**DEFENCE CONVERSION: A COMPARISON OF THE INNOVATION PROCESSES
OF DEFENCE AND NON-DEFENCE PRODUCTS IN THE
ELECTRONIC SECTOR OF THE CANADIAN DEFENCE INDUSTRY**

by
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in partial fulfillment of
the requirements for the degree of
Master of Management Studies

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ABSTRACT

Converting Canada's defence industry through new product development, based on a conscious effort to transform military technology for civil use, has been largely neglected in the literature. In an attempt to shed some light on defence conversion, this study investigates differences between activities in the innovation process of non-defence and defence products and provides explanations for these differences. The study reports on the findings of personal interviews and questionnaire surveys consisting of twenty-seven senior managers from seven high technology firms in the electronic sector of the Canadian defence industry. Results revealed that managers depend on formal development processes put in place for defence products and are expected to adapt these processes to non-defence product development requirements based largely on trial-and-error procedures.

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1. INTRODUCTION

At the height of the Cold War, Western governments spent billions of dollars for the research and development of advanced weapons systems. Vast sums of money flowed into technology and industrial bases, yet, most of the products developed remained within defence (Brandt 1994; Ettlinger 1993; Melman 1985). Now that the East-West conflict is over, rapid and dramatic cuts have been experienced in defence budgets (Brandt 1994; Ettlinger 1993; Walker and Willett 1993). Consequently, defence firms have suffered a great loss of demand (Brandt 1994; Walker and Willett 1993). Public policy makers are attempting to save defence jobs, technology, and infrastructure by converting them into a flexible, commercial base capable of supporting both defence and non-defence needs (Brandt 1994; Elsner 1993; Ettlinger 1993; Finch 1994; Kelley and Watkins 1995; Walker and Willet 1993). Two little-used terms are finding their way into the defence ministry's lexicon: "defence conversion" and "dual-use technologies."

The United States Department of Defense Conversion Commission, which was brought into existence to evaluate the impact of the defence drawdown, has defined conversion as "the process by which people, skills, technology, equipment, and facilities in defense are shifted into alternative economic applications" (Defense Conversion Commission 1992). Dual-use technology, which is often associated with the process of defence conversion (Brandt 1994; Ettlinger 1993), is defined as "technology that has both military and commercial applications" (Alic *et al* 1992).

There exists a difference between civilian and military firms. This difference is often a result of a mixture of government laws, regulations, and culture. Factors that have caused this difference include: specific accounting and auditing requirements, government claims on technical data rights (Brandt 1994; Kelley and Watkins 1995), military specifications and standards, and unique contract requirements (Brandt 1994; Kumar and Kumar 1993). These conditions placed upon defence firms are far more restrictive than those applicable to non-defence firms. Under these governing factors, therefore, firms with defence and non-defence divisions find it hard, if not impossible, to transfer technologies between those divisions (Brandt 1994; Kelley and Watkins 1995).

The difference just described is as much based on government laws, regulations, and corporate culture as on product development difficulties. In non-defence firms, the factors that are likely to influence the success of a product include: the coordination of the create, make, and market functions; the understanding of the customers and the marketplace; the value of the product to the customer; the organization's proficiency in marketing; and, the quality and efficiency of technical management (Maidique and Zirger 1985). Yet, in defence firms, the *modus operandi* is the production of customized products for one market - the government (Ettlinger 1993). Consequently, market development, which typifies non-defence firms, is in essence, non-existent in traditional defence firms (Ettlinger 1993).

The absence of a need for extensive marketing in defence firms is characterized by how the conception of projects habitually originates within military departments, whereas, for non-defence firms, product ideas generally emanate from the identification of "user needs." Though, work activities in the innovation processes of both defence and non-defence firms may appear on the surface to be somewhat similar, the emphasis placed on them, and the way they are carried out and managed, differs. For example, stringent military standards result into very detailed product specifications in the innovation process of defence products relative to non-defence products.

Technological innovation is an important component of today's manufacturing environment in general and is of specific importance to Canada's defence industry (Cooper and Kleinschmidt 1991; Kumar and Kumar 1993). Converting this industry through new product development, based on a conscious effort to transform military technology for civil use, is not evident (Walker and Willet 1993). Differences in both defence and non-defence innovation processes prevent defence firms from successfully shifting into areas of non-defence production. In order for conversion and/or dual-use programs to be successful, public policy makers, researchers, and managers must understand these differences.

This study has two objectives. The first objective of this research is to identify the differences, if any, between the innovation processes of defence and non-defence products. The second objective is to provide some explanation for these differences.

Identifying and furnishing explanations for the differences in both defence and non-defence processes will provide public policy makers with greater information on which to base policy aimed at facilitating the defence industry's transition to commercial markets, and supply researchers and managers with information on which to base conversion and/or dual-use strategies.

This study will define innovation and describe its importance for today's manufacturing environment. A comprehensive literature review will provide the basis for a conceptual model. The research methodology outlines the manner in which the research was operationalized. The results of the study reveal differences in the innovation processes of defence and non-defence products and explain these differences. The conclusion draws attention to the most notable results and their implications for public policy makers, researchers, and managers. Finally, the benefits and limitations of the study are discussed.

2. LITERATURE REVIEW

The literature review is divided into four major sections. The first section suggests a definition of innovation based on an examination of the literature dealing with innovation. The second section examines the importance of innovation processes for modern corporations in general. The third section explores the different perspectives from which various innovation models have been described. Whereas, the final section of the literature review depicts the innovation process in defence firms.

2.1 Innovation Defined

Rutherford and Goss (1982) define innovation as a "complex activity which proceeds from conception of a new idea to a solution of the problem, then to the actual utilization of a new item of economic or social value." This definition implies that innovation occurs only when an economic or social value has been achieved (Kumar and Kumar 1993).

The term innovation shall be used interchangeably with the phrase new product development. Innovativeness or newness can mean first of its kind, new to the market or new to the company, i.e. the firm has never fabricated or sold the product previously although other firms might have, this includes new product lines, addition to existing product lines, and major improvements to existing products (Kumar *et al* 1994).

2.2 Importance of New Product Development

New products are central to the growth and profitability of modern corporations. Increased competition, the internationalization of markets, and the quickening pace of technological change are forcing companies to make product innovation a vital facet of their corporate plans. In fact, a Coopers and Lybrand (1985) study reported that most companies are counting heavily on new product development for growth and prosperity. Moreover, a study conducted by the Conference Board (Hopkins 1980) revealed that, by an eight-to-one ratio, chief executive officers (CEOs) believed that their firms would be much more dependent on new products in the years ahead. In 1986, for example, about forty percent of sales of U.S. firms came from new products - up considerably from thirty-three percent five years earlier (Cooper and Kleinschmidt 1991).

