared attributes of inherent responsiveness, cyclical nature, and dependence on an effective and controlled feedback process.

This paper begins with a detailed description of evolutionary acquisition. It then provides an analysis of the major influences on defence planning, acquisition and capability requirements: those being Canada's foreign and defence policies, the future battlespace and security environment, and the rapid pace of emerging technology. Following a description of the current Canadian Forces' acquisition environment and its capability based planning methodology, the paper concludes that the methodology, in addition to sharing the attributes of evolutionary acquisition, that those attributes are necessary to address the common effects of the major influences, and hence is complimented by it.

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CHAPTER 1 - INTRODUCTION

> Research into the war of the future is not . . . an idle pastime. It is, rather, an ever-present practical necessity.
>
> Giulio Douhet, Airpower theorist[1]

Background

Alexander Graham Bell once stated that "the most successful men in the end are those whose success is the result of steady accretion. It is the man who carefully advances step by step, with his mind becoming wider and wider … who is bound to succeed in the greatest degree."[2] Perhaps the same can be said for the weapons that man develops, that by accretion, like his mind, can evolve and maintain the ever necessary advantage over those of his adversaries. This is perhaps truer of aerospace weapon systems with their inherent reliance on technology, and therefore the ability for modern militaries to manage their aerospace capabilities intelligently, economically, and efficiently is essential. On this year, the 100th anniversary of powered flight in Canada and the Commonwealth, commemorating the day Alexander Douglas McCurdy piloted his Alexander Graham Bell co-designed Silver Dart over the frozen Bras D'Or Lake near Baddeck, Nova Scotia on February 29, 1909, one has to ask, how much has aerospace capability evolved since, and how effective was the management of that journey along the way?

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[1] Giulio Douhet, *The Command of the Air*, Ed. Richard H. Kohn and Joseph P. Harahan, trans. Dino Ferrari, (Washington, DC: Office of Air Force History, 1983), 145-146.

[2] Orison Swett Marden. *How They Succeeded.* (1901) Ch. 2. quoted in Wikiquote. "Alexander Graham Bell." http://en.wikiquote.org/wiki/Alexander_Graham_Bell; Internet; accessed 19 April, 2009.

Concepts without resources are mere hallucinations. Similarly, it can be said that no matter how exceptional and seemingly advanced a promised capability may be, until the final product is delivered and implemented, the best of acquisition strategies have still achieved nothing. It takes an average of over 16 years to deliver a major defence capital project in Canada.[3] And in addition to taking that long, the capability, once delivered, is often either drastically overpriced, or has reached technological obsolescence, or both. Managing modern technologically-dependent weapon systems and platforms and their integral complex sensors this way is no longer acceptable.

Defence acquisition, despite being one of the most critical aspects of delivering military capability, has historically been one of its most criticized and debated. There is no shortage of proposals and submissions for acquisition reform, organizational restructures, policy changes, process improvements, and revolutions and evolutions in an effort to improve this vast and complex process. The most often heard criticism with the defence acquisition process is that it takes too long, and that the capability is usually delivered over budget.[4]

In simple terms, the purpose of defence acquisition is to satisfy a desired military capability. The complex process is inherently influenced by a variety of factors, such as the will of the nation, foreign and defence policies, existing and emerging technologies, and the nature of past, current, and future conflicts. Further adding to this overall complexity, is that these influences originate from a variety of different sources. These

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[3] Alan S. Williams. *Reinventing Canadian Procurement: A View from the Inside* (Montreal and Kingston: McGill-Queen's University Press, 2006), 95.

[4] Auditor General of Canada. *Department of National Defence: Major Capital Projects – Project Initiation and Implementation Within DND*, Chapter 17. (1992), art. 17.6; http://www.oag-bvg.gc.ca/internet/English/parl_oag_199212_17_e_8070.html; Internet; accessed 15 January, 2009.art. 17.6.

sources range from the multitude of departments and levels of government with their embedded complex governance and policies, through domestic and international laws, to lobbying by armies of representatives from many of the world's largest and most powerful corporations. With such extensive influence, it is easy to appreciate that acquisition change or reform tends to occur at a glacial pace.[5]

Compounding this complexity is the reality of today's technological and security environments. The Cold War era presented a clear enemy with a specific and concise threat. It was easy to predict what technologies were needed to be maintained, and for how long. In today's security climate, it is no longer a stable or predictable threat environment that is being faced, but rather, a dynamic one, and therefore traditional acquisition strategies and long-term threat-based strategic planning approaches are no longer as effective. Combining this with a significantly faster pace of changing technology renders the previously accustomed-to long weapon system development times unsuitable.[6]

Amongst the multitude of modern equipment continuously acquired by contemporary forces, aerospace weapon systems rank amongst the most complex. "Air Forces are generally considered to be capital intensive, technology centric and readiness

[5] The complexity of defence acquisition is reflected in the existence of the United States Defense Acquisition University (DAU), an institution that teaches acquisition to the US military. Canada has much less of a formal teaching process, a much smaller military, and an exponentially smaller defence budget. None the less, for those reasons it is equally, if not more important for Canada to be able to manage its defence acquisition even more systematically or carefully as it acquires much less equipment, with a greater span of capability, that must last a much longer time.

[6] Bobak Ferdowsi. "Product Development Strategies in Evolutionary Acquisition," (Master's thesis, Boston, MA: Massachusetts Institute of Technology, Sept 2003), 16; http://lean.mit.edu/index2.php?option=com_docman&task=doc_view&gid=130&Itemid=88; Internet; accessed 2 March, 2009.

dependent."[7] Adding to these inherent characteristics are high corporate competitiveness, lengthy development times, technological complexity, extensive regulatory oversight, training and maintenance costs, expected lengthy service life, and the significance of the risk of failure. Finally, the actual procurement or purchase of that equipment is merely one of the many steps of the acquisition process. Initially defining the capability requirement prior to its procurement and the implementation and life cycle management of the equipment once it is procured further compounds that complexity.

As a result in part of the recently released 2008 *Canada First Defence Strategy*, the Canadian Forces is currently undertaking an unprecedented level of capability modernization. An estimated 490 billion dollars will be spent over the next two decades; as a means of shaping and influencing Canada's military strength, capability, and relevance for the next 30 years.[8] In aerospace capability alone, the Canadian Forces is in the process of acquiring a total of nine new fleets of aerospace weapon systems over the next 20 years.[9]

With such an unprecedented amount of capability being delivered in such a short period, how can it be ensured that the right capability is being delivered at the right time, and in the right amount? In an effort to reduce acquisition time, cost, and risk while providing the right capability to the right user in a timely manner, the United States Department of Defense has formally adopted the concept of evolutionary acquisition as

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[7] Department of National Defence. *The Aerospace Capability Framework.* (Ottawa: DND Canada, 2003), 26; http://www.airforce.forces.gc.ca/site/vision/pdf/Aerospace/print/Aerospace_Chpt1_e.pdf; Internet; accessed 5 March 2009.

[8] Department of National Defence. *Canada First Defence Strategy. (*Ottawa: 2005*),* 4; http://www.forces.gc.ca/site/focus/first/June18_0910_CFDS_english_low-res.pdf; Internet; accessed 8 November 2008.

their preferred acquisition strategy for capital projects. The United Kingdom has also recently embraced a similar strategy as one of their key processes within its Appropriate Acquisition Approaches.[10] Although Canada has not yet formally embraced or incorporated evolutionary acquisition in its procurement process, the most recent Chief of Review Services audit of Defence Procurement recommended, amongst other things, that the concept of evolutionary acquisition be considered in future acquisition projects. [11]

Evolutionary acquisition is "an approach … that delivers capability in increments, recognizing, up front, the need for future capability improvements."[12] It is a strategy that develops and delivers new capabilities over time rather than in a single step, either via multiple spirals or increments, or both. These spirals or increments build on the preceding ones to provide successive amounts of capability, eventually resulting in a

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[9] The nine new fleets include: CH-148, C-17, C-130J, Fixed-Wing SAR, Medium-Heavy Lift Helicopter, Uninhabited Air Vehicle, CH-47F, New Maritime Patrol Aircraft, Next Generation Fighter. Department of National Defence. *Canada First Defence Strategy*, 4.

[10] Acquisition Operating Framework, A3 "will increase the agility in acquisition through the increased use of incremental capability enhancements and modified off-the-shelf (MOTS)/ commercial off-the-shelf (COTS) solutions. This increased agility will improve our responsiveness to changing requirements and capability needs." United Kingdom. Ministry of Defense. http://www.aof.mod.uk/aofcontent/strategic/guide/sg_whatnextforacq.htm; accessed 20 Mar 09. The origins of the AOF are from the MOD's Smart Acquisition process, which had the aim "to acquire Defence capability faster, cheaper, better and more effectively integrated. Hambleton, Ken et al. *Conquering Complexity*: *Lessons for defence systems acquisition.* (Norwich, England: The Stationary Office Inc, 2005), 81.

[11] The actual recommendation was to pursue spiral and incremental procurement strategies, which as will be explained in Chapter 2 of this paper, are two of the principle development strategies of evolutionary acquisition. Department of National Defence. *Perspectives on the Capital Equipment Acquisition Process*. Chief Review Services. (Ottawa: DND Canada, 2006), 19. Unfortunately, there is very little information about evolutionary acquisition in the Project Approval Guide or the Procurement Administration Manual, DND's principle procurement guidance documents. Department of National Defence. *Project Approval Guide.* http://vcds.mil.ca/sites/page-eng.asp?page=4343; DWAN Intranet; accessed 13 Feb 2009. Department of National Defence. *Procurement Administration Manual.* Release 1.0, 14 February 2005, (AL 14 December 2008); http://dgmssc.ottawa-hull.mil.ca/matknet/english/Procurement/PAM/; DWAN Internet; accessed 28 January 2009.

[12] United States. Department of Defense. *Department of Defence Instruction 5000.02 - Operation of the Defense Acquisition System*, (8 December 2008), 13; http://www.dtic.mil/whs/directives/corres/pdf/500002p.pdf; Internet; accessed 21 January 2009.

system that meets the full capability originally envisioned at the beginning of the project.[13]

As revolutionary as the concept of evolutionary acquisition may seem, it is not a new concept, having its origins in the 1980's in the software industry, and eventually migrating its way into defense acquisition in the 1990's. However, it is relatively new as a matter of formal policy, and for that reason, few projects have been completed utilizing evolutionary acquisition within its current definitions. For the same reason, little in-depth analysis has been conducted of those projects to date to truly measure its success as an effective and efficient acquisition strategy for defence procurement, particularly with aerospace weapon systems.

In support of defence acquisition, the Canadian Forces along with several of its allies[14] has introduced the concept of capability-based planning as a methodology of strategic planning of future defence capabilities. Capability-based planning "was developed as an alternative to threat-based planning."[15] It is a method of planning for future capability requirements that "involves a functional analysis of operational requirements. Capabilities are identified based on the tasks required. Once the required capability inventory is defined, the most cost effective and efficient options to satisfy the requirements are sought."[16] This methodology was pursued to better manage future

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[13] This description of evolutionary acquisition is a compilation derived from the various sources referred to in Chapter 2.

[14] The United States, United Kingdom, Australia, and New Zealand, among others. The Technical Cooperation Program. *Guide to Capability-Based Planning*. A Paper prepared by the Joint Systems and Analysis Group, Technical Panel 3 (JSA TP-3) of TTCP for the MORS Workshop held in Alexandria, VA, USA 19-21 October 2004, 1; . http://www.mors.org/meetings/cbp/read/TP-3_CBP.pdf; Internet; accessed 13 March, 2009.

[15] The Technical Cooperation Program. *Guide to Capability-Based Planning*, 1.

[16] *Ibid*.

capabilities and procurement while at the same time enabling the concentration on development of capability rather than acquisition of new platforms. Also inherent in this methodology is the identification of capability gaps and deficiencies of the military's existing force structure and potential proposals or alternatives to filling those gaps, for which solutions will inevitably lead to adding additional capabilities to existing platforms. Therefore, considering existing fiscal and resource realities, in the interest of closing the gaps and delivering the minimum required capability sooner to the operators, it follows that the ability to evolve existing platforms is a worthy option, making evolutionary acquisition a complimentary strategy to capability based planning.

This paper will argue that evolutionary acquisition, as an effective strategy in enabling the delivery of evolving operational aerospace capabilities, should be considered as a complimentary acquisition strategy to the Canadian Forces' capability based planning methodology. This complementariness lies primarily in the shared and necessary attributes of inherent responsiveness, cyclical nature, and dependence on an effective and controlled feedback process.

Scope

The scope of this paper will be limited to addressing the concept of evolutionary acquisition as it compliments capability-based planning in the context of operational capability delivery for the Canadian Forces. The Canadian defence procurement process is in itself quite complex. Although much has been published over the years about the procurement process and the problems with it, this paper will not dwell into that particular history or into the intricate details of the process itself. Rather, it will address

acquisition in general, concentrating primarily on the events that occur before the actual contracting and purchase, specifically those of capability management and planning.

As well, although it will be argued that evolutionary acquisition should be strongly considered as a strategy that is complimentary to capability based planning, there are important factors, considerations, and effects that must be considered prior to fully implementing such a strategy into the relatively modest Canadian Forces acquisition process. Although a detailed analysis of these considerations is beyond the scope of this paper, they are worth mentioning as subjects for further analysis and study. The most important of these factors include constraints with current defence acquisition policy; resources, including personnel and platforms, training, maintenance, and test and evaluation; cost, including the effects on annual budgets and the impact of accrual accounting; and finally Canada's industrial defence capacity.

Outline

This paper will analyze the effectiveness of evolutionary acquisition as a strategy for the acquisition of evolving aerospace weapon systems and demonstrate that it compliments the Canadian Forces' capability based planning methodology. This will be achieved by first providing a detailed description of evolutionary acquisition. This will be followed by an analysis of the major influences on defence planning, acquisition and capability requirements. Finally, a description of the current Canadian Forces' acquisition environment and its capability based planning methodology will be provided.

Specifically, Chapter 2 will provide a detailed description of evolutionary acquisition. This will include its origins and an overview of the various definitions from

a defence procurement perspective. This will be followed by an analysis of its' inherent characteristics, including its advantages, disadvantages, and some measures of success. This analysis will highlight evolutionary acquisition's attributes of inherent responsiveness, cyclical nature, and dependence on an effective and controlled feedback process.

Armed with an understanding of evolutionary acquisition, Chapter 3 will provide a detailed analysis of some of the major influences and their effects on defence planning, acquisition and capability requirements. These major influences will include Canada's foreign and defence policies as influenced by its strategic situation, the future battlespace and security environment, and the rapid pace of emerging technology. It will be demonstrated that due to the nature and effects of these influences, the attributes of evolutionary acquisition are necessary.

With a solid understanding of the concept of evolutionary acquisition and the major influences and their effects on defence planning, acquisition and capability requirements, Chapter 4 will examine the Canadian Forces' current acquisition environment and the recently developed application of the capability based planning methodology. This will be achieved by providing an overview of the acquisition system, highlighting several deficiencies with respect to capability management. Next, the process of how operational capability requirements are defined, from initial conception of a national Defence Policy, through to the Defence Planning and Management Process will be discussed. This will be followed by an overview of how capability requirements are translated into capital projects. Finally, the chapter will examine the management of aerospace capability in particular in terms of Canada's aerospace power doctrine, vision,

and inherent characteristics. It will be demonstrated that capability based planning, in addition to having the same major influences as evolutionary acquisition, also shares its attributes of inherent responsiveness, cyclical nature, and dependence on an effective and controlled feedback process, and that these attributes are necessary to address the effects of those major influences, and hence is complimented by it.