Accordingly, there have been a number of attempts in recent years to impose some sort of conceptual order to the innovation process (Baker and McTavish 1976; Becker and Whisler 1967; Cooper 1990; Cooper and Kleinschmidt 1991; Cooper and More 1979; Kotler 1976; Maidique and Zirger 1985; Robertson 1974; Rubenstein and Ettlie 1979; Saren 1984; Twiss 1980), the purpose being to understand it better and provide a more secure basis for policy formulation (Kline and Rosenberg 1986).

While technological innovation is central to the growth of modern corporations in general, it is of specific importance to Canada's defence industry. In fact, defence firms must continually cope with the intense pressure of improving weaponry for the strategic

advancement of the armed forces (Kumar and Kumar 1993). Despite the importance of technological innovation for defence firms, limited research that has been conducted in this area.

2.3 Innovation Models

Saren (1984) reviews the different models of the innovation process which have been proposed in the literature and constructs a taxonomy according to different types:

- Departmental-Stage models;
- Activity-Stage models;
- Decision-Stage models.

Each model illustrates a different approach to the conceptual representation of innovation in the firm.

2.3.1 Departmental-Stage Models

Departmental-stage models depict the simplest approach to representing the innovation process. These models break down the innovation process into a series of stages associated with departments of the firm. The innovation process moves from conception of an idea through several departments sequentially until a new product finally enters the market. The innovation moves in and out of the departments of the firm, e.g., R&D, Design, Production, and Marketing. Robertson (1974) builds upon the basic concept of the departmental-stage model incorporating some influences of socio-economic and

technological factors. As shown in Figure 1, the innovation passes through four departments, each of which is affected by and interacts with socio-economic and technological elements.

Figure 1 Departmental-Stage Model

Source: Robertson (1974)

More complex and realistic departmental-stage models may identify a larger number of departments involved in the process, but essentially they adopt a similar approach. These departmental-stage models are an accurate representation insofar as the various

departments cited are usually involved with innovation in the firm in some way. However, the conceptual accuracy of such models is questioned on the basis of what the models imply, or more often do not indicate, about the nature of the innovation process in the firm. These models do not expose the activities carried out on the innovation within departments nor show the state of development of the innovation as it emerges from departments.

2.3.2 Activity-Stage Models

Activity-stage models identify activities that are performed during innovation and, as such, are considered to be an improvement over the departmental-stage models (Saren 1984). The activity-stage model which has become the standard in management textbooks is that applied by Kotler (1976) and Baker and McTavish (1976). As shown in Figure 2, the innovation process consists of six sequential stages, in each of which some specific activity is performed.

Step one consists of garnering ideas of new products. Ideas emerging from this stage are "screened" in step two. Most often, they are screened according to a number of criteria such as technical feasibility, compatibility with firms' objectives, product-mix, and availability of resources. Step three involves the application of commercial estimates regarding potential costs, prices, and sales of the resulting new product. Step four comprises the development of a prototype which is tested in step five. The final step includes activities such as development for production, test marketing, and launch.

Figure 2 Activity-Stages in the New Product Development Process

Source: Based on Baker and McTavish (1976)

Activity-stage models such as the one discussed above, improve on the department-stage approach insofar as they expose the tasks that are carried out on the innovation within each stage. Moreover, these models pay attention to the state of development of the innovation as it passes between stages, something which was also lacking in the department-stage approach. However, the activity-stage approach implies a

straightforward progression from stage to stage, and gives no indication of alternative paths available at particular junctures in the process. In reality, many such alternatives may exist and alternatives require decisions to be made.

2.3.3 Decision-Stage Models

Decision-stage models take account of the series of decisions made by managers involved in the innovation process and the quality of information on which these decisions are based. Rubenstein and Ettlie (1979) suggest that decisions in the innovation process can be categorized according to the functional context in which they are taken, i.e., decisions are grouped according to the effect they have on various activities or departments such as Marketing, R&D, Production, and Finance. However, this categorization of decisions does not indicate the actual sequence of decisions. Cooper and More (1979) overcome this weakness by splitting up the innovation process into decision "modules" which they term Risk Management Modules. Innovation in the firm is viewed as an evolutionary sequence of modules as shown in Figure 3.

Each module comprises four activities: (1) Information gathering to reduce uncertainties; (2) Evaluation of information; (3) Decision making; and, (4) Identification of remaining key uncertainties. In each module, two types of decisions are involved: (1) Go/No Go (i.e. should the project be continued or stopped?); (2) and, if continued, then what next (i.e. what further information is required?).

Figure 3 Risk Management Modules

Source: Cooper and More (1979)

The difference between the Cooper-More model and other decision-stage models is that it considers alternatives and decisions involved, and attempts to identify the common "building-blocks" of the innovation process. One advantage of this approach is that the decision modules can be linked to actual activity-stages. Cooper and More illustrate this for one specific innovation, the development of Du Pont's Canadian "milk pouch" (see Figure 4). Here, Cooper and More consider what both "activity" and a number of "decision" models ignore: decision points between stages. Although implicit in most

models, Cooper and More made decision points an explicit feature of their model. Saren (1984) suggests that Cooper and More decision-stage type models provide a more practical basis for examining the innovation process.

2.3.4 Stage-Gate Systems

With the exception of the Cooper- More model, the aforementioned models portray conceptual, not operational schemes of a "typical" innovation process. Cooper's (1990) Stage-Gate model, which combines the basic elements of both "activity" and "decision" models, both conceptualizes and operationalizes the new product development process. Specifically, it provides a "blueprint" for managing innovation. The Stage-Gate model has been generating a lot of interest among researchers and practitioners. In fact, it seems that a number of corporations which have adopted Stage-Gate Systems, e.g. General Motors, 3M, and Northern Telecom, on average are more successful innovators (Cooper 1990; Cooper and Kleinschmidt 1991). Thus, this model is a good candidate for guiding part of this study considering that it details actual new product processes and is used by several well-managed and forward-thinking companies. Stage-Gate Systems are briefly described below.