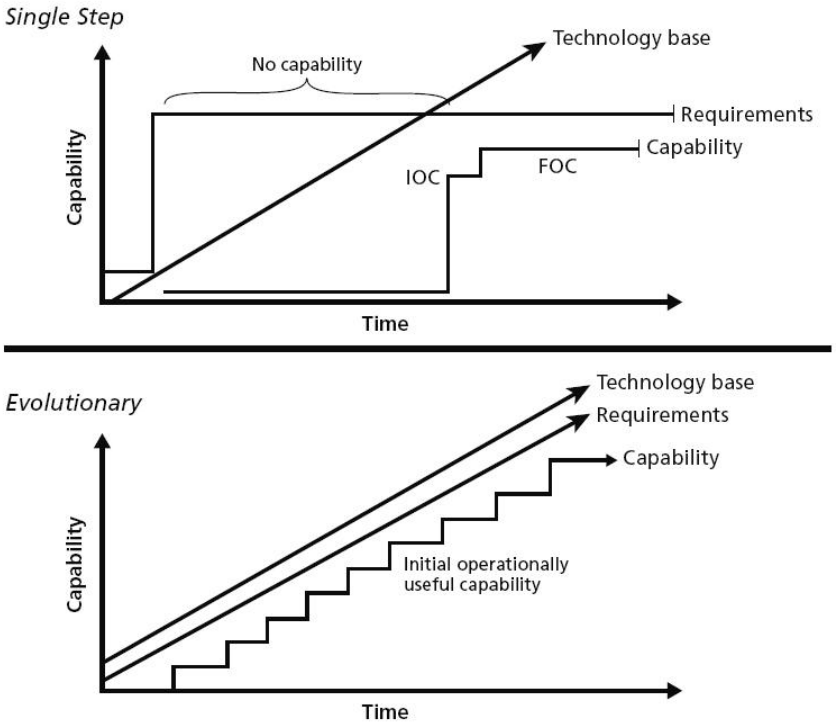
CHAPTER 2 - EVOLUTIONARY ACQUISITION

Introduction

This chapter will explore the concept of evolutionary acquisition. It will provide detailed definitions, descriptions, and interpretations of evolutionary acquisition predominantly concentrating on documented experiences from the United States defense acquisition process. Following an overview of its origins, the chapter will provide an examination of its inherent development processes, primarily spiral and incremental development. The chapter will then discuss evolutionary acquisition characteristics, highlighting some of the inherent advantages and disadvantages, and providing some criteria for success. The characteristics will be discussed in terms of requirements and specifications; user feedback and test and evaluation; technology; and funding and costs. The discussion will be placed in the context of evolutionary acquisition's attributes of inherent responsiveness, cyclical nature, and dependence on an effective and controlled feedback process. These characteristics will be seen later in the paper as necessary to addressing the effects of the major influences to defence planning, acquisition and capability requirements, and as complimentary to capability based planning.

Evolutionary Acquisition - Defined

The purpose of an evolutionary acquisition strategy is to develop and deliver new capabilities over time rather than in a single step. As shown in Figure 2.1, at the core of



NOTES: IOC = initial operational capability; FOC = full operational capability.

Figure 2.1 - Evolutionary Acquisition vs Single Step Acquisition.

Source: Lumb, Mark D., "Meeting the Security Challenges of the 21st Century," briefing, Second Annual Defense Acquisition University-South Contracting Conference and Exposition, February 18–19, 2004, quoted in Lorell, Mark A., Lowell, Julia F., and Younossi, Obaid. Evolutionary Acquisition Implementation Challenges for Defense Space Programs. RAND Corporation. Santa Monica, CA: 2006, 17.

the strategy, new capabilities are acquired in "multiple, shorter-phased spirals or increments." These initial spirals or increments are aimed at providing a basic capability that is "operationally useful relatively quickly."[17] Follow-on spirals or increments build on the preceding ones to provide successive amounts of capability, eventually resulting in a system that meets the full capability originally envisioned at the beginning of the

[17] Mark A. Lorell, Julia F. Lowell and Obaid Younossi. *Evolutionary Acquisition Implementation Challenges for Defense Space Programs.* (RAND Corporation. Santa Monica, CA: 2006), xv; http://www.rand.org/pubs/monographs/2006/RAND_MG431.pdf:; Internet; accessed 15 January, 2009.

project. In contrast, traditional approaches focus on a single step to achieving full capability, an approach that some claim "often results in inordinately long developmental schedules that produce no useful operational capability for many years, and that often lead to serious problems with schedule slippage and cost growth." [18]

The United States Department of Defence (DOD) Directive 5000.01 - *The Defense Acquisition System* has mandated that "evolutionary acquisition is the preferred DoD strategy for rapid acquisition of mature technology for the user." [19] It defines evolutionary acquisition as:

> an approach … that delivers capability in increments, recognizing, up front, the need for future capability improvements. The objective is to balance needs and available capability with resources, and to put capability into the hands of the user quickly. The success of the strategy depends on phased definition of capability needs and system requirements, and the maturation of technologies that lead to disciplined development and production of systems that provide increasing capability over time.[20]

DOD 5000.02 *Operation of the Defense Acquisition System* expands upon this definition by highlighting that evolutionary acquisition "requires collaboration among the user, tester, and developer."[21] Furthermore, it requires that the increments be dependant on "available mature technology" and that "technology development preceding initiation of an increment shall continue until the required level of maturity is achieved, and prototypes of the system or key system elements are produced."[22] The primary objective

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[18] Lorell, Lowell and Younossi. *Evolutionary Acquisition …*, xv.

[19] United States. Department of Defense. *Department of Defence Instruction 5000.02*, 13.

[20] *Ibid.*

[21] *Ibid.*

[22] *Ibid.*

being that "each increment is a militarily useful and supportable operational capability that can be developed, produced, deployed, and sustained." [23]

Air Force Instruction 63-101 *Operations of Capabilities Based Acquisition System* speaks to the advantages of evolutionary acquisition as allowing "for the ability to incrementally refine capability requirements, insert technology or additional capabilities, react to the environment, and exploit opportunities as they arise."[24] The document defines success of such a strategy as depending "on consistent and continuous definition of operational capability requirements coupled with the maturation of technologies that lead to the disciplined development of systems that provide increasing capability."[25] The overall objective is to "balance needs and potential capabilities with resources, and to quickly put capabilities into the hands of the operator."[26]

In a paper published by the United Kingdom Defence Science and Technology Laboratory entitled "Rapid Acquisition of Adaptable Systems", evolutionary acquisition is defined as:

> an acquisition strategy that develops and deploys a core capability with the intent to reduce the maintenance burden, improve reliability or field additional capability, (through the upgrade of existing systems or addition of new ones) as customer requirements evolve, technology matures and the constraints, and interfaces become better understood. It delivers capability in increments . . . , at varying intervals throughout the life of the system, with each increment increasing the overall capability of the system.[27]

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[23] *Ibid*.

[24] United States. Secretary of the Air Force. *Air Force Instruction 63-101: Operations of Capabilities Based Acquisition System.* (29 July 2005), 7; http://www.e-publishing.af.mil/shared/media/epubs/AFI63-101.pdf; Internet; accessed 15 January 2009.

[25] *Ibid*,. 6.

[26] *Ibid*,. 7.

[27] Dr. Niki Jobson. "Rapid Acquisition of Adaptable Systems," Defence Science and Technology Laboratory. (Porton Down, UK: 6 Feb 2008), 1; http://dgmssc.ottawa-

As can be seen, four common themes emerge from these definitions. First and foremost, an initial operational capability, albeit perhaps limited, is delivered early. Secondly, it is recognized up front that there will be a requirement for and benefits provided by future enhancements or improvements to the capability. Thirdly, the success of the enhancements or improvements is dependant on the utility and quality of the feedback. And lastly, it is recognized up front that there is a requirement to *plan* accordingly for evolution.

Origins of Evolutionary Acquisition

The concept of evolutionary acquisition is not new. Its' origins are really a migration of several ideas into one labelled concept that has a common desire to revamp the acquisition environment such that it exploits emerging technologies and drastically reduces the acquisition time. The idea really gained interest and importance when it became apparent technology was outpacing capability development, especially in the areas of information technology and software. The United States military started seriously exploring the idea in the mid 1990's.[28]

As an example, a 1980's study by the National Defence Research Institute and RAND Corporation proposed, as an alternate method to reduce acquisition times within an era of smaller budgets and shortened capability development response times, a whole

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hull.mil.ca/MATKNET/NR/rdonlyres/A2C10309-0263-4204-B9A3-F8392B57ACDA/0/TIMPASLAFinalreport_v10.pdf; DWAN Intranet; accessed 27 March 2009.

[28]United States. Department of Defense. *Chairman of the Joint Chiefs of Staff Manual - Operation Of The Joint Capabilities Integration And Development System.* (1 May 2007), A-1; http://www.dtic.mil/cjcs_directives/cdata/unlimit/m317001.pdf; Internet; accessed 2 March 2009.

new strategy entitled *An Acquisition Strategy, Process, and Organization for Innovative Systems.* It was envisioned that this strategy would permit "novel" or complex and higher risk projects to capitalize on undeveloped but low risk portions of that project, permitting some or limited capability to be delivered early. The theory was that demonstration of that capability and its potential for maturity would then be remitted as a new project into the acquisition cycle.[29]

In an article entitled, "A Ten-Year Review of the Vision for Transforming the Defense Acquisition System," its authors suggest that there were three main drivers that were most relevant to defense acquisition transformation.[30] These were the changing needs of warfighters as a result of growing unconventional threats and asymmetrical warfare combined with the reliance on emerging technologies, the rapid pace of commercial technological development, especially when commercial acquisition cycles were on average 2.5 times faster than military cycles, and budgetary constraints. It was also recognized that the military had to shift their "technology insertion strategies from leader to follower" by necessity, as a result of shifting from military-centric technology to commercial-technology.[31] The evolutionary acquisition strategy made its way formally into DOD publications in 2003 following the direction by then-Deputy Secretary of Defence Paul Wolfowitz to revise all acquisition documents such that they "create an

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[29] John Birkler et al. *An Acquisition Strategy, Process, and Organization for Innovative Systems.* (Washington, DC, RAND, 2000), ix – xvi.

[30] Edward W. Rogers, and Col. Robert P. Birmingham, "A Ten-Year Review Of The Vision For Transforming The Defense Acquisition System," *Defense Acquisition Review Journal*, (January–April 2004), 49-52; http://www.dau.mil/pubs/arq/2004arq/Rogers.pdf; Internet; accessed 5 January, 2009.

[31] *Ibid.*, 56.

acquisition policy environment that fosters efficiency, flexibility, creativity, and innovation." [32]

Development Processes

While evolutionary acquisition is the strategy to deliver a capability, it is the evolutionary development processes supporting that strategy that actually "refine …the capability for fielding."[33] There are generally three different development processes pursued by industry: waterfall, incremental, and spiral. The first of the three, waterfall development, is not considered an evolutionary development process, as it only delivers one usable product. The other two, incremental and spiral development, produce evolving products or capabilities over time, and are the most common of evolutionary acquisition strategies. The most significant difference between the latter two are that incremental development envisions what the end-state will be, and achieves it through increments, while spiral development knows the desired direction, but the full potential is yet unclear. [34] The three processes will be described in greater detail below.

Waterfall Development

The traditional development process that delivers only one final capability is referred to as waterfall development. Although it in itself is not an evolutionary

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[32] Paul Wolfowitz. *Cancellation of DOD 5000 Defense Acquisition Policy Documents*. Memorandum For Director - Deputy Secretary of Defense, Washington Headquarters Services, 30 October 2002; http://www.dau.mil/pubs/pm/pmpdf02/Nov_Dec/wolf1-jf3.pdf; Internet; accessed 25 January 2009.

[33] Kenneth Farkas and Major Paul Thurston. "Evolutionary Acquisition Strategies and Spiral Development Processes," *Program Manager*, (July-August 2003), 13; http://www.dau.mil/pubs/pm/pmpdf03/july/fark-ja03.pdf; Internet; accessed 8 January, 2009.

[34] *Ibid*.

acquisition development process, its understanding is important as it is often a foundation for the steps within the other two. As shown in Figure 2.2, in waterfall development, each of the steps in a design process is executed only once. The result is a single product that meets the pre-determined requirement. This is a good development process to use if the desire is for a structured and predictable project and results. However, "at the same time, the waterfall is unresponsive to dynamic environments, such as budget cuts, new technology insertion, and changing user needs".[35] The cost of changes go up an order of magnitude with each step accomplished, there is no interim capability provided, no flexibility in requirements, and finally no opportunity for user feedback.[36]

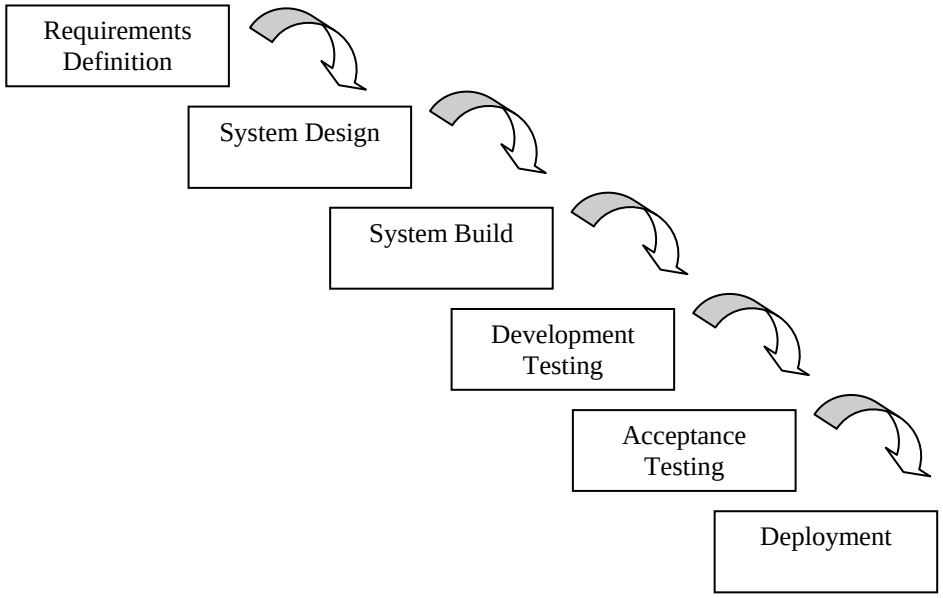


Figure 2.2 - Waterfall Development Process.

[35] Ferdowsi. "Product Development Strategies in Evolutionary Acquisition", 49.

[36] *Ibid.*

Furthermore, waterfall development processes are highly susceptible to schedule slippage and cost overruns, though, those susceptibilities can be mitigated using a design-to-schedule or design-to-cost strategy. In either of these strategies the project is aggressively fixed to a target schedule or to a cost at which point the work stops, and it moves to the next stage. This strategy requires that expectations be set from highest to lowest priority and therefore only the highest priority ones are completed before the money or schedule runs out. This strategy works well within the individual steps in an evolutionary acquisition.[37]

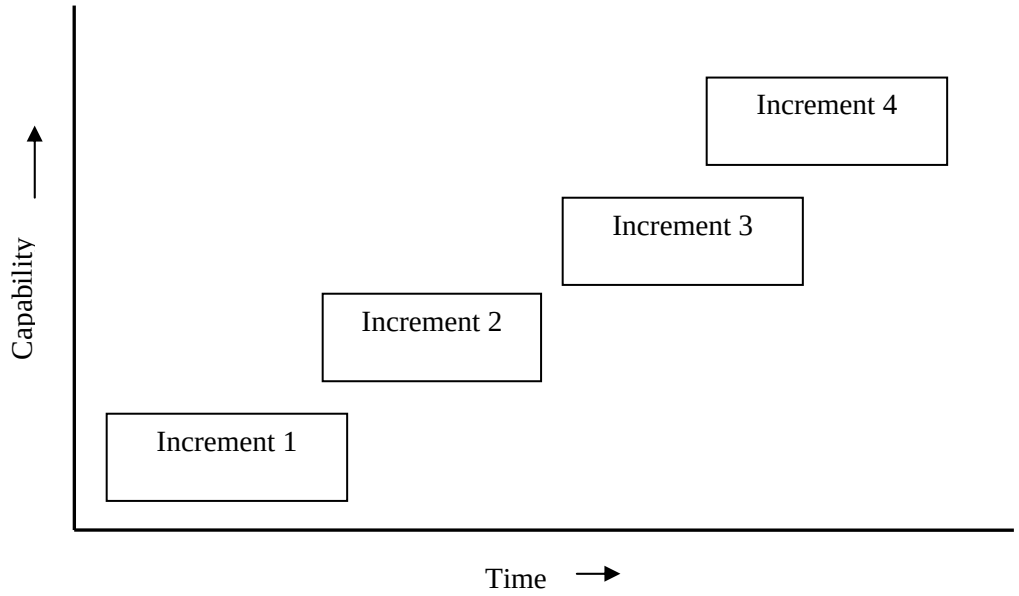
Incremental Development

In incremental development the desired end-state capability requirements are known, but those requirements are met over time through the development of several increments, or steps of increasing capability, that are each dependent upon the availability of mature technology at the time.[38] The concept is portrayed in Figure 2.3. The U.S. Department of Defence – *Defence Acquisition Guide* defines incremental development as one in which the initial capability documents "include a firm definition of the entire end-state capability, as well as firm definitions of interim increments, including an initial operating capability date for each increment". The US Joint Capability Publication defines incremental development as being "a militarily useful and supportable operational capability that can be effectively developed, produced or acquired, deployed, and sustained. Each increment of capability will have its own set of threshold and objective

[37] *Ibid.*, 54-55.

[38] United States. Secretary of the Air Force. *Air Force Instruction 63-101*, 7.

values set by the user."[39] The DOD *Defense Acquisition Guidebook* adds that a "program acquisition strategy defines each increment of capability and how it will be funded, developed, tested, produced, and operationally supported."[40]



Note: Each increment defines and delivers a complete capability. Each increment is independent of the other.

Figure 2.3 - Incremental Development Process

Traditional incremental development processes included the commonly known Pre-planned Product Improvement (P3I) and Block Upgrades. P3I, as the name suggests, are more reflective of an incremental development, while block upgrades, because they are not normally planned-for upfront, are not. Rather, block-upgrades rely on full capability on first delivery with subsequent block upgrades improving on that capability

[39] United States. Department of Defense. *Chairman of the Joint Chiefs of Staff Manual…*, GL-10.

[40] United States. Department of Defense. *Defense Acquisition Guidebook*, (20 December 2004), art. 3.1.4; http://jitc.fhu.disa.mil/jitc_dri/pdfs/dagnov2004.pdf; Internet; accessed 21 January 2009.

overtime.[41] These developments tend to take a longer time and are sometimes more revolutionary than evolutionary.[42] A block-upgrade approach is considered a final end-item, as there may have been no intention for that individual platform to ever return for another upgrade.[43] In this sense, they were not really traditionally considered evolutionary type acquisitions, as the end-states were not known during original acquisition. However, DOD 5000.02 now recognizes the benefits of block upgrades and P3I as evolutionary type acquisitions and has mandated that they shall be managed as separate increments under the terms of its evolutionary acquisition instructions.[44]

Spiral Development

In spiral development, the capability requirements for the first spiral or increment[45] are defined at project initiation while future spirals or increments and the precise end-state capabilities although maybe envisioned, are not known. The capability requirements for subsequent spirals or increments are refined through a balance of technology demonstration and risk management.[46] As defined in the *Defence Acquisition Guidebook*, the acquisition strategy defines only the "first increment of capability and how it will be funded, developed, tested, produced, and supported … and establishes a management approach that will be used to define the exact capability needs for each

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[41] Ferdowsi. "Product Development Strategies in Evolutionary Acquisition", 61-62.

[42] Col (Ret'd)Wayne M. Johnson and Carl O. Johnson. "The Promise And Perils Of Spiral Acquisition: A Practical Approach To Evolutionary Acquisition," *Acquisition Review Quarterly,* (Summer 2002), 177; http://www.dau.mil/pubs/arq/2002arq/JohnsonSM2.pdf; Internet; accessed 7 January, 2009.

[43] *Ibid.*, 180.

[44] United States. Department of Defense. *Department of Defence Instruction 5000.02,* 13.

[45] Much of the researched literature uses the term "increments" interchangeably with "spirals" in spiral development.

[46] United States. Secretary of the Air Force. *Air Force Instruction 63-101,* 7.

subsequent increment." [47] The US *Joint Capability Publication* defines spiral development as "an instance of an incremental development strategy where the end state is unknown. Technology is developed to a desired maturity and injected into the delivery of an increment of capability."[48]

As shown in Figure 2.4, a key element of spiral development is that it "relies on user feedback and technology maturation to define requirements for future increments." [49]

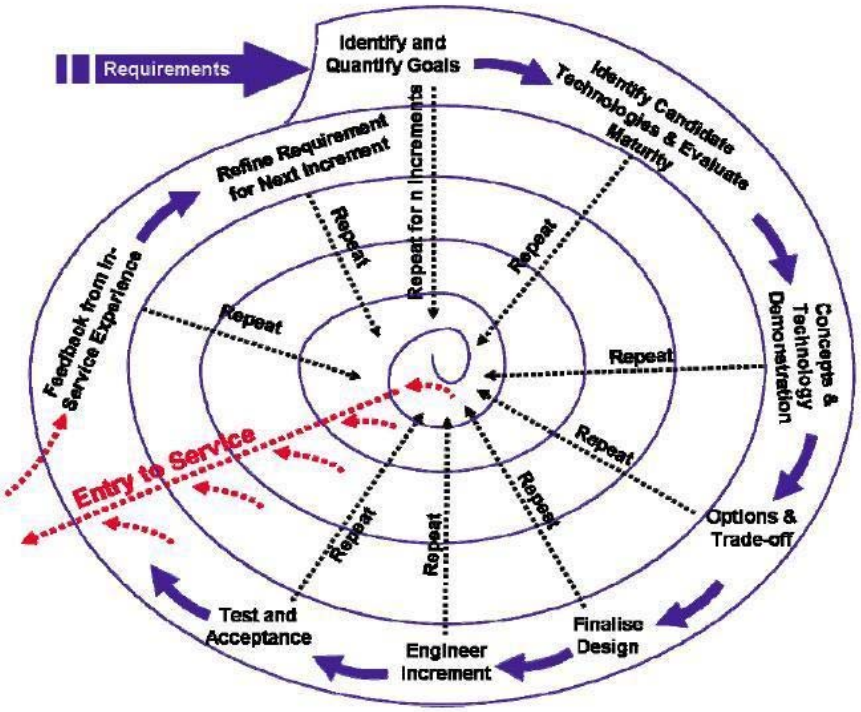

Figure 2.4 – Spiral Development Process.

Source: H Smith. "Short Lifecycle Acquisition of Defence Systems", MSc thesis Cranfield University, July 2007, quoted in Jobson, Dr. Niki. "Rapid Acquisition

[47] United States. Department of Defense. *Defense Acquisition Guidebook*, art. 3.1.4.

[48] United States. Department of Defense. *Chairman of the Joint Chiefs of Staff Manual…*,GL-10 – Glossary.

[49] United States. Secretary of the Air Force. *Air Force Instruction 63-101*, 7.

of Adaptable Systems," Defence Science and Technology Laboratory. Porton Down, UK: 6 Feb 2008, 25.

It is an iterative process and it provides the opportunity for and depends on collaboration and interaction between the user and the developer. The capability requirements are refined through experimentation and risk management, and through constant feedback the user is, in theory, provided the best possible capability within the increment.[50]

Origins of Spiral Development

It is worth discussing the origins of spiral development for two reasons. First, the concept is significantly different than the other two, and second, to discuss how the original definition has evolved within the acquisition world.

Although spiral development is not a new concept, it was not considered as formal US DOD guidance until 1995, eventually formally becoming in 2001 the preferred development process as part of evolutionary acquisition for acquiring new operational capabilities.[51] Although the DOD had been conducting incremental-type developments for many years, spiral development was a concept with its origins primarily in, amongst other places, the software development world. Primarily due to developmental uncertainty, the software development world recognized that detailed requirements and specifications were not very useful, but rather effective and successful development depended on prototypes and user feedback. Although there were several proposals submitted within the DOD throughout the 1980's and 90's endorsing spiral

[50] E.C. Aldridge. *Evolutionary Acquisition and Spiral Development.* Memorandum – Under Secretary of Defence, Acquisition, Technology and Logistics. 12 April 2002; http://www.acquisition.navy.mil/rda/content/download/863/3763/file/041202acq.pdf; Internet; accessed 16 January, 2009.

[51] Farkas and Thurston. "Evolutionary Acquisition Strategies …", 10.

development strategies, it wasn't until Dr Barry Boehm, whom many consider the founder of spiral development, published the 1988 TRW Defense Systems Group's article in the journal *Computer*, probably the most influential article of its kind at the time.[52] In the article, Dr Boehm proposed a method of improving the software development process by creating an approach that was "risk-driven" rather than "document driven or code driven".[53]

In 2000, partly influenced by the US DOD's increasing interest in spiral development, Dr Boehm recognized that there was a need to refine his development model and published "Spiral Development: Experience, Principles and Refinements," later simplifying his findings in his 2001 article "The Spiral Model as a Tool for Evolutionary Acquisition". Dr Boehm captures the essence of his model in the following definition:

> The spiral development model is a risk-driven process model generator. It is used to guide multi-stakeholder concurrent engineering of software-intensive systems. It has two main distinguishing features. One is a cyclic approach for incrementally growing a system's degree of definition and implementation while decreasing its degree of risk. The other is a set of anchor point milestones for ensuring stakeholder commitment to feasible and mutually satisfactory system solutions.[54]

The importance of this definition is that since spiral development is primarily a risk-mitigation process, the level of risk acceptance dictates the path the development

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[52] Richard K. Sylvester and Joseph A. Ferrara. "Conflict And Ambiguity: Implementing Evolutionary Acquisition," *Acquisition Review Quarterly*, (Winter 2003), 7-9; http://www.dau.mil/pubs/arq/2003arq/Sylvesterwt3.pdf; Internet; accessed 8 January, 2009.

[53] B. Boehm and W. Hansen. "Spiral Development: Experience, Principles, and Refinements'" Spiral Development Workshop. Carnagie Mellon Software Engineering Institute. (February 9, 2000), 61; http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA382590&Location=U2&doc=GetTRDoc.pdf; Internet; accessed 2 March, 2009.

[54] *Ibid.*, 3.

must take, and that, as a process model, it answers two main questions: "What should be done next? How long should it continue?"[55]

Therefore, the model is "actually a risk-driven process model generator, in which different risk patterns can lead to choosing incremental, waterfall, evolutionary prototyping, or other subsets of the process elements."[56] Although spiral development was in itself not intended to produce spiralling operational capabilities, but rather spiralling prototypes "as a means of soliciting feedback from the user and other stakeholders,"[57] there is no reason why once the stakeholders are satisfied with the operational prototype, that the product be implemented or fielded as an initial capability, as was portrayed at Figure 2.4.

Spiral developments are not necessarily always the right choice nor are they effective for every acquisition. Spiral development primarily works well with information systems such as Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) systems and information management systems such as those with a multitude of sensors. For systems that are both software and hardware intensive, it is best to follow a spiral developmental approach for the embedded software, while it is best to follow a sequential incremental approach for the hardware. The incremental approach for hardware development better accommodates lead times for production facilities and long lead critical component orders.[58]

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[55] Barry Boehm and Wilfred Hansen. "The spiral model as a tool for evolutionary acquisition." *Crosstalk The Journal of Defense Software Engineering*. (May, 2001), 4.; http://lookingtosea.ucsd.edu/library/SpiralModel-Boehm200105.pdf; Internet; accessed 21 January, 2009.

[56] Boehm and Hansen. "Spiral Development…", 3.

[57] Ferdowsi. "Product Development Strategies in Evolutionary Acquisition", 64-65.

[58] Boehm and Hansen. "The spiral model as a tool…", 9.

As a summary, the major differences between the three development processes lie primarily in the requirements definition and the number of useable iterations. Waterfall processes have only an initial and fixed requirements definition, and the least number of iterations. Incremental development has some flexibility in requirements definition and a moderate amount of iterations, but only occurring between successful deliveries. Spiral development has a highly flexible and only minimum initial requirements definition and is highly iteration-centric.[59] With the exception of waterfall development, their similarities lie primarily in their ability to respond to changes in technology and capability requirements and their inherent necessity for quality user feedback.

Why choose Evolutionary Acquisition?

There are several reasons why an evolutionary acquisition strategy would be selected or utilized. These include platform versus derivative choices, changing user requirements, and project constraints.

Bobak Ferdowsi, in his Master's Thesis entitled "Product Development Strategies in Evolutionary Acquisition," argues that development or design choice selection of an aerospace weapon system can determine up to 80% of a projects cost. Therefore, the development choice selected within an acquisition strategy is critical.[60] When it comes to addressing new aerospace weapon system capabilities, one of the most important design choices is whether to design a complete new platform or to develop a derivative of

[59] Ferdowsi. "Product Development Strategies in Evolutionary Acquisition", 44.

[60] Ferdowsi's thesis studied six major capital acquisitions utilizing evolutionary acquisition strategies. *Ibid.*, 17-18.

an existing platform. The development of a new platform can take up to ten times more funding and time than a derivative platform.[61]

Ferdowsi offers several frameworks that compare new aerospace designs to incremental designs or original platforms versus derivative platforms.[62] One of these frameworks includes radical innovation which "changes the fundamental architecture and core concepts" while "incremental innovation refines and extends an established design." Other frameworks include modular and architectural innovations. "The former indicates a change in the core concept, but not the architecture of the product, while the latter keeps the core the same while changing architecture."[63] Selection of the most appropriate framework will lead one to selecting the most appropriate evolutionary acquisition strategy.

Another reason for choosing evolutionary acquisition is that throughout the development process of a weapon system, capability requirements can change. These changes, or rather refinements, occur for a variety of reasons including changes to the identified or prevailing threats, introduction of new missions and tasks, new or different users are introduced to operate the system, technology improves overtime, parts become obsolete or unsupportable, or government policy changes.[64]

Other possible reasons for choosing evolutionary acquisition may be due to constraints imposed on the project. For instance, perhaps the development funds are spread across several years, vice being provided up-front in a lump sum. The complexity

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[61] *Ibid.*, 18.

[62] *Ibid.*, 17.

[63] *Ibid.*, 31-32.

[64] Farkas and Thurston. "Evolutionary Acquisition Strategies …", 11.

of the full capability may require several years to accomplish, yet an initial capability, albeit reduced, is required immediately. Finally, perhaps the technology is not yet mature enough to achieve the final desired capability in the near term.[65] The overall benefit is that an evolutionary acquisition strategy both accommodates and welcomes change.