Figure 4 The Flow Diagram of Du Pont of Canada's Milk Pouch

E: denotes evaluation/decision point

Source: Cooper and More (1979)

Stage-gate systems recognize that product innovation is a process and, like other processes, it can be managed. Stage-gate systems parcel the innovation process into an ordained set of stages, themselves composed of a group of defined, connected, and often parallel activities. In Stage-gate systems, the entrance to each stage is a gate. These gates govern the innovation process in the same way that quality control checkpoints guide the production process. Each gate is characterized by a set of inputs, a set of exit criteria, and an output. The inputs are the deliverables that must be brought to the gate. The exit criteria are the points upon which the project will be evaluated. The outputs are the decisions at the gate, i.e., a Go/Kill/Hold/Recycle. A typical stage-gate system is shown in Figure 5.

Figure 5 An Overview of a Stage-Gate System

Source: Cooper (1990)

The various stages, major steps undertaken at each stage, and gates of a typical Stage-Gate System are described below. Detailed activities performed at each stage are listed in Appendix I.

Idea

The innovation process begins with a new product idea, which is submitted to Gate 1, Initial Screen.

Gate 1 - Initial Screen

Initial screening amounts to subjecting the new product idea to several crucial "must meet" and "should meet" criteria. These criteria deal with strategic alignment, project feasibility, magnitude of the opportunity, differential advantage, synergy with the company's core business and resources, and market attractiveness. A checklist for the "must meet" criteria and a scoring model (weighted rating scales) for the "should meet" criteria are employed. If the decision is Go, the project advances into the Preliminary Assessment stage.

Stage 1 - Preliminary Assessment

The objective of this first stage is to determine the project's technical and marketplace worth. A preliminary technical assessment is carried out, which entails an estimate of development and manufacturing feasibility, as well as possible costs and time to execute.

In parallel, a preliminary market assessment is executed, which requires contacts with key users, focus groups, and even a quick concept test with a handful of potential users.

Gate 2 - Second Screen

At Gate 2, the project is again subjected to the original set of "must meet" and "should meet" criteria used at Gate 1, but this time, in the light of the new information collected in Stage 1. Again, a checklist and a scoring model are employed. In addition, financial return is assessed through a quick and simple calculation such as the payback period.

Stage 2 - Definition

Stage 2 is the last stage prior to product development. Here, market research studies are performed to identify customers' needs, wants, and preferences. A detailed technical assessment focuses on the viability of the project, i.e. customer needs and wants are translated into technically feasible solutions. This might involve preliminary design or laboratory work, but at this stage, should not be construed as a full-fledge development project. An operations assessment can be a part of this stage, where issues of manufacturability, such as costs and investment are considered. A detailed financial analysis, a discounted cash flow approach complete with sensitivity analysis, is conducted as an input to Gate 3.

Gate 3 - Decision on Business Case

Gate 3 is the last gate prior to the Development Stage and is the last point at which the project can be killed before going into heavy spending. Once again, the project is subjected to the set of "must meet" and "should meet" criteria used at Gate 2. A review of each of the activities in Stage 2 is performed, i.e. checking to see if the activities were actually undertaken, the quality of execution was sound, and the results positive. Before the project proceeds into the Development Stage, agreement must be reached on several key items: target market definition; definition of the product concept; specification of a product positioning strategy; delineation of the product benefits to be delivered; and on the essential and desired product features, attributes, and specifications. The marketing, development, and preliminary operations plans are reviewed and approved at this gate. The results of the financial analysis are also closely examined because of the heavy spending commitment which results from a Go decision at this gate.

Stage 3 - Development

This stage involves the development of the product and, at the same time, the execution of detailed test, marketing, and operations plans. An up-to-date version of the financial analysis is produced, and legal/patent/copyright issues are also addressed during this stage.

Gate 4 - Post-Development Review

At this gate, development work is reviewed and checked making sure that it has been completed in a quality fashion. Detailed marketing and operations plans are also reviewed for likely future execution, and test or validation plans for the next stage are approved for immediate implementation.

Stage 4 - Validation

Stage 4 tests the viability of the project, i.e. the product itself, the production process, customer acceptance, and the economics of the project. Several activities are performed during this stage: (1) In-house tests are conducted to check on production quality and product performance; (2) User or field trials of the product are executed to verify that the product functions under actual use conditions, and also to gauge potential customers' reaction to the product; (3) Trail or pilot production is performed to test and debug the production process, as well as to determine more precise production costs and rates; (4) Pretest market, test market, or trial sell is conducted to gauge customer reaction, measure the effectiveness of the launch plan, and determine expected market share and revenues; and (5) a revised financial analysis is accomplished to check on the continued economic viability of the project, based on new and more accurate revenue and cost data.

Gate 5 - Pre-Commercialization Decision

This last gate leads to full commercialization. It is also the last point at which the project can be killed if necessary. At this gate there is a focus on assessing the quality of the

activities performed at the Validation Stage as well as their results. Financial projections are reviewed and determine whether or not the project moves ahead. Operations and marketing plans are also reviewed and approved for execution in Stage 5.

Stage 5 - Commercialization

This last stage involves the execution of both the marketing launch plan and the operations plan.

Post-Implementation Review

This is the point in the innovation process where the project and product's performance is reviewed. The most recent data on revenues, costs, expenditures, profits, and timing are compared with those projected to measure performance. A critical assessment of the project's strengths and weaknesses is carried out. This review demarcates the end of the project.

2.4 Innovation Process in Defence Firms

Technological innovation is especially important to Canada's defence industry. Defence firms must constantly improve weaponry for the strategic advancement of the military (Kumar and Kumar 1993). In order for this industry to remain current, healthy, and competitive, a deeper understanding of the innovation process in the defence industry must be accomplished.

Research which specifically describes and characterizes in detail the new product development process in defence firms is rare in the Canadian context. The limited research that has been conducted in this area examines the innovation process in the Canadian defence industry only in terms of its cost effective speed (Kumar and Kumar 1993).

The work of Kumar and Kumar (1993) provides a description of the innovation process in defence firms. The major phases of the innovation process they identify are shown in Figure 6 and described below. Detailed activities performed at each stage are listed in Appendix 2.

Figure 6 Innovation Process in Canadian Defence Firms

Source: Based on Kumar and Kumar (1993)

Phase I - Conceptualization of Projects/Programs

Often the concept of a Department of National Defence (DND) project may arise from the identification of requirements from a government policy, the need to amend an operational problem and/or the need to enhance the capability of an existing system. The concept is brought forward by a section of the military establishment, or in some cases government officials closely associated with it, or with industry in general. The concept of large projects habitually originate within the DND whereas smaller projects or niche type activities, geared towards enhancing certain features of new or existing products, usually originate from industry. In some cases, however, aggressive firms, engaging in research and development activities, develop a technology which could be of use to the military establishment.