Evolutionary Acquisition Characteristics

Evolutionary acquisition strategies have several common characteristics and criteria for success which should be both understood and considered prior to their application. As evolutionary acquisition was being espoused as the acquisition process of choice for the future, many reports and papers from a variety of civilian and military acquisition experts emerged, including several reports and papers from the DOD's Defense Acquisition University, the US Government Accountability Office (GAO), Congressional Research Service's – *CRS Reports to Congress*, and from a variety of subject matter experts, both sceptics and supporters alike, involved in defence acquisition. Of note, in 2006, RAND Corporation published a study entitled *Evolutionary - Acquisition - Implementation Challenges for Defense Space Programs*. The object of the study, one of the first to do so, was to report "research findings and lessons learned relevant to DOD … implementing evolutionary acquisition."[66] Although the study was limited to five major space acquisition programs that applied the newly mandated evolutionary acquisition concept, the report concluded that the findings should be applicable to all major DOD evolutionary acquisition programs. Also of note are Dr.

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[65] Richard B.Rippere. "Acquisition Transformation: Lead in to Gold?" *Defense AT&L*: (July-August 2004), 37; http://www.dau.mil/pubs/dam/07_08_2004/ripp-ja04.pdf; Internet; accessed 16 December 2008.

[66] Lorell, Lowell and Younossi. *Evolutionary Acquisition …*, iii.

Boehm's publications. Boehm provides several important considerations and criteria for success. Finally, articles published by Colonel Wayne Johnson and Carl Johnson, program director and vice president of the United States Air Force Global Hawk programs, Richard Sylvester and Dr Joseph Ferrara, authors and advisors of U.S. D.O.D. acquisition policy, and the research conducted by Bobak Ferdowsi provide a good overview of the fundamentals of evolutionary acquisition.

The discussion that follows examines some characteristics of evolutionary acquisitions, highlights some of the inherent advantages and disadvantages, and discusses some criteria for success. This will be achieved by examining acquisition requirements and specifications, including system design and project plans; the importance of test and evaluation and user feedback; the influence of technology; and concerns with funding and costs. From this examination, the attributes of inherent responsiveness, cyclical nature, and dependence on an effective and controlled feedback process will become apparent.

Requirements Definition and the Project Plan

One of the most important aspects of any project is the definition phase during which requirements and specifications are defined, and the project is planned out. Requirements and specifications must be defined clearly and objectively. The complicating characteristic inherent to the spiral development process in particular is that system requirements, by definition, emerge and evolve over time. The definition phase of an evolutionary acquisition strategy can be discussed by examining four of its constituent areas: requirements and specifications, the system design, the project plan, and inherent to the all three, risk management.

It is important that the initial project definition phase focus on capability objectives rather than specifications. The degree of detail in the requirements should be primarily driven by risk considerations, and generally the focus should be on mission capability objectives rather than technical requirements. The key is to not to over-specify. If the risks associated with writing detailed specifications are low, with mature or readily available or Commercial-of-the-Shelf (COTS) technology, then the technical requirements should be fairly detailed. If on the other hand there are inherent higher risks to detailing specifications, particularly if the technology has not matured or is restricted to military applications, then the project should avoid detailed technical specifications and rather stick to generalized capabilities.[67]

The second key aspect to successful evolutionary acquisition is an effective system design. Although ideally a particular system architecture should be selected to last the life of the project, with the rapid pace of technology this is not always the case. Therefore, system architectures often have to be built and designed with an inherent capability for modification.[68] Thus, the acquisition strategy has to take a whole-systems view, not just for the next spiral, but for the long term flexibility of the weapon system. This means that occasionally, capability requirements may be dropped from one spiral or increment and moved onto the next one if there are transient or irresolvable temporary constraints such as costs, schedule or technology maturity. Furthermore, there may be instances when improvements may be made in spirals or increments that do not seem to actually contribute to the end goal. [69] These might be hardware improvements designed

[67] Boehm and Hansen. "The spiral model as a tool…", 4 – 10.

[68] Johnson and Johnson. "The Promise And Perils …", 179.

[69] *Ibid.,* 180.

to support future systems that are not fully mature yet but for which the architecture is already known. Flexibility, although a double-edge sword in this case, is the key to successful evolutionary acquisition developments.[70]

The third key aspect is with respect to project planning. Evolutionary acquisition programs, by their very nature, can be defined by ambiguous and unclear project descriptions. Evolutionary acquisition strategies can require an enormous amount of front loaded project management planning and engineering. This is due to the necessity to plan up-front complex program structure, which includes multiple separate, overlapping increments, each requiring definitions requirements, milestone establishments, and additional system engineering to support the upgrades and technology insertion at each increment.[71] This can result in project definitions often being unclear with respect to "system design, quantities to be procured, development and procurement costs, and program schedule"[72] This can often result in project approvals being granted on less information than would normally be required. Such ambiguity not only can potentially risk in escalating costs, but may also affect the credibility of the organizations seeking the funding. Ambiguity can also result in ill-defined benchmarks or project milestones. This then makes it difficult to have clear and effective measures of performance, compounding the risks further.[73] Therefore it is important to provide clear project descriptions and definitions, even though the final requirements may not be known.

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[70] *Ibid*., 182.

[71] Lorell, Lowell and Younossi. *Evolutionary Acquisition* …, 51.

[72] Gary J. Pagliano and Ronald O'Rourke. "Evolutionary Acquisition and Spiral Development in DOD Programs: Policy Issues for Congress," *CRS Report for Congress*, (17 May 2006), 5; http://digital.library.unt.edu/govdocs/crs/permalink/meta-crs-9304:1; Internet accessed 18 December 2008.

Evolutionary acquisition inherently delivers different variants of the same system. This can complicate logistics support and life-cycle management. The acquisition plan needs to effectively map out how it will or will not upgrade, retrofit, or perhaps even dispose of earlier versions.[74] Multiple variants of the product also have a huge influence on configuration management post implementation with respect to training and qualifications of both operators and maintainers. This creates many additional complexities in cost. Therefore, in the planning and definition phases, emphasis should be placed on both the actual weapon system and the lifecycle and implementation activities.[75]

One of the advantages of evolutionary acquisition is its ability to assist in managing and controlling risk. The idea is that risks are spread out across several spirals, thus not trapping any one spiral or increment in a higher than acceptable risk. Thus, the level of effort in each spiral should be driven by risk considerations, keeping all risk to an acceptable level.[76] This means that spiral or incremental developments must be both rapid and must be as independent from each other as possible, yet they must provide a capability increase that is of value to the user. The avoiding of dependency reduces the risk of parallel developments.[77]

In summary, with respect to requirements definition and the project plan, caution must be exercised with respect to requirements management so that they define capability rather than technical requirements. Secondly, the system design must be adaptable and

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[73] Pagliano and O'Rourke. "Evolutionary Acquisition and Spiral Development…", 5.

[74] Lorell, Lowell and Younossi. *Evolutionary Acquisition …*, 84.

[75] Boehm and Hansen. "The spiral model as a tool…", 4 – 10.

[76] *Ibid.*

[77] Johnson and Johnson. "The Promise And Perils …", 178.

considered for the life of the project. Thirdly, though project planning can often seem ambiguous and therefore pose risks to project acceptance or funding, project planners must provide clear and measurable objectives of the overall project. Finally, consideration should be given such that the level of effort in each spiral or increment is as equally risk driven as it is capability driven. These measures will enable the acquisition strategy to be better managed, and therefore be more effectively responsive to change.

Controlled User Feedback

The most significant advantage to pursuing an evolutionary acquisition strategy is its inherent ability to incorporate lessons learned from both the test and evaluation community and from operational use of the weapon system into future spirals or increments, making the process more responsive, in a timely and controlled manner. However, achieving success from these inherent and seemingly straight forward concepts can be constrained by two major influences, user expectation, and the lack of a controlled feed-back process.

Spiral development permits the user to refine the weapon system employment-concept over time. If there is anything the users do not like, theoretically, the problem can be fixed within a couple of spirals. This refinement is not as rapidly responsive for a block-upgrade type approach, where it can take years for user defined problems to be fixed. However, this feedback loop can also be a double edged sword in that users can be compelled to over-refine the specifications, thus resulting in delays in delivering what should otherwise be valuable enhancements to capability.[78] Therefore, it is important

[78] *Ibid.,* 182-3.

that each spiral cycle always consider the primary objectives, constraints, alternatives, and risks, and undergo a solid review prior to a commitment to proceed. [79]

The most damaging influence to evolutionary acquisition is the lack of respect of its fundamental principles. Evolutionary projects can have a tendency to be structured to achieve revolutionary, rather than evolutionary increases in capability within one increment of the project. The objective of evolutionary acquisition is to balance operational needs and capability with available resources in order to deliver the product to the user sooner. It relies on maturation of technology leading to disciplined development and delivery of systems that provide an increasing capability. Requirements that cannot be met within these limitations must wait for follow-on increments.[80]

It follows then that users must understand that the initial capability will not be perfect, nor will it be complete, but it will have operational utility.[81] It is important then that users do not make a false comparison, which is to compare the first spiral of the new system with the legacy system and expect a significant improvement.[82] Significant improvements only occur over time.

The second major influence to a successful feedback process is the implementation of structured and effective controls. Conceptually, spiral development envisions "constantly functioning feedback loops from the user community to fine-tune requirements and make sure the developers produce end products that meet real needs in

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[79] Boehm and Hansen. "The spiral model as a tool…", 4 – 10.

[80] United States. Government Accountability Office. *Report to Congressional Committees - Defense Acquisitions: Major Weapon Systems Continue to Experience Cost and Schedule Problems under DOD's Revised Policy*, (April 2006), 17; http://www.gao.gov/new.items/d06368.pdf; Internet; accessed 21 January, 2009.

[81] Johnson and Johnson. "The Promise And Perils …", 179.

[82] *Ibid.*, 186.

the field." Unfortunately, the reality is that feedback in the early development phases is relatively uncontrolled and can lead to counterproductive and sometimes inconsistent requirements and technologies. This can undermine the fundamental advantages of evolutionary acquisition, because users tend to push for delivery of the full capability early on, tending towards one step programs. This tendency can be exacerbated when multiple communities are stakeholders in the same project.[83] To mitigate the problems of unstructured feedback requires policies with effective compliance and controls that ensure that performance is measured against specific criteria ensuring "disciplined, transparent, and knowledge-based investment decisions."[84]

Fundamental to controlled user feedback is the test and evaluation program. It is "crucial to aerospace programs, where error is intolerable . . . and it serves to identify the usability of the developed product."[85] While evolutionary acquisition gives the acquirers a critical role in determining which requirements are met and when, this must be leveraged against the power of the test and evaluation world by determining which systems will go forward and which should be halted by allowing the acquirers to "shape a system based on technology maturity and what can be produced at any given point in time, rather than what is required or what passes the test."[86] For this to be achieved, acquirers and testers need to meet very early in the project definition, in order to limit the amount of operational testing and rely more on operational assessments of each

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[83] Lorell, Lowell and Younossi. *Evolutionary Acquisition …*, 83-84.

[84] United States. Government Accountability Office. *Report to Congressional Committees - Defense Acquisitions …*, 18-21.

[85] Ferdowsi. "Product Development Strategies in Evolutionary Acquisition," 45.

[86] Sylvester and Ferrara. "Conflict And Ambiguity…", 11.

increment capability, limiting full operational test and evaluation on the final increments or spirals. [87]

In summary, key to achieving the inherent benefits of evolutionary acquisition is the appropriate management of user expectations and the establishment of structured and effective feedback processes, including managing test and evaluation efforts so that it encourages rather than hinders development.

Technology

Perhaps the greatest influence on evolutionary acquisition is the rapid pace and unpredictability of technology. Therefore, one of the primary reasons for using evolutionary acquisition is to ensure that segments of weapon system development do not occur before their respective critical technologies are mature. However, it is often easy to ignore this basic principle. Unfortunately, project managers tend to view immature critical technology at the beginning of the development as an acceptable risk, as long it can be shown that there is a credible plan to mature the technology by the time the project reaches design review and development. Therefore, the risk management plan tends to be viewed as an acceptable substitute for demonstrated and proven technology.[88] However, the fact is that "the greater the maturity, the less likely it is to change, and the easier it is to incorporate into the development," and therefore project managers must

[87] *Ibid*., 20.

[88] United States. Government Accountability Office. *Report to Congressional Committees - Defense Acquisitions…*, 15.

ensure they are using the latest technology, as measured by standards such as the US DOD's Technology Readiness Levels, COTS, or (non developmental items) NDI's.[89]

A potential difficulty faced by project managers of evolutionary acquisition projects is having industry bid on unknown technology and finding a developer-bidder that will be in a position to adapt to and deliver the best capabilities in the long run, not just the best initial capability that meets the objectives of the first spiral. The project manager can only write requirements for the first spiral, for that which the technology currently exists, because that is all he knows. The proposals from bidders can only offer a capability based on today's technology, and a promise to incorporate the future technology in future spirals. [90] This can only be mitigated by engaging in a strong and healthy relationship with the defence industry.

In summary, one of the major challenges with evolutionary acquisition lies in that future increments or spirals, and the technology required for them, may be for the most part unknown. Therefore, project manager's need to be connected to the intelligence world, the research and development world, and most importantly, must have a cooperative and trustworthy working relationship with industry in order to best anticipate and prepare for the future. They also need to be connected to the user community to predict and react to necessary improvements, knowing how a user is planning on using it, and being able to foresee when systems fail.

[89] Ferdowsi. "Product Development Strategies in Evolutionary Acquisition," 46.

Funding and Costs

A challenge for any acquisition strategy is addressing planned and actual funding and costs, and this is no different for evolutionary acquisition. The following will discuss the importance and perception of evolutionary acquisition costs, the reasons why costs may escalate, and will address the need for and challenges with using an evolutionary acquisition costing approach.

One advantage, and perhaps potential problem with evolutionary acquisition is that there is no advance commitment of funds to subsequent iterations; consequently, funding has to be requested for each one. Unfortunately, funding approval organizations tend to view evolutionary acquisition type strategies, which are characterized by "innovation funds" or "technology investments", quite negatively.[91] It is therefore critical that those holding the purse strings not only understand the merits of evolutionary acquisition, but also their inherent costing uncertainties. Thus, trust in both the acquisition decisions and in the regulatory processes is essential.

With respect to the defense industry being quite supportive of evolutionary acquisition, for no other reasons than that it "mirrors the commercial process for bringing products to market", they do have some concerns. Defense industries traditionally rely on high quantity production runs as a key source of profitability. By following an evolutionary acquisition approach, industry will have smaller volume production runs of different increments, each with a reduced rate of profit.[92] The possibility then exists that

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[90] Rippere. "Acquisition Transformation…", 37.

[91] Sylvester and Ferrara. "Conflict And Ambiguity…", 17.

[92] *Ibid.*, 16.

industry would artificially increase the price of each production run to ensure its profit margins are met.

There are several factors that affect escalating costs of evolutionary acquisition projects. In addition to the normal influences of requirements creep and requirements changes which affect all acquisition programs, evolutionary acquisition-specific factors include contractor buy-in, over-optimism of technology by the contractor and the operators, flawed technological maturity assessments, and inadequate assessment of overall program risk.[93] Additionally, funding forecasts or projections tend to be volatile due to inherent potential for repeated and often unnecessary refinements in capability requirements or technical approaches. [94]

Thus, ideally, evolutionary acquisition programs should have an evolutionary costing approach. By necessity, spiral development approaches generally tend to emphasize cost analysis on the initial spiral or increment, often at the expense of the follow-on phases. Given the uncertainties of future increments or spirals, cost analysis estimates need to evolve and be updated continuously as the project structure and requirements change and become more refined. Therefore there is a requirement for an evolutionary costing methodology in order to avoid cost estimates, and based merely on this pre-approved funding allocations for the future on increments are spirals. What is required is a cooperative and joint cost model between the contractor and the government based upon mutually agreed methodologies, based on assumptions, and cost factors. [95]

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[93] Lorell, Lowell and Younossi. *Evolutionary Acquisition …,* 49.

[94] Pagliano and O'Rourke. "Evolutionary Acquisition and Spiral Development…", 5.

[95] Lorell, Lowell and Younossi. *Evolutionary Acquisition …,* 49-50 and 86-87.

Chapter Summary

This chapter has explored the concept and characteristics of evolutionary acquisition strategies. It has providing detailed definitions, descriptions, and the evolution of evolutionary acquisition, predominantly from experience gained in United States defence acquisitions. It has discussed its origins, and its characteristics, including its inherent advantages and disadvantages and some of its criteria for success. These were discussed in terms of requirements and specifications, system design, and project plans; test and evaluation and user feedback; technology; and funding and costs.

From this analysis, it can be surmised that evolutionary acquisition is inherently responsive in nature. If managed carefully, it is responsive, primarily by design, to changes in technology, but in the same vein, is equally responsive to evolving capability requirements. Secondly, as a strategy that is inherently cyclical in nature, its processes are suitable and complimentary to capability evolution. Finally, the importance of effective and controlled user feedback, be it via test and evaluation or from operational usage experience, is integral to the process. Although there are inherent challenges to implementing the strategy within existing policy and budgetary constraints, it is none-the-less as a process an effective tool in managing change.

Armed with an understanding of the concept and characteristics of evolutionary acquisition, the next chapter will examine the major influences and their effects on defence planning, acquisition, and the definition or capability requirements. From this examination it will be demonstrated that the nature and effects of these influences render the attributes of evolutionary acquisition necessary.

CHAPTER 3 – MAJOR INFLUENCES ON ACQUISITION AND CAPABILITY REQUIREMENTS

Introduction

The previous chapter defined evolutionary acquisition as an effective strategy to delivering evolving aerospace capability in increments or spirals that exploits emerging technology and enables evolution in capability over time. It was demonstrated that evolutionary acquisition has the attributes of responsiveness, cyclical nature, and reliance on effective and controlled feedback. This chapter will provide a detailed analysis of some of the major influences and their effects on defence planning, acquisition, and capability requirements that render these attributes necessary.

As previously described, evolutionary acquisition can be characterized as a responsive strategy to external influences such as evolving technology, changes in capability requirements, and adaptability to a new threat environment. Similarly, it will be demonstrated later in Chapter 4 that capability based planning can also be characterized as a responsive methodology to these external influences. Additionally, it will also be shown that amongst some of the influences of capability based planning are defence policy, technology, threat, resources, and the management organization.[96] What follows in this chapter is a closer examination of what could be considered three of the most important common influencing factors to evolutionary acquisition and capability based planning, namely defence policy as influenced by the country's strategic reality, the modern battlespace and future security environment, and the pace of emerging

technology. It will be demonstrated that the dynamic and evolving nature of these influences produce effects that necessitate the attributes of inherent responsiveness, cyclical nature, and dependence on an effective and controlled feedback.

Defence Policy - Canada's Strategic Reality

Defence planning and capability requirements are influenced by Canada's foreign and defence policies, which in turn are primarily influenced by Canada's strategic circumstances. In general terms, Canada has a significantly large landmass and coastline with a relatively small population mostly within a short distance of its southern border with the United States. It is democratic with relatively liberal national values, has a well-educated population, and a modern industrialized economy that is well integrated globally. However, the most significant factor is Canada's relationship with the United States, specifically with respect to continental defence, the economy, and the balancing of its bilateral and multilateral relationships.

Canada's successful relationship with the United States is dependent on two conditions: protecting Canada from an external attack, and protecting the United States from an attack from within Canada. This is reflected in Canada's defence policy, which states that the primary role of the Canadian Forces is the defence of Canada and of North America. [97] Consequently, this primary role and its implicit responsibilities, including the requirement for interoperability with the U.S. military, can have a significant

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[96] *Guide to Capability-Based Planning* considers the major influences as Technology, Defence policy, Threat, Resources, and Management organization. The Technical Cooperation Program. *Guide to Capability-Based Planning,* 5.

[97] *Canada's International Policy Statement: A Role of Pride and Influence in the World – Defence* (Ottawa, Ontario. Prime Minister's Office, 2005), 2.

influence on the CF's force structure, construct, and capabilities.[98] The CF faces the difficult task of deciding on where and to what degree it can keep up with American defence developments. This can be quite daunting, especially at a time when the amount of US defence spending continues to expand the capability gap between the US military and the rest of the world.[99]

The importance of economic strength lies in both the existence and the sustainment of Canada's prosperity, which in turn serves as an enabler of power and influence in achieving its interests abroad. The dependency and vulnerability of the Canada-U.S. economic relationship has a great influence on security and foreign policy decisions Canada makes, since this economic relationship is strongly dependant on an open yet secure border, Canada, by necessity, is required to take part in mutual security policy initiatives such as the National Security Policy[100] and the Security and Prosperity Partnership of North America.[101] Thus, Canada's economic reality further reiterates the influence and importance of interoperability between the two nation's defence and security forces.

Despite a strong bilateral relationship with the United States, multilateral relationships are also of great importance to Canada. Motivated by its primary

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[98] The responsibilities implicit to the primary role of defending North America include being a "strong, reliable defence partner" collaborating with the US in the North American Aerospace Defence Command (NORAD), mutual assistance in response to civilian emergencies, and pursuing an effective collaboration on operations. This requires that "key aspects of our equipment and doctrine [be] compatible. Department of National Defence. *Canada First Defence Strategy*, 8.

[99] Department of National Defence. *Future Security Environment - 2025.* (Ottawa, On: 2007), para 38; http://cradpdf.drdc.gc.ca/PDFS/unc35/p520084.pdf; Internet; accessed 29 Feb 2009.

[100] Privy Council Office. *Securing an Open Society: One Year Later - Progress Report on the Implementation of Canada's National Security Policy.* (Ottawa, Ontario: National Library of Canada, 2004), 41.

[101] Canada. "Security and Prosperity Partnership of North America." Website. http://www.spp-psp.gc.ca/menu-en.aspx; Internet; accessed 9 November 2008.

interests[102] Canada chooses to align itself multilaterally for several reasons including economic influence, prosperity, and security. As an example, with respect to economic power and influence abroad, "G8 membership enables Canada to pursue its broad foreign and economic policy agenda and interests, and to help shape global developments on a range of issues, including responses to global crises."[103] Therefore, despite the fact that Canada's international relationships "both constrain and impel the Canadian Government in the process of shaping Canadian foreign policy"[104], Canada must remain an ally in good standing with countries that are militarily, politically, and economically important to it. Thus, these multilateral relationships also significantly influence defence policy, and in turn defence interoperability and capability requirements.

As stated in Canada's *Aerospace Capability Framework*, these bilateral and multilateral influences have both benefits and costs. As a benefit, "collective security arrangements can facilitate the sharing of regional and international security responsibilities, thus increasing overall capacity or reducing costs to the various partners."[105] However, the "corollary is that membership in collective security arrangements may also generate requirements for capabilities beyond those required for purely national purposes**.**"[106] Given the importance of these relationships, and of

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[102] Among Canada's interests are: greater international support for freedom and security, democracy, rule of law, human rights and environmental stewardship; and accountable and consistent use of the multilateral system to deliver results on global issues of concern to Canadians. *Canada's International Policy Statement: A Role of Pride and Influence in the World – Diplomacy* (Ottawa, Ontario. Minister of Foreign Affairs, 2005), 5.

[103] Government of Canada. "Canada's G8 Website" http://www.g8.gc.ca/members-en.asp; Internet; accessed 8 November 2008

[104] Kim Richard Nossal. *The Politics of Canadian Foreign Policy,* (Scarborough, Ontario: Prentice-Hall Canada Inc, 1997), 36.

[105] Department of National Defence. *The Aerospace Capability Framework,* 15.

[106] *Ibid.*

"combined and joint operations in the future, it is critical the Air Force do everything possible to ensure interoperability with other services and nations."[107] Additionally, "given the leading role the U.S. often exercises in regional and international security operations, interoperability with the U.S. must remain a dominant requirement." [108]

In summary, the impact of Canada's strategic reality is that, by necessity, Canada must maintain defence capabilities that meet the needs of and are interoperable with, first and foremost, those of the United States, and then secondly, those of NATO and other important allies. Furthermore, meeting those interoperability requirements also implies a necessity to keep pace with the dynamic and evolving nature of those military capabilities. The requirement to do this is not a matter of choice, but a matter of necessity for Canada to exercise it's foreign and defence policies.

The Modern Battlespace and the Future Security Environment

Perhaps the most important, though not always the most highly prioritized influential factors on defence planning, acquisition, and capability requirements are the modern battlespace and the future security environment. The importance of these inter-related factors can be demonstrated by describing them in terms of the security environments' dynamic and evolving nature, the balance between higher and lower combat intensity operations, and the requirement to conduct joint operations.

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[107] *Ibid.*, 34.

[108] The paragraph goes on to state that "The key to interoperability will be the ability to communicate securely and with some degree of assurance, to share information by data-link, to avoid fratricide and, in the case of offensive platforms, to be capable of precisely delivering air-to-surface munitions. As well, since security operations will become increasingly reliant on inter-agency cooperation, equipment, doctrine and planning must take into account the requirements to work with other government departments and agencies, international aid agencies and non-governmental organizations." *Ibid.*

As detailed in Canada's *Strategic Capability Roadmap*, the future holds "an increasing number of evolving asymmetric threats, non-state actors, rogue nations and criminal activities … in addition to the destabilizing social, economic, environmental, and resource factors that could trigger traditional state-on-state conflict."[109] The document also explains that future operations will need to occur in the "physical, cognitive and cyber realms, at home and abroad, in complex or extreme environments primarily in the urban-littoral, against both conventional and asymmetric means and weapons."[110] Therefore, the CF will be required to be capable of operating "across the full spectrum of domestic, continental and international operations, . . . all requiring kinetic, non-kinetic and enabling capabilities and a clear understanding of the objective."[111]

Although the trend is towards asymmetric intrastate warfare, high intensity state-on-state conflict cannot be discounted. The challenge is managing the risk of uncertainty of a high intensity interstate conflict occurring. According to the *Future Security Environment - 2025*, there are two options with respect to balancing capability management for the two types of warfare. The first approach, sometimes called "hedging",[112] is to retain existing systems or limit the acquisition of new platforms in order to maintain combat training effectiveness for high intensity state on state conflicts. With respect to limiting the acquiring of new platforms, the options include scaling back the number of replacement platforms or delivering them with less capability. The

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[109] Department of National Defence. *Strategic Capability Roadmap – Draft.* Version 1.0 (July 2008), 5; http://cfd.mil.ca/sites/page-eng.asp?page=3518; DWAN Intranet; accessed 29 Feb 2009.

[110] *Ibid.*

[111] *Ibid.*, 6.

[112] Department of National Defence. *Future Security Environment.…*, para 14.

advantage of the hedging approach is that "it permits resource concentration on capabilities best suited for the most likely conflict environments, while retaining enough residual capacity to enable the forces to plan and surge for the more unlikely higher intensity possibilities."[113] From a foreign policy perspective, this provides the government the flexibility to focus on less-intense intrastate conflicts while retaining a surging capacity for large scale regional conflicts. As this approach is dynamic and evolving in nature, it would therefore be best facilitated by the attributes afforded by an evolutionary type acquisition strategy, especially with respect to aerospace capability.

The second approach is to eliminate the traditional combat capabilities that enable a higher-intensity combat capability in order to specialize on capabilities for less intense operations. This latter option however, would necessitate accepting the inability to participate in or surge for more hostile environments or limiting involvement to combat support.[114] The consequence of this inability is that is also affects the country's foreign policy, and hence its influence abroad. Additionally, the ability to resurrect an effective aerospace weapon system capability in a relatively short order would be challenging, relying on traditionally lengthy one-step acquisition processes.

Finally, the future battlespace will need a CF that has "joint air, land, maritime, special operations and operational support forces that will be able to conduct operations through the provision of task-tailored components of varied composition and size as necessary to meet mission requirements."[115] Their effectiveness will "be able to be optimized by fully exploiting the strengths of each component to create required joint

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[113] *Ibid.*

[114] *Ibid.*, para 15.

[115] Department of National Defence. *Strategic Capability Roadmap…*, 10.

effects."[116] Joint forces will be required to be involved in "activities such as joint manoeuvre, joint fires, C4ISR, and sustainment within the complex future battlespace."[117] With respect to capability requirements, in a joint environment, while "military strategy asks what the force is required to achieve; the joint vision asks what the force is expected to become",[118] thus, the demand for evolving and maturing capability will not only be initiated jointly, but will be essential to the accomplishment of all joint missions.

Therefore in summary, the future security environment will produce unstable, dynamic, and evolving threats that will need to be encountered across the full spectrum of operations and requiring a full range of capability. The favoured approach to managing this situation is to retain existing systems, and concentrate on evolving those systems and capabilities over time such that they remain best suited for the conflict environment at any given moment, while maintaining a surge capacity for all out war. Finally, the necessity to operate in a joint environment predetermines interoperability requirements of capability and equipment, thus capability evolution in one element will most likely require the same evolution across the other elements as well.

Pace of Emerging Technology

Another significant influencing factor on defence planning, acquisition and capability requirements is the effect of the pace of emerging technology. The future

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[116] *Ibid.*

[117] *Ibid.*, 11.

[118] Cavoli, Christina. "DAU Alumni Association Sponsors 20th Annual Acquisition Symposium. Evolutionary Acquisition – Delivering Warfighting Capabilities Today and Tomorrow", *Program Manager*, (July-August 2003), 27; http://www.dau.mil/pubs/pm/pmpdf03/july/cav-ja03.pdf; Internet; accessed 8 January, 2009.

battlespace, particularly that of aerospace systems, will be technologically dependent. Military forces of the future will be either enabled or constrained by the characteristics of technology, as will society at large. The challenge of modern militaries then is to "continuously modernize [themselves] by conceptualizing the future in order to prepare for, and harness, the derivative and entirely new capabilities that will result from continuous and accelerating technological advancements."[119]

The influence of emerging technologies on aerospace capability requirements is important in three areas: the speed of technology advancement, the nature of the advancing technologies themselves, and the challenges that this pace will impose on defence capabilities. Those challenges include the influence of peace-time verses times of conflict, and the emergence of commercial over military technology and its ready access by adversaries. The discussion that follows will demonstrate the importance of the influence of technology within the context of aerospace power.

As stated within *Canadian Forces Aerospace Doctrine*, one of the primary characteristic of aerospace power is its sensitivity to technology**. "**Relatively small innovations in technology can have a significant impact on [its] effectiveness. . . Technological advances dictate an ongoing requirement for continuous improvement and development of aerospace forces."[120] The United States *Air Force Basic Doctrine* shares the same sentiment by stating that "[t]he Air Force nurtures and promotes its ability to translate our technology into operational capability – to prevail in conflict and avert

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[119] LCol Bernd Horn and Peter Gizewski. *Towards the Brave New World: Canada's Army in the 21st Century*, (Kingston ON: Directorate of Land Strategic Concepts, 2003), 101.