Phase II - Establishment of Requirements and Issuing of Request for Proposal

Once a concept takes the shape of a project, a Program Management Office (PMO) is organized. The PMO is usually comprised of representatives from DND, Supply and Services Canada, and Industry Canada. One of the chief responsibilities of the PMO is to develop a Statement of Requirements (SOR). The SOR is produced through consultation with the DND's research wing, CRAD. CRAD's assistance is sought to help in the understanding of the depth and breadth of technical problems which may arise and to expose the possible solutions. The establishment of the SOR leads to the Request for Proposal (RFP).

Phase III - Proposal Development by Industry

Firms interested in the project submit a bid in response to a RFP. The principal activities undertaken during this phase include the following: preliminary budget and schedule estimates, risk assessment, requirements analysis, preliminary design, draft logistics, maintenance, and manufacturing plans, developing program management strategies, testing plans and production plans. On occasion, some of the more aggressive firms submit a working prototype as part of their proposal. Firms ordinarily have between 30-60 days for submission of their proposals.

Phase IV - Contract Award

The PMO examines the bid proposals and either awards the contract to a single firm or comes up with a short list of attractive firms. In the case of the latter, these firms may be required to furnish supplementary information, which is then examined before any decision is made to award the contract. Ordinarily the DND has around 120 days, from the deadline date for submitting a bid proposal, to respond to interested firms.

Phase V - Final Negotiation

Once the contract has been awarded, the PMO and the selected firm engage in a series of meetings to determine the complete requirements of the product. These meetings ensure the firm's awareness and understanding of the specifications the design must meet before development commences. A complete list of contractually imposed military standards and specifications are outlined. As well, measures are taken to ensure compliance.

Conditions of the contract, such as, budget and schedule estimates, program development monitoring, test plans, and system elements acquisition, are also finalized at this phase.

Phase VI - Design Development

During this phase, design analyses are continually updated through empirical testing. The intent is to identify and correct potential problems prior to full scale development, as well as to ensure that adequate reliability and performance margins are achieved. In addition, the design analyses are aimed at providing a systematic assessment of the engineering concepts and design approaches, measured against appropriate specifications, objectives and standards. The output of the design analyses includes the production of engineering drawings, a mockup of the system, computer software component integration, a preliminary list of tools and special equipment, test specifications, and ultimately a production design release.

Phase VII - System Preproduction Implementation and Integration Testing

At this phase the first model of the system is produced, tested, and validated. The model could either be a working prototype or an engineering audit model built according to the actual technical data package. A considerable portion of the required documentation is also developed at this phase. Ultimately the product design is released.

Phase VIII - System Elements Acquisition

The principal activities undertaken at this phase include the following: the procurement of major components of the product, special equipment, and fabricating tools, updating product baseline documentation and source/specification control drawings, and finalizing manufacturing processes and procedures.

Phase IX - Production

Full scale production is undertaken at this phase. Other activities conducted include updating the design package, product baseline documentation, configuration inspection, fabricating hardware equipment, performing qualification tests, and producing installation checkout kits.

Phase X - Integration and Qualification

The chief activities undertaken at this phase include the accomplishment of engineering qualification and integration tests, production of test reports, and updating all necessary documentation. Finally, the product is delivered to the end user or installed as appropriate.

3. PROPOSED MODEL

In comparing Cooper's (1990) Stage-Gate model and Kumar and Kumar's (1993) conceptual scheme of the innovation process in Canadian defence firms, it becomes clear that while the processes involved in defence and non-defence innovations may appear to be similar, the emphasis placed on them, and the ways they are carried out and managed differ. For example, stringent military standards result into very detailed product and process specifications in the innovation process of defence products relative to non-defence products. Moreover, a number of activities involved in the defence innovation process do not take place in the case of non-defence innovations. Unlike non-defence firms, the conception of projects in defence firms originate within military departments - the customers. Product ideas for non-defence firms generally emanate from the identification of "user needs."

The proposed model (see Figure 7) conceptualizes the activities in the new product development process of non-defence and defence products. The model consists of a representation of the stages and activities of the new product development process of non-defence products and a representation of the stages and activities of the new product development process of defence products. The dotted line which separates the two representations denotes the different emphasis placed on activities.

A better understanding of the differences in processes and emphasis on activities will provide public policy makers with greater information on which to base policy aimed at

facilitating the defence industry's transition to commercial markets, and supply researchers and managers with information on which to base conversion and/or dual-use strategies.

Perrow's (1967) perspective on organizations provides a basis for comparing non-defence and defence innovation processes. This perspective suggests that non-defence and defence innovation processes can be compared on the basis of activity characteristics by using two separate dimensions - variety and analyzability. Details of Perrow's model are provided in the methodology section.

Figure 7 A Conceptual Model of the Differences Between Activities in the Innovation Process of Non-Defence and Defence Products

4. RESEARCH OBJECTIVES

A review of the literature has stimulated the following two objectives:

1. To identify the differences between activities in the innovation process of non-defence and defence products.
2. To provide explanations for the above differences.

5. RESEARCH METHODOLOGY

This section describes the steps undertaken to conduct the study. It is divided into four sub-sections. The first sub-section specifies the research design; the second details the sampling design; the third provides a detailed account of the data collection method; while, the last sub-section explains the analysis performed on the data.

5.1 Research Design

The research involved an investigation of the activities which take place in the innovation processes of both non-defence and defence products. Research which specifically compares these two processes is non-existent in the Canadian context. Thus, this research was exploratory in nature. An ex post facto design was employed. A primary data collection method was applied.

Both personal interview and questionnaire techniques were used to obtain information concerning this study's objectives.

5.2 Sampling Design

The sample included seven high technology firms in the Electronic sector of the Defence industry, within the Ottawa Valley and Greater Montreal regions, which design and produce both non-defence and defence products, and have revenues of at least \$20 million. Convenience sampling was used to determine the appropriate firms. The

Electronics sector of the Defence industry was favoured because it is comprised of firms which actively pursue new product development programs.

5.3 Data Collection Method

Respondents included senior managers within each of the following three functions: (1) business development; (2) R&D/engineering; and, (3) manufacturing. Managers were selected on the basis of their active involvement in the new product development process of non-defence and/or defence products. Table 1 shows the number of managers which were interviewed in each of the participating firms.