[120] Department of National Defence. *Canadian Forces Aerospace Doctrine*. (Ottawa, On: Sep 2003), 28; http://www.airforce.forces.gc.ca/CFAWC/cdd/Publications/B-GA-400-000-FP-000.pdf; Intranet; accessed 29 Feb 2009.

technological surprise."[121] Therefore, since "[a]erospace power depends, in large part, on technology and the ability of a trained labour force to sustain and supply it" [122] relying on traditional defence development and acquisition processes that can take up to 15 years to deliver capability "will be a recipe for certain technological irrelevance."[123] For example, at the current rates of computer evolution, fifteen years is the equivalent of ten doubling-periods in processing or 1000-fold increase in computation speed.[124] Therefore, today's critical enabling technologies will most likely not be acceptable on tomorrow's battlefield.[125]

With respect to the nature of emerging technologies, according to LCol Bernd Horn and Peter Gizewski, author and editor of *Towards a Brave New World: Canada's Army in the 21st Century*, in his chapter "Defying Definition: The Future Battlespace", by 2030, various technologies that are currently in their infancy will become fundamental to future military capabilities. These include ultra-strong and light weight materials, advanced weapons, micro-technologies, small networked sensors, as well communications and information systems that are cheaper, lighter, smaller, and much more energy efficient.[126] They may also include non-technology, biotechnology and genetic engineering, and cognitive science. The convergence of these emerging

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[121] United States. Department of Defense. *Air Force Basic Doctrine*, (17 November 2003), 75.

[122] Clayton K.S. Chun. *Aerospace Power in the Twenty-First Century – A Basic Primer.* (Colorado Springs, CO, United States Air Force Academy in cooperation with Air University Press, July 2001), 289.

[123] Horn and Gizewski. *Towards the Brave New World…*, 104.

[124] *Ibid.*

[125] United States. Department of Defense. Defence Acquisition University. *Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment*. (Defense Acquisition University Press, Fort Belvoir, VA, June 2005), xvi; http://www.dau.mil/pubs/pdf/Managers_Guide.pdf; Internet; accessed 21 January 2009.

[126] Department of National Defence. *Strategic Capability Roadmap…*, 7.

technologies may lead to revolutionary developments in data linkage, UAV's, distributed training, soldier performance enhancement, and human-machine interfaces and integration.[127] Finally, since militaries of the future will most likely not be the "dominant source of technological innovation that they once were," militaries will need to "leverage the commercial sector in order to militarize those advanced technologies that can best augment military capabilities."[128] Therefore, it is essential that defence planners and weapon system developers not only maintain the pace of technology, but ensure that the right specific emerging technologies are exploited at the right time and place.

One challenge imposed on defence capability development is that the technological development and requirements of military capability are influenced quite differently during peace time than during times of conflict. Clayton Chun, author of *Aerospace Power in the Twenty-First Century* suggests a few of these differences. Firstly, it is often assumed that threats do not change significantly during the traditionally long development and production times of modern weapon systems.[129] During the Cold War, weapon system development could afford to be slow and deliberate. "Technology was created and tested extensively to ensure that weapons worked with great reliability." [130] Peacetime affords "engineers and scientists . . .the luxury of time to correct mistakes or test alternatives,"[131] however, "technology and innovation during an act of conflict is a different situation all together."[132] Although motivation among design engineers and

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[127] Horn and Gizewski. *Towards the Brave New World…*, 101.

[128] *Ibid.*, 104.

[129] Chun. *Aerospace Power in the Twenty-First Century…*, 313.

[130] *Ibid.*

[131] *Ibid.*

[132] *Ibid.*

scientists may be higher during a crisis and the military may not face the same level of scrutiny, the compressed schedule to implement the proposed program may result in higher costs and potentially greater risk of errors and development program. The one advantage to developing weapons during conflict is that immediate feedback is gained through combat experience. The disadvantage is that a rush towards developing a weapon system without clear direction could result in a massive misuse of already scarce resources.[133] Therefore, an effective and adaptive acquisition strategy is essential to exploit this advantage while mitigating the risks of the disadvantage.

Another challenge for modern militaries will be to keep pace with emerging technologies while maintaining a technological advantage over potential adversaries. Since it can be assumed that potential adversaries may generally have access to the same defence technology, either due to it being predominantly commercially developed or due to foreign exploitation of defence research, development, testing, and evaluation, our military "must not only field new technology rapidly, but also must maintain the technological edge in systems that will remain in service for decades." Furthermore, "recognizing that potential adversaries will employ varying levels of technology, it is essential that the CF not become over-reliant on certain technologies such that we create vulnerabilities."[134] Therefore, there is a requirement to "leverage the best technology available from both government and commercial sources; rapidly transition the technology into new materiel systems; refresh the technology, as needed, to maintain the advantage …throughout the life of a system; and protect sensitive leading-edge research

[133] *Ibid.,* 313-314.

[134] Department of National Defence. *Strategic Capability Roadmap…,* 7.

and technology against unauthorized or inadvertent loss or disclosure."[135] Again, an effective and evolving acquisition strategy supports this requirement.

Reliance on commercial technology has many advantages. "Competitive free markets can separate and identify the best and most cost effective technology for an application", thus permit the military "to reap the benefits of obtaining tested superior and cost-effective solutions to difficult problems."[136] Military applications of new technology do not tend to be narrowly focused, while the commercial world can provide greater manpower and many different approaches.[137]

Chun suggests that there are two different paths that can be taken in the management of aerospace forces and the pace of emerging technology. The first and more risky is to create new technology based on desires or requirements, a more directed approach to weapons technology advancement. The second approach is to utilize or adapt available technology as it is invented. The challenge is for the organizational willingness to adapt to change, which is sometimes difficult due to organizational resistance. If the technology is not exploited soon enough, it will lay idle until "the service faces an emergency – or, in many cases, until an adversary adopts the technology", after which the "emphasis will quickly shift to finding a countermeasure or defense", thus being reactive, rather than proactive, counter to the principles of war of maintaining the initiative and always being on the offensive.[138] This adaptability to change necessitates a responsive and cyclical acquisition strategy.

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[135] United States. Department of Defense. Defence Acquisition University. *Manager's Guide to Technology…,* xvi.

[136] Chun. *Aerospace Power in the Twenty-First Century…*, 316.

[137] *Ibid.*

[138] *Ibid.,* 310.

In summary, the future battle space, particularly that of aerospace weaponry, will depend significantly on emerging technologies. And this dependence will either enable or constrain military forces. Overcoming the challenges of continuously modernizing themselves when considering the rapid pace of emerging technology, the nature of the advancing technologies themselves, and the ready-access to them by its adversaries will be key in the future security environment. This is especially true for aerospace forces which are inherently sensitive to technology. Success will depend highly on organizational willingness to adapt to change, the ability to adapt the new technology rapidly before the adversary does, and finally a capability management framework and acquisition strategy that responds to change. Evolutionary acquisition is an effective strategy to meeting those challenges.

Chapter Summary

This aim of this chapter was to analyse and expand upon some of the major influences and their effects on defence planning, acquisition, and capability requirements that render necessary the evolutionary acquisitions attributes of inherent responsiveness, cyclical nature, and dependence on an effective and controlled feedback. This was achieved by conducting a close examination of three of the most important influencing factors, namely defence policy as influenced by the country's strategic reality, the modern battlespace and future security environment, and the pace of emerging technology.

The impact of Canada's strategic situation vis-à-vis the United States and its allies demonstrates the forces and constraints on the development of foreign and defence policy

and hence directly influences the ebb and flow and nature of defence capabilities. The future battlespace and security environment coupled with the increasing pace of emerging technology will not only define the required capabilities of the future, but will dictate their relevance and effectiveness. Thus, the Canadian Forces will have to be "more integrated, more adaptable and more capable." And the "ability to effectively deal with change is inherent in [that] adaptability."[139] Evolutionary acquisition strategies provide responsive approaches to the effects of the major influences of defence policy, the modern battlespace and future security environment, and the pace of emerging technology. As will be demonstrated in the next chapter, capability based planning methodologies are also responsive to the same influences and as such are well complimented by evolutionary acquisition strategies.

[139] Department of National Defence. *Strategic Capability Roadmap…*, 4.

CHAPTER 4 - DEFENCE ACQUISITION AND CAPABILITY BASED-PLANNING

Introduction

This chapter will examine the Canadian Force's current acquisition environment and the application of the recently developed capability based planning methodology. This will be achieved by first providing an overview of the acquisition system, highlighting several deficiencies with respect to capability management. Then the process of how operational capability requirements are defined, from initial conception of a national Defence Policy, through to the Defence Planning and Management Process will be discussed. Finally, the chapter will examine the management of Canada's aerospace capability in particular in terms of its aerospace power doctrine, vision, and inherent characteristics. It will be demonstrated that capability based planning, in addition to having the same major influences as those of evolutionary acquisition, also shares its attributes of inherent responsiveness, cyclical nature, and dependence on an effective and controlled feedback process that are necessary to address the effects of those influences, and hence is well complimented by an evolutionary acquisition strategy.

Acquisition - defined

Acquisition and procurement are terms that are often considered synonymously and used interchangeably, however they are different. The dictionary definition of acquisition is the "act of acquiring"[140], which is "to come to have as a new or added

[140] Merriam-Webster online Dictionary. http://www.merriam-webster.com/dictionary/acquisition; Internet; accessed 20 Mar 2009.

characteristic, trait, or ability,"[141] while that of procurement is "the act or process of procuring, . . . the obtaining of military supplies by a government."[142] The US Defence Acquisition University defines acquisition as including "design, engineering, test and evaluation, production, and operations in support of defense systems."[143] On the other hand, it defines procurement, as "the act of buying goods and services for the Government," and is "but one of the many functions performed as part of the acquisition process." Items that are "procured" are not necessarily "subject to the full range of functions inherent in the acquisition process."[144] Finally, the United Kingdom Acquisition Operating Framework defines acquisition as being the "activities of setting and managing requirements, negotiating and managing contracts, project and technology management, support and termination or disposal based on a through life approach to acquiring military capability."[145]

In Canadian publications, the differentiation is not quite as clear. Although no formal definition of the term acquisition is provided, the two terms acquisition and procurement seem to be used synonymously. Public Works and Government Services Canada (PWGSC) defines procurement as the "process of obtaining materiel and services which includes the determination of requirements and acquisition from a supply system

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[141] Merriam-Webster online Dictionary. http://www.merriam-webster.com/dictionary/acquiring; Internet; accessed 20 March 2009.

[142] Merriam-Webster online Dictionary. http://www.merriam-webster.com/dictionary/procurement; Internet; accessed 20 March 2009.

[143] United States. Department of Defense. *Introduction to Defense Acquisition Management 7th Edition*, (Fort Belvoir, VA, Defence Acquisition University Press, September 2005), 1; http://www.dau.mil/pubs/gdbks/Intro_2Def_Acq_Mgmt_7th_Ed.pdf; Internet; accessed 21 January 2009.

[144] United States. Department of Defense. *Introduction to Defense Acquisition…*, 1.

[145] Acquisition Operating Framework website - http://www.aof.mod.uk/aofcontent/strategic/guide/sg_whatisacq.htm;

or by purchase from the trade." [146] The DND Project Administration Manual (PAM) defines procurement as "the action of obtaining materiel and/or services to satisfy a requirement" and expands upon this by stating that the "procurement process begins with the identification of the requirement and the approved funding; it includes all associated contracting, contract management and financial activities required to satisfy that requirement and ends when the procurement files, including associated contracting and financial activities, are closed."[147]

For the purpose of this paper, the term acquisition will be utilized to mean the entire process of acquiring capabilities, from capability planning and management, to purchasing and delivery, life-cycle management, and disposal. The term procurement, with its limited definition will only be used in the context of Canadian acquisition. Additionally, it is not the purpose of this paper to analyse in detail the Canadian defence procurement process, but rather it is to examine evolutionary acquisition as it compliments capability based planning. Therefore the procurement process will be briefly discussed only as a matter of introducing it and of highlighting the challenges associated with the delivery of defence capability, as it applies to capability based planning and evolutionary acquisition.

Canadian Defence Procurement Process

As a broad overview and in simple terms, there are several organizations responsible for conducting Canadian defence procurement, including DND, PWGSC, and

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[146] Public Works and Government Services Canada. *Supply Manual*. Version 08-2 (Ottawa: Canada, 2008), Glossary; http://www.tpsgc-pwgsc.gc.ca/app-acq/ga-sm/index-eng.html; Internet; accessed 24 January 2009.

[147] Department of National Defence. *Procurement Administration Manual*, art. 1.2.1 and 1.2.2.

Industry Canada. Industry Canada is responsible for industrial and regional benefits. Within DND, the military, under the Chief of the Defence Staff is responsible for defining capability requirements, while the Assistant Deputy Minister (Materiel) ADM(Mat), under the Deputy Minister is responsible for delivering the solution.[148] All contracts are established and managed by PWGSC, which as the "common service agency for the Government of Canada . . .[provides] the departments . . ., with services in support of their programs." [149] The approval of expenditures and contracting limits, or project funding is regulated by the Treasury Board, on behalf of the Queen's Privy Council for Canada.[150]

Within DND, the defence procurement process has been through several iterations over the years. The current process is managed and overseen by the Defence Planning and Management (DP&M) framework, which is managed on behalf of the Deputy Minister and Vice Chief of the Defence Staff by the Director Force Planning and Program Coordination. The Defence Services Program (DSP), formally known as the Defence Management System, is the "total of all departmentally approved activities and projects, which are deemed to be essential to the delivery of affordable and effective defence services to the Government and Canadians." It conforms to government policy and is expressed in resource terms including people, capital assets, and financial.[151]

Criticism of defence procurement has existed for probably as long as the military has been purchasing equipment. As stated in the last Chief of Review Services audit on

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[148] Alan S Williams. *Reinventing Canadian Procurement…*, 4.

[149] Public Works and Government Services Canada. *Supply Manual*, art. 1.014.

[150] *Ibid.*, art. 1.

defence procurement conducted in 2006, "capital acquisition is a complex multi-variable, dynamic that is problem plagued and which has eluded correction for one reason or another despite continuous efforts to reform it."[152] It adds that "continuous efforts over the last 20 years to keep the process relevant and flexible have not reduced the time frames required to obtain new equipment."[153] Despite the vast number of problems identified in that and other reports, the scope of this paper will limit its analysis to the problems related to the definition and implementation of capability requirements.

Allan Williams, former ADM (MAT), in his book *Re-inventing Canadian Defence Procurement* argues that one of the key essential prerequisites to an effective defence-procurement process is "good strategic planning and effective budgetary management."[154] As an explanation for why it takes over 16 years to complete major defence acquisitions, he argues that one of the main reasons is that the military takes too much time to finalize its statement of requirements.[155] In fact, in accordance with the 2006 CRS audit, the period from when the initial requirement is identified to when the project receives approval to move into implementation, a period which includes options analysis, substantive estimates, and selection of preferred options, takes an average of eight years.[156] Williams suggests that these delays are further compounded by the fact that accountability for defence procurement is subject to overlap and duplication. He also

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[151] Department of National Defence. Director Force Planning and Program Coordination - Defence Services Program. http://vcds.mil.ca/sites/page-eng.asp?page=4725; DWAN Intranet; accessed 14 Mar, 2009.

[152] Department of National Defence. *Perspectives on the Capital Equipment…*, 2.

[153] *Ibid.*

[154] Alan S. Williams. *Reinventing Canadian Procurement* …, 23.

[155] *Ibid.*

[156] Department of National Defence. *Perspectives on the Capital Equipment…*, B1.

suggests that the Canadian government and industry relationship needs to be re-examined.[157] These suggestions are indicative of an acquisition process that is perhaps not as effective or efficient as it should be. Consequently this has considerable adverse affects on strategic capability planning and the timely delivery of that capability.