Table 1 Number of Respondents by Firm and Functional Area

	F 1	F 2	F 3	F 4	F 5	F 6	F 7	Total
Business Development Non-Defence	1	1		1			1	4
Business Development Defence	1	1	1	1	1			5
R&D/Engineering Non-Defence	1	1		1		1	1	5
R&D/Engineering Defence	1	1	1	1	1			5
Manufacturing Non-Defence	1	1				1		3
Manufacturing Defence	1	1	1		1	1		5
								27

F: firm

Managers were interviewed individually. The questionnaire was administered following the interview. The interview and administration of the questionnaire took between 45 to

75 minutes to complete. Twenty-seven interviews were conducted and 27 completed questionnaires were collected.

5.3.1 Perrow's Model

Perrow's (1967) perspective on organizations provided a basis for comparing both non-defence and defence innovation processes. This perspective considers technology as the defining characteristic of organizations. By technology is meant here, the nature of work activities. That is "the actions that an individual performs on an object, with or without the aid of tools or mechanical devices, in order to make some changes in that object" (Perrow 1967: p. 195). This definition of organizational technology emphasizes the product development process irrespective of whether the product is a person, symbol, or thing. In addition, the definition implies that organizations are not characterized by a single technology. In which case the product development process practised in the non-defence group of an organizational department will differ from the product development process practised by the defence group and other organizational departments.

In Perrow's view, technology can be determined by using two separate dimensions of work activities. The first dimension is variety. Variety is the amount of variation and diversity in group work activities. For example, in groups where work activities are low in variety (i.e. narrow and routine) employees encounter few problems and the day-to-day job requirements are repetitious. In contrast, other groups may have work that is high in variety (i.e. work is unpredictable) and employees may not know what work is needed

from one day to the next. The second dimension is analyzability. Analyzability refers to a well-defined versus an ill-defined nature of activities. For example, when the product development process in a group is analyzable, the work can be reduced to explicit steps and established techniques. While work that is not analyzable presents a different demand for employees. When problems arise, there are no obvious steps to follow to attain a solution. Employees may use trial and error and rely on experience and intuition.

Perrow's technology framework shown in Figure 8 dichotomizes and cross-classifies these two dimensions - variety and analyzability. The dimensions form four technology quadrants. The technology quadrants represent routine, non-routine, engineering, and craft technologies and most activities fall within the elliptical area.

Routine technologies are low in variety and high in analyzability. Organizational groups with routine technology are characterized by standard procedures and few exceptions. In contrast, nonroutine technologies are high in task variety but low in analyzability. Organizational groups with nonroutine technologies must deal with numerous problems that are not readily analyzed. Solutions to crises depend on trial-and-error procedures, technical knowledge, experience, and intuition.

The dotted line in Figure 8 illustrates a one-dimensional scale of organizational group routineness-nonroutineness. The routine-nonroutine diagonal indicates that the dimension of analyzability and variety are interrelated. That is, technologies with high variety also

tend to be low in analyzability. Conversely, technologies with low variety tend to be more analyzable.

Figure 8 Perrow's Technology Framework

Source: Based on Perrow (1967), Magnusen (1977), Daft and Macintosh (1978).

Perrow's framework offers two additional categories: engineering and craft technologies. Engineering technologies are characterized by considerable variety in the tasks performed, including unpredictable problems. However, work activities are analyzable and can be completed using established procedures and techniques. Craft technologies are characterized by low variety in the work, yet the product development process is not analyzable or well-defined. A few organizational groups fit into the engineering or craft quadrants, but most can be categorized along the single dimension of routine versus nonroutine.

While the conceptualization given in Figure 8 may appear static, movement between quadrants is common. One may move from the nonroutine technology quadrant to the craft technology quadrant by lowering variety in work tasks. If the analyzability of work tasks increases, one may move from the nonroutine technology quadrant to the engineering technology quadrant. Likewise, if variety of work tasks is decreased and analyzability is increased, one may move from the nonroutine technology quadrant to the routine technology quadrant.

Perrow's perspective is used in this study for comparing activities on the basis of their characteristics. To understand the nature of defence and non-defence work activities means to be able to control them better and achieve more predictability and efficiency in movement between quadrants.

5.3.2 Interview Guide and Questionnaire Design

Appendix 1 lists work activities often carried out within the new product development process of non-defence products (based on Cooper and Kleinschmidt 1991). Appendix 2 lists work activities generally accomplished within each stage of the innovation process of defence products (based on Kumar and Kumar 1993). These have been combined in Appendix 3 to form an exhaustive list of work activities within both non-defence and defence innovation processes categorized by functional departments of the firm. This list provided the foundation upon which the interview guide (See Appendix 5) and questionnaire (See Appendix 7) were based.

The interview guide had three parts. Parts 1, 2, and 3 were meant for managers within business development, R&D/engineering, and manufacturing, respectively. Each part was divided into two sections. Section 1 was intended for managers involved with non-defence innovation, while section 2 was intended for managers involved with defence innovation.

Overall, the interview probed for the different contributions, made by both non-defence and defence groups from various organizational departments, to the new product development process. For example, each manager of a non-defence group was asked to describe his or her department's contribution to the new product development process of a non-defence product. Likewise, each manager from a defence group was asked to describe his or her department's contribution to the new product development process of

a defence product. The interview also explored the variability and analyzability of work activities of non-defence and defence groups. Based on task variability and analyzability measures developed by Van de Ven and Delbecq (1974), a variety and analyzability index was constructed. The index included four questions, i.e. two questions which measured analyzability and two which measured variety.

The questionnaire also possessed three parts. Parts 1, 2, and 3 were meant for managers within business development, R&D/engineering, and manufacturing, respectively. However, unlike the interview guide, each part of the questionnaire was divided into four sections. Sections 1A and 1B were meant for managers involved with non-defence innovation, while sections 2A and 2B were meant for managers involved with defence innovation.

Essentially, sections 1A and 2A sought information on the amount of resources (money or time) organizational groups spend on carrying out particular work activities. That is, managers were asked to weigh, on a scale of 1-7, the extent of resources their organizational group spends on performing specific activities. Activities which received a score of 1 or 2 were considered to have a small amount of resources spent on them, while activities which received a score of 3, 4, or 5 were considered to have a moderate amount of resources spent on them. Activities which received a score of 6 or 7 were considered to have a substantial amount of resources spent on them.

Sections 1B and 2B examined managerial perceptions about the variability and analyzability of specific activities. Again, based on Van de Ven and Delbecq's (1974) measures of task variability and analyzability, a variety and analyzability index was constructed. The index included four questions, i.e. two questions which measured analyzability and two which measured variety. Using Cronbach coefficient alpha, Van de Ven and Delbecq found high reliability of their task analyzability index ($\alpha = .86$), and of their task variability index ($\alpha = .89$). Based upon an analysis of task analyzability and task variability on intraorganizational structure, Van de Ven and Delbecq derive a taxonomy of departments within complex organizations. Managers were asked to respond to the variability and analyzability measures of activities which were given a score of 3 or higher in sections 1A or 2A.

In addition, respondents were asked to describe the reasons why activities which obtained a score of 6 or 7, in sections 1A and 2A of the questionnaire, had a substantial amount of resources spent on them.

5.3.3 *Pre-test*

A pre-test was conducted with one Montreal-based firm, to help identify any problems which might occur during data collection. The pre-test did not result in any significant changes in the research instruments.

5.4 Data Analysis

An objective coding scheme, commonly referred to as content analysis, was applied to the interview data.

The questionnaire responses to the scaled questions from sections 1A and 2A were analyzed in the same manner. Mean tests were performed on the data to determine the degree of consensus to each question (assuming that parametric assumptions are satisfied). Mean "technology" scores for responses to the analyzability and variability index from sections 1B and 2B were determined. Mean scores were then classified in accordance to Perrow's four technology quadrants.

6. DIFFERENCES BETWEEN THE INNOVATION PROCESS OF NON-DEFENCE AND DEFENCE PRODUCTS: RESPONDENTS' PERCEPTIONS

Respondents' perceptions regarding the differences between the innovation process of non-defence and defence products are presented in three major sections. The first section exposes perceived differences in business development activities. The second section reports on perceived differences in R&D/engineering activities. The third section deals with perceived differences in manufacturing activities. Explanations for differences in processes are also provided in all three sections.

6.1 Business Development Activities

This section is divided into three sub-sections. The first sub-section examines differences between the amount of resources managers spend on performing business development innovation activities. The second sub-section examines differences in managerial perceptions about the variability and analyzability of business development innovation activities. The third sub-section describes key differences between the innovation process of non-defence and defence products.

6.1.1 Differences Regarding the Amount of Resources Spent

The study revealed that managers involved with the new product development process of non-defence products spend a considerable amount of resources on "front-end" and "intermediate" business development innovation activities. Table 2 lists mean scores for the amount of resources managers spend on performing business development activities

in the case of non-defence products. This table shows that managers commit a significant sum of money and time to "Obtaining product ideas from the user", "Developing a product concept which satisfies customer requirements", and to "Committing lead customers." These activities received mean scores of 4.25, 5.0, and 4.5 on a scale of 1-7, respectively.

Managers consult with potential users to obtain new product ideas and, as the consultation process progresses, managers develop, along with the customer, a set of preliminary requirements for the likely new product. Managers try to generate commitment of customers to buy the product early on since upper management, typically, is reluctant to invest in developing a product without a firm indication of customers' intent to purchase.

Managers involved with the new product development process of defence products also spend a significant amount of resources on "Obtaining product ideas from the user" and on "Developing a product concept which satisfies customer requirements." When asked to gauge the extent of resources spent on these activities, managers gave them scores of 5.2 and 5.8, respectively (see Table 3).

Table 2 Mean Scores for the Extent of Resources Spent on Performing Business Development Activities in the Case of Non-Defence Products (N=4)

"Front-End" Activities	Low	High	Mean
Developing a product concept which satisfies customer requirements	4	6	5.0
Obtaining product ideas from the user	1	6	4.25
Estimating potential revenues and sales volumes	2	6	4.25
Estimating required investments (R&D, capital, prototypes)	3	5	3.75
Assessing technical risks	3	4	3.75
Responding to a Request for Proposal (RFP)	1	7	3.25
Obtaining product ideas from a source other than the user	2	4	2.75
"Intermediate" Activities	Low	High	Mean
Committing lead customers	2	6	4.5
Identifying and evaluating the competition	2	6	4.25
Administering field tests	3	5	4.0
Developing marketing plans	2	5	3.5
Assessing competitive products	2	5	3.0
Designing fallback alternatives	1	4	2.75
Developing project management strategies	1	3	2.0
"Back-End" Activities	Low	High	Mean
Obtaining feedback from users to confirm acceptance	3	4	3.5
Assessing the product on a continuous basis for further refinement	2	5	3.5
Developing sales programs for the product	2	5	3.25
Installing the product	1	7	3.25
Conducting field tracking and correction	1	4	3.0
Conducting a review of the total development cycle	1	4	2.5
Making service related material available to dealers	1	5	2.25
Confirming that process capability meets volume requirements	1	3	1.75

Table 3 Mean Scores for the Extent of Resources Spent on Performing Business Development Activities in the Case of Defence Products (N=5)

"Front-End" Activities	Low	High	Mean
Responding to a Request for Proposal (RFP)	4	7	6.0
Developing a product concept which satisfies customer requirements	5	7	5.8
Obtaining product ideas from the user	2	6	5.2
Estimating potential revenues and sales volumes	4	7	5.2
Assessing technical risks	3	6	4.4
Estimating required investments (R&D, capital, prototypes)	2	6	4.2
Obtaining product ideas from a source other than the user	2	4	3.0
"Intermediate" Activities	Low	High	Mean
Developing marketing plans	3	7	5.0
Committing lead customers	3	6	5.0
Administering field tests	1	6	4.2
Identifying and evaluating the competition	2	7	4.0
Assessing competitive products	2	6	3.8
Designing fallback alternatives	2	5	3.0
Developing project management strategies	1	6	2.8
"Back-End" Activities	Low	High	Mean
Assessing the product on a continuous basis for further refinement	3	6	4.6
Developing sales programs for the product	2	7	4.4
Obtaining feedback from users to confirm acceptance	2	6	4.2
Conducting field tracking and correction	2	6	4.2
Installing the product	1	6	4.2
Making service related material available to dealers	2	6	3.75
Conducting a review of the total development cycle	2	5	3.6
Confirming that process capability meets volume requirements	2	4	3.0

Managers confer regularly with their “points of contact” in the Department of National Defence (DND) in order to track anticipated programs and, identify at an early stage, possible product requirements. Programs and requirements are identified well in advance of a request for proposal (RFP). Managers concede that if they waited for a RFP to begin development they would not be able to submit a competitive bid proposal. As one manager explained:

“It is our job to talk to the customer, which we do on a regular basis. We are the first people, in talking to the customer, to identify requirements...

New product development begins long before a RFP. If you wait for a RFP to start your development you’ll never get it done in time. These days you can’t afford to show up in the market place with a capability only, you’ve got to show up with a capability and a product, a product that might have about 70% of what the customer needs and you just have to tweak the rest of it. By the time the RFP hits the street we are prepared.”