General (Ret'd) Paul Manson, former Chief of the Defence Staff commented on the differences between the CF-18 and Maritime Helicopter Project (MHP). The first took six years to complete, while MHP, after almost 30 years, has yet to deliver a new capability. He explains that the major difference between the two is the impact of Canadian-izing specifications rather than buying commercial off the shelf (COTS). Buying off-the-shelf products or technology reduces project times from an average of up to twelve years, down to three or less, as was the case for the Griffon, Airbus, and the C-17. He argues that the Canadian procurement process attempts to mitigate risk by writing requirements that are far too detailed. He suggests that the CF should write specifications for what they want the equipment to do rather than telling industry what the equipment should be.[158]

With respect to risk management problems in CF acquisition; Brian MacDonald, the President of Strategic Insight Planning and Communication, while writing for the Conference of Defence Associations Institute and referring to project delays argues that DND does not get best value for money when one considers "search costs", time spent looking for alternative solutions, "calculation costs", the time spent on both the

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[157] Alan S. Williams. *Reinventing Canadian Procurement* …, 5.

[158] Paul Manson. "Procurement Cycle Growth – the race between obsolescence and acquisition of military equipment in Canada 1960 to the present." Presentation to the Conference of Defence Associations Institute, 22 July 2005; http://www.cda-cdai.ca/presentations/procurementcyclegrowth.htm; Internet; accessed 15 January, 2009.

government and industry drafting complex algorithms and factor weightings, and "loss of capability costs", time spent still using inadequate equipment. This time is all spent as a method to minimize risk. However, in reality, the only risks that are being managed are financial risks in contract overruns, contract risks in meeting specifications, and political risks in embarrassing procurement decisions. The problem is that politicians are willing to accept "operational risk", the risk associated with a substandard platform not accomplishing the required mission under "adverse conditions" or wartime.[159] This argument is also echoed in the 2006 CRS audit.[160]

These recurring problems with Canadian procurement are not new. The 1992 Report of the Auditor General on Major Capital Projects, reported several problems after reviewing Project Initiation and Implementation within DND. The major complaint was that in addition to late delivery and cost escalation there was generally a "failure to provide equipment that meets the operational requirement."[161] With respect to project initiation, **"**dynamic instability is inherent in the basic design concept." Acquisition strategies "form a hierarchical, sequential process that starts with current government policy and the current geopolitical situation." The fact is that force development does its planning based on today's government policy and the missions and tasks assigned by them. Unfortunately, procurement, due to its traditionally lengthy process needs to be planned 10 to 20 years in advance.[162] The report also states that "even when it had

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[159] MacDonald, Brian. "Chapter 6 – Joint Acquisition," *Creating an Acquisition Model that Delivers.* Conference of Defence Associations Institute. (April 2006), 55; http://www.cda-cdai.ca/Vimy_Papers/vimy_paper1.pdf; Internet; accessed 27 January 2009.

[160] Department of National Defence. *Perspectives on the Capital Equipment …*, 20.

[161] Auditor General of Canada. *Department of National Defence: Major Capital Projects* - art. 17.6.

[162] *Ibid.*, art. 17.51.

become obvious …. that the estimate of what is most likely to happen had been unrealistic for some time, the Defence Program Management System continued to process much of the same lists of projects."[163]

As can be seen, not much has changed. With respect to the handling and insertion of new technologies, the 2006 CRS audit recommended that the acquisition process be redesigned such that "it is flexible and responsive enough to acquire those [new] technologies in time to handle the evolving threat. In dealing with this situation, the Department has found it necessary to [treat] wartime needs as urgent operational requirements."[164] Although there is now a method of fast tracking capability for national security reasons via the National Security Exemption clause,[165] this method should really only be used as a last resort as it does not always consider the long term effects and capability of the equipment.

Finally, in the interest of reducing acquisition time and of better managing capability delivery, the 2006 CRS audit recommended that the "concept of increasing spending up-front on research and development, test and evaluation, industry funded studies . . . to provide more rigour and holistic approach to capability development for future project stability" be further studied.[166] And it also recommended that DND "consider alternate approaches such as spiral acquisition and incremental purchasing rather than securing the whole capability up-front," and that such a strategy be considered for quantity as well as capability.[167]

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[163] *Ibid.*, art. 17.33 and 17.35

[164] Department of National Defence. *Perspectives on the Capital Equipment* …, 3.

[165] Department of National Defence. *Procurement Administration Manual.* Art. 3.1.1.1.3.3.

[166] Department of National Defence. *Perspectives on the Capital Equipment* …,22.

[167] *Ibid*.

In summary, it is clear that Canadian defence procurement has historically been plagued with problems that have affected its ability to effectively manage capability requirements and that those problems continue to be a major contributor to the delays and increased cost in acquisition. The problems include taking much too long to define its capability requirements, a problem amplified with Canadian-izing and over-specifying, and resorting to fast-tracking capability via the National Security Exemption, which in the end is counter-productive to a viable long-term capabilities management strategy. Additionally, despite the traditional necessity for planning for capability procurement 10 to 20 years in advance, current acquisition processes have often proceeded with developing and delivering capabilities long after their original requirement has ceased to exist. This is indicative of a lack of process in managing changing requirements and inserting emerging technologies into capability development. Thus, the CRS recommendations of investing more into an effective holistic capability development process and the use of evolutionary acquisition strategies will help in resolving some of these problems. In short, a more responsive, cyclical, and feedback enabled process is necessary.

Capability Based Planning

Having briefly highlighted some of the problems associated with the procurement process in terms of requirements definition and management, the process of defining capability requirements, specifically capabilities-based planning and capability management will now be examined.

The first step in an effective defence acquisition process is to define the capability requirements. This particular part of the process, within the greater context of Canadian Forces defence acquisition, including its guiding regulations, polices, and supporting documents have undergone significant change over the past several years. This is partly as a result of Canadian Forces Transformation as well as influences such as acquisition reform and similar directions that have been taken by Canada's allies. This section will provide an overview of the current, albeit relatively new process, as it is the foundation for how all future defence capabilities will be managed by the Canadian Forces. This will be discussed in terms of how the process is complimented by the attributes shared with evolutionary acquisition, particularly their inherent responsiveness, cyclic nature, and dependence on an effective and controlled feedback process.

The recently developed capability definition process is based on the concept of capability based planning, a concept designed to support long-term force structure planning that is being implemented by the five nations of the The Technical Cooperation Program (TTCP).[168] Though the process is the foundation for the conceptualization, design, and building of future military capabilities, each nation is adopting its own slight variations of it.[169] As defined by the TTCP *Guide to Capability Based Planning*, "Capability-Based Planning was developed as an alternative to threat-based planning."[170] It is a method that "involves a functional analysis of operational requirements. Capabilities are identified based on the tasks required. Once the required capability

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[168] The five TTCP nations are Canada, the United Kingdom, the Unites States, Australia, and New Zealand. The Technical Cooperation Program. *Guide to Capability-Based Planning*, 1. The five TTCP nations are Canada, the United Kingdom, the Unites States, Australia, and New Zealand.

[169] *Ibid.*

[170] *Ibid.*

inventory is defined, the most cost effective and efficient options to satisfy the requirements are sought."[171] The process aims to be a top-down, coherent, and logical method of determining the future capabilities based on forward looking comprehensive analysis of the future security environment rather than on the traditional reactive process. The traditional Canadian Forces capability management reactive processes stemmed either from the bottom-up identification of unsatisfactory or deficient capabilities that were derived from previous operations or conflicts, or, from an ad hoc process achieved through a combination of short term business planning and long term planning instruments such as the Long Term Capital Plan (LTCP), that were both unable to "determine the long-term effects of the capabilities [the forces] retains and the ones it plans to acquire."[172] Compounding the problem is that instruments like the LTCP's, which were submitted annually outlining a five-year planning horizon were not linked to one another, and were based on the threats faced individually by the three individual components, army, navy, and air force, rather than on a joint strategic vision. The result produced a stove-piped requirements list that existed in a "strategic void" that had no authority nor any approved capital funding.[173]

As shown in Figure 5, capability based planning "provides a more rational basis for making decisions on future acquisitions, and makes planning more responsive to

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[171] *Ibid.*

[172] Charles Morrisey. "A CF Strategic Capability Planning Process", *Second Annual Graduate Student Symposium*, Conference of Defence Associations Institute. (12-13 November 1999), 1; http://www.cda-cdai.ca/symposia/1999/morrisy99.htm; Internet; accessed 27 January 2009.

[173] Elinor Sloan. "The Strategic Capability Investment Plan: Origins, Evolution and Future Prospects" Canadian Defence & Foreign Affairs Institute (March 2006), 20-21; http://www.cdfai.org/PDF/The%20Strategic%20Capability%20Investment%20Plan.pdf; Internet; accessed 15 January, 2009.

uncertainty, economic constraints and risk."[174] Additionally, "it focuses on goals and end-states and encourages innovation . . .[and asks] questions regarding what do we need to do rather than what equipment are we replacing."[175] It "recognizes the interdependence of systems . . . in delivering defence capability, and the need to be able to examine options and tradeoffs among these capability elements . . .to identify optimum force development investments."[176]

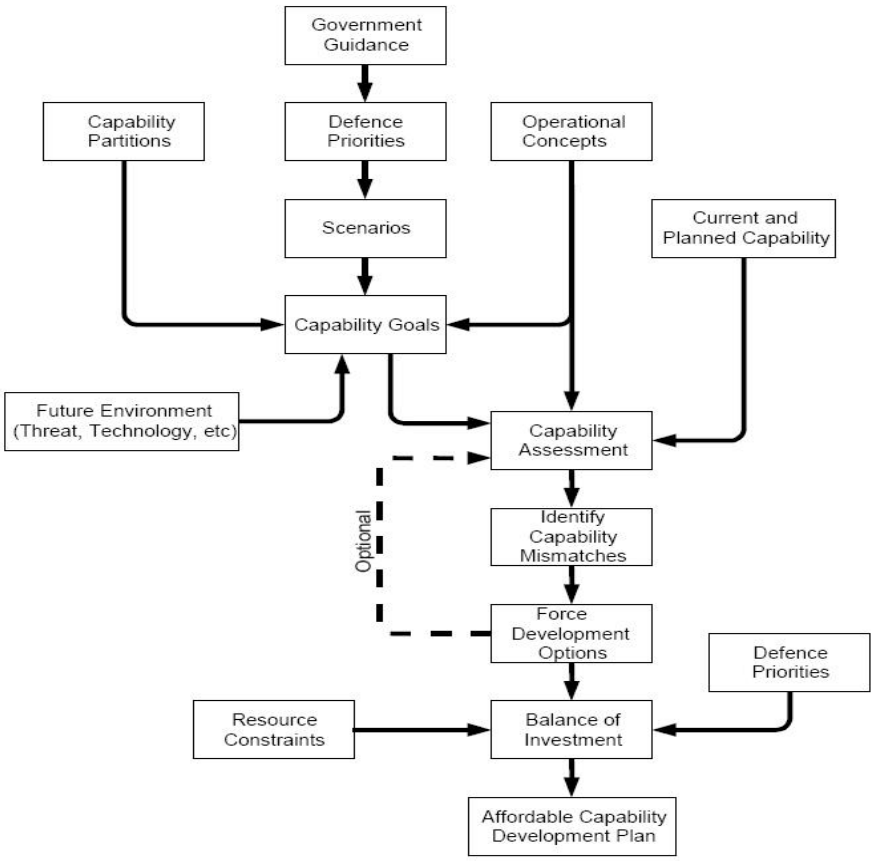

Figure 4.1 - Generic Capability Based Planning Process

Source: The Technical Cooperation Program. *Guide to Capability-Based Planning,* 4.

[174] The Technical Cooperation Program. *Guide to Capability-Based Planning,* 1.

[175] *Ibid.*

[176] *Ibid.,* 2.

Among the strengths inherent to capability based planning are that it "caters to a more diffuse and dynamic strategic environment; . . .links procurement decisions to strategic goals . . .[and] encourages innovation through moving away from determining equipment solutions prematurely," and improves the quality of information provided to capability developers.[177] The Guide considers capability developers as including "the groups of planners who are required to implement the chosen initiatives and projects."[178] Capability developers "need to understand the synergies between their options and the rest of defence capability. Identifying these synergies is a complex and subjective task, but it will make success in [capability based planning] more likely."[179]

Canadian Forces Capability Planning and Management Processes

The Canadian Forces currently uses what it refers to as the Capability Planning and Capability Management processes as tools for force development. What follows is the Force Development process as directed by the Chief of the Defence Staff Planning Guidance to the Chief of Force Development[180] and as currently laid out in the Chief of Force Development (CFD) *Force Development and Capability Based Planning – CFD Handbook.*[181] The process is also reflective of the concept as described in the TTCP

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[177] *Ibid.*, 6.

[178] *Ibid.*

[179] *Ibid.*

[180] Gen R.J. Hillier. *CDS Planning Guidance - Chief Force Development.* National Defence Headquarters, Letter from the Chief of Defence Staff Ottawa, (30 Nov 2005).

[181] Department of National Defence. *CFD Handbook - Force Development and Capability Based Planning.* Chief of Force Development Handbook 2900-1 (DGFDA) v4.2, (July 2007); http://cfd.mil.ca/CapabilityManagement/Resources/D%20Mil%20CM%20General/Force%20Development%20and%20Capability%20Based%20Planning%20v%204.2.doc; DWAN Intranet; accessed 29 January 2009.

Guide to Capability-Based Planning.[182] Finally, the entire process is also documented in the first, currently draft release of the *Strategic Capability Roadmap*, a document whose purpose will become apparent in the ensuing discussion.

At the root of defining military capability requirements is the government's Defence Policy. This can take the form of the traditional White Papers, government platforms, or can come from the Speech from the Throne. The most recent document is the 2005 *Canada's International Policy Statement: A Role of Pride and Influence in the World – Defence,* which has come to be known as the Defence Policy Statement 2005. From the defence policy emerges a Defence Capability Plan (DCP) or similar document. The latest document to fulfill that role is the 2008 *Canada First Defence Strategy,* which "provides a detailed roadmap for the modernization of the Canadian Forces" and "identifies the military capabilities required to meet those objectives."[183] From this government policy emerges the Defence Strategic Guidance, a classified Chief of the Defence Staff and Deputy Minister released document that provides the "common frame of reference and rule set for the implementation of defence policy in force development, generation, employment and related corporate activities spanning a twenty year period"[184] and is renewed on a three to five year cycle. Parallel to this process is the development of three key documents: the *Future Security Environment,*[185] which analyses current and emerging trends and identifies and projects real and potential threats for the next twenty years; the Strategic Operating Concept (SOC), which articulates the

[182] "This paper represents the agreed view of the TP-3 representatives from the five TTCP Nations (Australia, Canada, New Zealand, United Kingdom and United States) on how CBP should be conducted". The Technical Cooperation Program. *Guide to Capability-Based Planning,* ii.

[183] Department of National Defence. *Canada First Defence Strategy,* 3.

[184] Department of National Defence. *CFD Handbook…,* 4.

"principles and tenets of future CF operations" based on how the government, and by extension the CF, will approach future operations; and finally the Force Planning Scenario Set (FPS), which are representative scenarios developed from the SOC that depict a "range of indicative events across the full spectrum of conflict." [186]

In the Canadian Forces context, capability planning is the process that translates policy into scenario-specific capability goals in terms of "components that enable the accomplishment of tasks and the creation of effects." The step that translates the scenarios into goals is referred to as Capability Analysis, which represents the bulk of the work. From the development of these goals, stems the Capability Management process, which determines the means to best deliver the capabilities.[187]

The Capability Management process consists of three main sub-processes. These include: an assessment of current and programmed capability over a set time period to determine capability mismatches and deficiencies; development of prioritized options in support of delivering the best capability mix in view of the *Strategic Capability Roadmap*; and the provision of oversight, guidance and direction of identify deviations from the approved capability plan. The end state is to produce a capable and cost-effective force that is aligned with government intent of military strategic vision.[188]

Capabilities are assessed for adequacy, deficiency, and efficiency improvement by investigating trends in all of the capability's subordinate functional components that

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[185] Department of National Defence. *Future Security Environment.*

[186] Department of National Defence. *CFD Handbook...,* 1-7.