Although the literature suggests that a small number of firms in the defence industry are involved in developing new technologies prior to a RFP (Kumar and Kumar 1993), this study suggests that most sample firms aggressively develop technologies in anticipation of upcoming DND programs.

Although an important part of the development process is undertaken prior to a RFP, considerable resources are devoted to responding to it. When asked to gauge the extent of resources spent on “Responding to a Request for Proposal (RFP)”, managers gave this activity a score of 6.0. Responding to a RFP occasions several heavily documented activities such as developing preliminary budgets and schedules, generating

manufacturing and maintenance plans, and thus requires a significant amount of money and time to complete.

On the other hand, managers involved with the new product development process of non-defence products do not spend as much money or time on responding to RFPs as their defence counterparts. When asked to gauge the extent of resources spent on performing this activity, managers gave it a score of 3.25. Apparently, managers pursue new business through aggressive marketing research activities.

Managers involved in non-defence innovation spend sizeable resources on identifying and evaluating their competition. The extent of resources spent on "Identifying and evaluating the competition", was scored at 4.25 by the managers. One manager explained the significance of this activity as follows:

"In commercial [markets] things move very fast. It's fast paced, there's lots of competition. Time to market is critical. The race is on to introduce new products. Leapfrogging or staying ahead of competitors is important."

A significant amount of resources is also devoted to this activity within the innovation process of defence products. When asked to gauge the extent of resources spent on performing this activity, managers gave it a score of 4.0. According to a manager:

"You've got to continuously monitor the competition so that you can differentiate your proposal. If you're just another 'me-too' this narrows your possibility of winning. You want to have a better quality product at a lower price. If you don't

have that, you better have some other factors that differentiate you from the competition.”

Overall, mean scores for non-defence activities were lower than those for defence. That is, managers involved with the innovation process of non-defence products spend less resources on activities than their defence colleagues. Non-defence activities require less money and time to complete relative to defence activities since they are not as heavily documented. As one manager explained:

“The difference between the development process of commercial and military products is that for military products there is more documentation. Just about everything is documented.”

Indeed, defence innovation requires an extensive amount of documentation. The documentation generally includes full engineering and manufacturing drawings with complete parts lists as well as complete lists of contractually imposed military standards and specifications (Kumar and Kumar 1993).

6.1.2 Differences in Variability and Analyzability

Analysis of managerial perceptions about the variability and analyzability of “front-end”, “intermediate”, and “back-end” business development activities revealed certain differences between non-defence and defence innovation activities.

Figure 9 classifies non-defence and defence mean “technology” scores for “front-end” business development activities in accordance to Perrow’s technology framework. The

four-fold figure exposes differences in managerial perceptions about the variability and analyzability of the following activities: "Obtaining product ideas from the user", "Developing a product concept which satisfies customer requirements", and "Estimating required investments (R&D, capital, prototypes)." While the boundaries of the quadrants in the figure may appear discrete, they are infact hazy.

When performed within the innovation process of non-defence products, "Obtaining product ideas from the user" and "Developing a product concept which satisfies customer requirements" are characterized as routine technologies, whereas when performed within the innovation process of defence products these activities are characterized as non-routine technologies.

Managers involved with non-defence innovation get product ideas from users and develop product concepts which satisfy customer requirements through regular interaction with users. The process of interacting with customers is common and well-defined. In fact, most new product ideas and improvements made to existing products are driven by the user. As one manager explained:

"All improvements in [our] products are driven by the customer. Customers give [us] insight into what the product ought to be."

Figure 9 A Comparison of Non-Defence and Defence Mean “Technology” Scores for “Front-End” Business Development Activities

LEGEND

Activity	N(V,A)	D(V,A)
1. Obtaining product ideas from the user.	(4.3.6.2)	(5.6.4.7)
2. Obtaining product ideas from a source other than the user.	(4.7.6.8)	(4.3.6.7)
3. Responding to a Request for Proposal (RFP).	(2.6.3.2)	(5.7.3.5)
4. Developing a product concept which satisfies customer requirements.	(4.4.5.6)	(6.0.3.8)
5. Estimating potential revenues and sales volumes.	(4.9.5.4)	(5.0.5.0)
6. Estimating required investments (R&D, capital, prototypes).	(2.6.2.2)	(5.5.5.6)
7. Assessing technical risks.	(3.5.4.5)	(4.7.5.2)

N: non-defence
D: defence

Managers involved with the innovation process of defence products obtain new product ideas from the military establishment through their network of personal relationships. Considerable effort is placed on getting involved in developing specifications, in conjunction with DND, in advance of a RFP. Managers concede that firms have a better chance of winning contracts if they are involved in developing specifications for the RFP.

According to a manager:

"[The process] hinges on personal relationships. It's frustrating."

"If you haven't helped to write the RFP, don't bother to respond to it. [Your] chances of winning are very small."

"If you get involved in developing specifications, you are in a better position to get the next million dollar program."

"The government has a bias towards a particular approach or technology before a RFP hits the streets."

"If you build in a bias in the RFP process, it excludes your competitors from bidding on it."

This is a complex and often frustrating process. Managers constantly encounter difficulties which are not easily analyzed. Sample firms thus rely heavily on the individual manager's intuition, experience, and technical knowledge to accomplish these activities.

As for "Estimating required investments (R&D, capital, prototypes)", when performed within the innovation process of non-defence products it is characterized as a craft technology, whereas when performed within the innovation process of defence products it is characterized as a routine technology.

Managers involved in non-defence innovation experience a low level of problem variety in performing this activity but find that problems arising from it are not easily analyzable. Though sample firms have set up procedures for estimating required investments for the development of non-defence products, managers rely on their intuition and experience gained from working in defence related markets to perform this activity.

On the other hand, managers involved in defence innovation experience a moderate level of problem variety in performing this activity, and when problems occur, they are subject to standard, analyzable procedures. Since specifications and requirements are notably well-documented from the onset of the new product development process, managers can readily assess required investments.

Figure 10 exposes differences in managerial perceptions about the variability and analyzability of the following “intermediate” business development activities: “Assessing competitive products” and “Committing lead customers.” For non-defence products, these activities are characterized as routine technologies, whereas for defence products they are characterized as non-routine technologies.