[187] *Ibid*., 7-8.

[188] *Ibid,* 15.

contribute to its generation.[189] Options or alternatives are then considered for "feasibility, cost, effectiveness, innovation, risk, achievability, divestment, value/benefit/return on investment, schedule, … , impact, technological maturity and consequence on force structure."[190] The process is intended to be holistic and therefore demands, by design, a joint and integrated view of capability sustainment and development. From this final analysis, a determination of future required capabilities and capacities is made, and consequently prioritized and promulgated in the *Strategic Capability Roadmap*.[191] This is the "strategic high-level input to the departmental Investment Plan (IP) generated by the Chief of Program."[192] The *Strategic Capability Roadmap* will also "serve to align and harmonize force development, research and development (R&D), as well as concept development and experimentation (CD&E) activity across DND/CF."[193] While this work occurs continuously, it is envisioned that the *Strategic Capability Roadmap* and IP will be produced on three year cycles.[194] The first draft version of the *Strategic Capability Roadmap* was released in July, 2008. The final output from this process is a Defence Capability Plan (DCP**)**, which directs what capability choices have been made, answering the why, how and when of acquisition or

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[189] The subordinate functional components of a capability include **P**ersonnel/Leadership/Individual Training, **R**esearch & Development/Op Research, **I**nfrastructure, Environment & Organization, **C**oncepts, Doctrine, Collective **T**raining, **I**nformation Management & Technology & **E**quipment and Support, often referred to as PRICIE. *Ibid*

[190] *Ibid*, 16.

[191] *Ibid.*

[192] Department of National Defence. *Strategic Capability Roadmap*, Forward

[193] *Ibid.*, 3.

[194] Dr. Ben Taylor, et al. "Producing an Integrated Capability Roadmap for the Canadian Forces," Proceedings of the NATO RTO SAS Specialist Meeting on Capability-Based Long Term Planning 2008, RTO-MP-SAS072, 9.1-9.X. (2008), 2; http://cfd.mil.ca/CapabilityManagement/Resources/D%20Mil%20CM%20General/Producing%20an%20Integrated%20Capability%20Roadmap%20for%20the%20Canadian%20Forces.doc; DWAN Intranet; accessed 21 March 2009.

divestment over a twenty year period. As alluded to earlier, the DCP, although a product of government policy, is also a product of this process. In essence, the DCP is the governments' approval of the plan. Finally, the Chief of Program assisted by the Program Management Board, implements the Defence Services Programme.

Dr. Ben Taylor (et al) in their article "Producing an Integrated Capability Roadmap for the Canadian Forces" suggests that the *Strategic Capability Roadmap* represents the third of three steps in the force development analysis process. The above processes of capability based planning, and capability management answer the questions of "what the CF needs to be able to do," and "how well the CF will be able to meet its requirements."[195] The third step, which he coined Capability Integration, should answer "how the CF's plans should change to better meet its requirements."[196] He suggests that ideally, examples of capability alternatives "may be to invest in a new platform, to upgrade the existing systems or to re-role another system to cover the deficiency."[197] He proposes that the CF create a Centre for Capability Analysis to identify viable courses of action in addressing perceived deficiencies. Outputs of this analysis would include items such as: the degree to which alternative addresses deficiency; the date when the alternative could enter service; costs; and level of technical and implementation risk.[198]

Furthermore, it was recognized by the CDS Action Team - Capabilities that while a "top-down" approach may be ideal from an integrated capability development perspective, a limited measure of "bottom-up" force development activity is inevitable,

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[195] *Ibid.*

[196] *Ibid.*

[197] *Ibid.*, 3.

[198] *Ibid.*

and ultimately beneficial."[199] The perspectives from individual environments, and "the wealth of experience and appreciation for environmental-based threats, concepts, capabilities and technologies, serves to better inform and enhance joint [force development] activity"[200] The team also noted that the Australian Defence Force "uses current force structure as the start point or baseline for future force development, and as a result, it introduces only incremental, or evolutionary changes through the on-going analysis of CBP planning scenarios."[201]

Finally, in recognition that a perceived gap may exist between capability-based planning and capability generation, Defence Research and Development Canada (DRDC) is working on a project with the aim of filling that gap referred to as the Capability Engineering Process (CEP) with its Collaborative Capability Definition Engineering and Management Technology Demonstrator (CapDEM TD). The principle goal of the CEP is to "support the decision making process regarding capability requirements and related capital project approvals"[202] and among its secondary goals, to raise risk tolerance, enable evolutionary acquisition, reduce acquisition time, link capability based planning with system acquisition, facilitate strategic agility and improve communication and collaboration with stakeholders.[203] The team recognizes that the current acquisition process is "in dire need of reform to address their lack of agility."[204] As such, it views

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[199] MGen J.P.Y.D Gosselin. *Final Report CDS Action Team 3 – Capabilities* Memorandum, National Defence Headquarters, Ottawa: CAT 3: 1950 – 9 (Team Leader), (2 August 05), 29.

[200] *Ibid*.

[201] *Ibid.*, 28.

[202] Defence Research and Development Canada. *CapDEM TD: The Capability Engineering Process (CEP) Foundations*. (DRDC Valcartier, February 2006), iii; http://pubs.drdc.gc.ca/PDFS/unc44/p524834.pdf; Internet; accessed 24 January 2009.

[203] *Ibid.*, 3.

[204] *Ibid.*, 6.

evolutionary acquisition, not only "akin to the Strategic Agility imperative"[205], but as the preferred approach due to "its ability to cope with change and address increasing levels of complexity . . . and better fits the highly dynamic and complex nature of the current Defence Environment."[206]

Within CEP, the term Strategic Agility is defined as "the ability to anticipate and plan to deal with future events, trends, problems and opportunities for the accomplishment of the vision." This ability enables transformation of strategy depending on changes in the security environment and the redirecting of "priorities in the capability evolution plan on a much shorter time frame."[207] CEP recognizes the merits of evolutionary acquisition and recommends that "evolutionary acquisition should be considered for all DND/CF projects that are complex and involve significant developments." [208]

In summary, the capability planning and management methodology is the foundation of future capability planning. Inherent in the process is a measure of responsiveness to defence policy, to the modern battlespace and future security threat environment, and to emerging technologies. Additionally, it is cyclical in nature, aiming to be repeated on a three-year cycle. Finally, it is also recognized that although primarily a top-down approach, capability based planning not only relies on the expertise of experienced and knowledgeable officers among its development staff, but is dependant on effective communication amongst all stakeholders and that bottom-up advice should

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[205] *Ibid.*, 7.

[206] *Ibid.*, 6.

[207] *Ibid.*, 9.

[208] *Ibid.*, 7

be encouraged. These observations suggest that evolutionary acquisition strategies to enhance or build on the existing capabilities are indeed complimentary to the capability based planning process.

Aerospace Capability

Having set the foundation of the capability based planning methodology and the process currently followed by the Canadian Forces in general, the management of Canada's aerospace capability in particular will be examined in terms of aerospace power doctrine, vision, and inherent characteristics.

As stated in *Strategic Vectors*, the Canadian Air Force's transformation vision document, the air force vision is "to remain a relevant instrument of national policy "and to contribute "effectively to the security of Canadians and the protection of Canadian security interests well into the 21st Century."[209] To enable this, "the Air Force will move from a primarily static, platform-focused Air Force to an expeditionary, network-enabled, capability-based and results-focused Aerospace Force."[210] To achieve this vision, the "Air Force has adopted capability-based planning as the means by which aerospace capabilities are acquired and maintained."[211]

To fully understand how aerospace weapons are managed, it is important to first understand the fundamentals of aerospace power. "In its broadest context, aerospace power involves the full range of a nation's civilian and military aerospace capability. . . . [and] can be integrated with land and maritime forces to contribute to joint and combined

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[209] Department of National Defence. *Strategic Vectors.* Director General Air Force Development. (Ottawa, On: 2004), 33.

[210] *Ibid.*

operations" [212] As discussed earlier, Canada's Air Force is currently undergoing one of the most significant transformations and capability enhancements it has ever seen. Complimenting the Air Force's transformation vision as that of the CF in general, which defines transformation as a "process of strategic re-orientation in response to anticipated or tangible change to the security environment, . . . to ensure their continued effectiveness and relevance,"[213] Canada's Air Force transformation is also primarily guided by a transformational goal that is not to seek the "complete restructuring or re-equipping of Canada's military forces, but [that] will instead blend existing structures and systems with emerging ones to create significantly enhanced capabilities relevant to future missions, roles and tasks." [214]

In doing so, it is recognized that "while aerospace power platforms such as aircraft have capabilities inherent in them, they alone do not constitute aerospace power capability. Possessing such capability normally involves bringing together a variety of platforms, systems and sensors."[215] This recognition also appreciates the importance and effects of emerging technologies by stating that to "transform capabilities, the Air Force will continuously exploit new technology to realize significant capability enhancements . . . that will be updated on a regular basis." [216]

This vision is in line with General (Ret'd) Paul Manson's suggestion that one characteristic of "modern air force systems is the increasing degree to which on-board

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[211] *Ibid.,* 36.

[212] Department of National Defence. *Canadian Forces Aerospace Doctrine*., 20.

[213] Department of National Defence. *Strategic Vectors,* 27.

[214] as approved by the CDS and DM at Joint Capabilities Review Board 05/03 14 April 2003, *Ibid.*

[215] *Ibid.,* 36.

[216] Department of National Defence. *The Aerospace Capability Framework,* 88.

equipment contributes to overall system effectiveness."[217] He suggests that "the aircraft itself has become simply a platform for the carrying of very sophisticated high-tech systems, the effective life spans of which are considerably shorter than that of the aircraft" and therefore the upgrade of aircraft systems "are the order of the day in many cases, with obvious cost advantages over complete aircraft replacement."[218]

It follows then that from the above mentioned characteristics of aerospace power and the transformational vision sought by Canada's Air Force that the acquisition and replacement of platforms will no longer be a viable option in the future security and technologically intensive environment. Rather, an evolutionary, cyclical, and continuous process of modernization will not only be complimentary to capability based planning, but will be essential to the maintenance of an effective, capable, and relevant air force.

Chapter Summary

This chapter has examined the Canadian Force's current acquisition environment and the application of the capability based planning methodology. This was achieved by providing an overview of and highlighting several deficiencies with the acquisition process with respect to capability management. The process of how operational capability requirements are defined, from initial conception of a national Defence Policy, through to the Defence Planning and Management Process was also discussed. Finally, the chapter examined the management of aerospace power in terms of Canada's aerospace power doctrine, vision, and inherent characteristics.

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[217] Paul Manson. "Chapter 5 – Airforce Acquisition," *Creating an Acquisition Model that Delivers.* Conference of Defence Associations Institute. (April 2006), 43; http://www.cda-cdai.ca/Vimy_Papers/vimy_paper1.pdf; Internet; accessed 27 January 2009.

[218] *Ibid.*

It can be seen that not only has the Canadian Forces embraced a capability-based planning and management methodology, but it has done so with the evolution of existing capabilities as a viable option**.** This is especially true for the management of aerospace capabilities, which recognizes that platform-centricity should not be the driving factor, but rather the effects enabled by that platform, and more importantly, the emerging technologies that can be incorporated into those platforms overtime to better exploit those capabilities. As the foundation for future defence planning, capability based planning is, and needs to be, responsive to changing policy, to the modern battlespace and future security threat environment, and to emerging technologies. It is cyclical in nature in that the process is repeated on a three year cycle. Finally, it recognizes the importance of top-down direction, intra-organizational knowledge and experience, and bottom-up advice, thus is founded on a controlled and effective feedback process. The sum of these observations supports the argument that the capability based planning methodology is well complimented by evolutionary acquisition strategies in the delivering of evolving aerospace weapon system capabilities in meeting the needs of the future.

CHAPTER 5 – CONCLUSION

The aim of this paper was to analyze the effectiveness of evolutionary acquisition as a strategy for the delivery of evolving aerospace weapon systems that compliments the Canadian Forces' capability based planning methodology. This was achieved by providing a detailed description of evolutionary acquisition, an analysis of the effects of major influences on defence planning, acquisition and capability requirements, and a description of the Canadian Forces' acquisition environment and capability based planning methodology. It was demonstrated that the complimentary nature of evolutionary acquisition to capability based planning revolves around the attributes of responsiveness, cyclic nature, and dependence upon effective and controlled user feedback. These attributes are necessary to address the effects of the major influences of defence policy, the modern battlespace and future security environment, and the pace of emerging technologies.

Evolutionary acquisition is inherently responsive in nature. If managed carefully, it is responsive to changes in technology and adaptable to evolving capability requirements. Furthermore, as a strategy that is inherently cyclical in nature, its processes are suitable and complimentary to capability evolution. Additionally, the importance of controlled user feedback be it via test and evaluation or from operational usage is integral to the process.

The impact of Canada's strategic situation vis-à-vis its allies is significant in the development of foreign and defence policy and hence directly influences the ebb and flow and nature of defence capabilities. The future battlespace and security environment,

coupled with the increasing pace of emerging technology will not only define the required capabilities of the future, but will dictate their relevance and effectiveness. Thus, the Canadian Forces will have to be more adaptable and have the ability and willingness to change and evolve. This will be particularly important in the management of aerospace power with its' inherent reliance on technology, and as a consequence its reliance on an ability to manage it intelligently, economically, and efficiently.

The Canadian Forces has embraced a capability-based planning and management methodology for defence planning, and has done so with the evolution of existing capabilities as a viable option**.** This is especially important for the management of aerospace capabilities, which recognizes that emerging technologies can, and should, be incorporated into those platforms over time, rather than in one lengthy step, in order to better exploit those emerging capabilities. As the foundation for future defence planning, capability based planning is, and needs to be, responsive to changing policy, to the future security threat environment, to emerging technologies, and to gaps in existing capabilities. It is cyclical in nature in that the process is repeated on a predictable and periodic cycle. Finally, it recognizes the importance of top-down direction, intra-organizational knowledge and experience, and bottom-up advice, thus is founded on a controlled and effective feedback process.

Douhet and Bell were correct in their assessment in stating that progress, whether during peace-time or in war, is a necessary continuum. Amongst the management of modern weaponry's ultimate objectives is the maintenance of an initiative over its adversaries, whom, as a result of the tendency for commercial development trends to lead military development, have access to the same technology. Aerospace capability has

evolved significantly since the Silver Dart first flew over Lake Bras D'or, and likewise, the weapons of war have also evolved immensely since Douhet first published his air power theories.

However, the basic principles of war have not changed. And, if recent history is indicative of the future, warfare will not become simpler; rather it will become more complex requiring more adaptable weapons and forces, and equally important, requiring strategies and processes that not only permit, but embrace adaptability through controlled and deliberate evolution. Evolutionary acquisition strategies and capability based planning methodologies provide the necessary responsive approaches to managing those evolving defence capabilities. Their cyclical nature ensure a continuous refinement and revisit of the influences of change. And an effective and controlled feedback process provides the necessary intellectual rigour essential for coherent and coordinated responsiveness. Therefore, evolutionary acquisition, as an effective strategy for the acquisition of evolving aerospace weapon systems, does indeed ideally compliment the Canadian Forces' capability based planning methodology. As Charles Darwin stated with respect to evolution, "[i]n the struggle for survival, the fittest win out at the expense of their rivals because they succeed in adapting themselves best to their environment." [219]

[219] Ritchie R. Ward. *The Living Clocks*. 1971. Quoted in Wikipedia, "Charles Darwin" http://en.wikiquote.org/wiki/Charles_Darwin; Internet accessed 18 April, 2009.

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