Figure 10 A Comparison of Non-Defence and Defence Mean “Technology” Scores for “Intermediate” Business Development Activities

LEGEND

Activity	N(V,A)	D(V,A)
8. Identifying and evaluating the competition.	(4.0,7.0)	(3.3,5.5)
9. Developing project management strategies.	(1.8,2.7)	(4.5,3.7)
10. Designing fallback alternatives.	(4.9,6.1)	(4.7,6.8)
11. Developing marketing plans.	(4.8,4.2)	(3.8,3.5)
12. Assessing competitive products.	(4.5,5.7)	(5.5,2.7)
13. Committing lead customers.	(5.8,5.6)	(7.6,4.2)
14. Administering field tests.	(3.8,4.7)	(5.1,3.0)

N: non-defence
D: defence

Managers involved in non-defence innovation assess competitive products and commit lead customers by standard procedures which are well-defined. Managers regularly assess competitive products by gathering information on them through constant interaction with customers, via the Internet and on-line databases, and through consultants. They persuade lead customers by offering a number of advantages, as one manager explained:

“[We] ask the potential customer to be a beta site. [We] offer them preferred pricing and tailor the product to their specific needs.”

Managers involved in defence innovation find it more difficult to assess competitive products than their non-defence counterparts. Managers have few known procedures for performing this activity because of the nature of the industry. That is, since defence products are not developed until a contract has been awarded, managers must rely on their knowledge of the industry in order to assess competitive bid proposals. As for committing lead customers, managers involved with defence innovation activities find it more difficult than their non-defence colleagues. According to one manager:

“In order to win contracts, [managers] must build a bias in the RFP process which excludes competitors.”

Figure 11 exposes a difference in managerial perception about the variability and analyzability of the “back-end” business development activity, “Developing sales programs for the product.” For non-defence products this activity is characterized as a routine technology, whereas for defence products it is characterized as a craft technology.

Sales programs for non-defence products are somewhat well-defined. They essentially consist of distributing sales literature and participating in trade shows. Managers involved in defence innovation also employ similar sales programs for defence products. However, in addition they rely heavily on their network of personal contacts to effectively sell new products to the military establishment.

6.1.3 Key Differences and Discussion

To this point, the report has dealt with the key differences between two business development activities: "Obtaining product ideas from the user" and "Developing a product concept which satisfies customer requirements."

Although, managers involved with non-defence and defence innovation may appear on the surface to obtain product ideas from users and develop product concepts in a similar manner, i.e. through regular interaction with users, the way these activities are carried out and managed, differs. When performed within non-defence innovation, the process of interacting with users is well-defined, whereas, when performed within defence innovation, the process is ill-defined.

Figure 11 A Comparison of Non-Defence and Defence Mean "Technology" Scores for "Back-End" Business Development Activities

LEGEND

Activity	N(V,A)	D(V,A)
15. Obtaining feedback from users to confirm acceptance.	(5.6,3.7)	(6.4,5.0)
16. Conducting field tracking and correction.	(3.9,5.6)	(4.6,4.7)
17. Confirming that process capability meets volume requirements.	(2.8,4.5)	(5.0,3.5)
18. Developing sales programs for the product.	(5.1,6.3)	(2.5,4.4)
19. Making service related material available to dealers.	(5.0,4.7)	(2.8,4.1)
20. Installing the product.	(3.9,1.7)	(4.0,2.9)
21. Assessing the product on a continuous basis for further refinement.	(5.0,5.2)	(5.1,4.7)
22. Conducting a review of the total development cycle.	(4.8,5.9)	(4.5,5.7)

N: non-defence
D: defence

Managers involved with non-defence innovation believe that a lack of a market orientation and inadequate market assessment lead to new product failure, particularly in high-technology firms. Several managers professed that market-oriented activities such as understanding of the customer and the marketplace influence the success of a product. As such, they have put in place a set of well-defined procedures in order to improve their assessment of "user needs."

On the other hand, managers involved with defence innovation do not have a set of ordained procedures to follow in order to perform these two activities. Due to the nature of the industry, managers depend on their personal contacts to obtain new product ideas and develop product concepts which satisfy user needs. Consequently, managers must rely on their intuition and experience in order to assess the validity of their contacts' opinions.

6.2 R&D/Engineering Activities

This section is divided into three sub-sections. The first sub-section examines differences between the amount of resources managers spend on performing R&D/engineering innovation activities. The second sub-section examines differences in managerial perceptions about the variability and analyzability of R&D/engineering innovation activities. The third sub-section describes key differences between the innovation processes for non-defence and defence products.

6.2.1 Differences Regarding the Amount of Resources Spent

Managers involved with the new product development process of non-defence products, spend a considerable amount of resources on “back-end” R&D/engineering innovation activities. Table 4 lists mean scores for the amount of resources managers spend on R&D/engineering activities in the case of non-defence products. This table shows that managers commit a significant sum of money and time to “Developing prototypes”, “Correcting potential problems prior to full scale development”, and to “Creating the production design release.” These activities received mean scores of 5.4, 4.6, and 5.0, respectively.

It is important for R&D/engineering to arrive at a prototype as quickly as possible to demonstrate the new product’s capability to customers and to demonstrate to upper management the department’s ability to develop non-defence products. As one manager explained:

Table 4 Mean Scores for the Extent of Resources Spent on Performing R&D/Engineering Activities in the Case of Non-Defence Products (N=5)

"Front-End" Activities	Low	High	Mean
Developing product specifications based on user needs and wants	2	6	4.0
Assessing technical feasibility	2	6	4.0
Selecting final product designs	2	7	4.0
Adhering to customer standards and specifications	1	6	3.8
Estimating laboratory resources needed to obtain results	1	5	3.0
Preparing preliminary sketches and models which demonstrate possible product scenarios	2	5	3.0
Identifying major elements of the production system (facilities, tools and equipment)	1	6	3.0
Undertaking tests on competitive products	1	3	2.0
"Back-End" Activities	Low	High	Mean
Developing prototypes	5	7	5.4
Creating the production design release	3	7	5.0
Correcting potential problems prior to full scale development	3	6	4.6
Developing quality strategies	2	7	3.8
Developing operator training plans	2	5	3.4
Establishing policies on source selection	2	6	3.2
Developing maintenance plans	2	5	2.8
Creating mockups of the system	2	4	2.6

“What we are looking at is to get to a demonstration unit as fast as possible. Because commercial products are new to us, we want to demonstrate the new product’s capability very early-on to see if we have succeeded.”

Once the prototype is developed, R&D/engineering tests it, corrects all potential problems, and drafts the production design. Substantial resources are allocated to correcting potential problems, and to the creation of the production design release once the prototype has been validated by customers.

Managers involved with the innovation process of defence products spend less resources on “Developing prototypes” than their non-defence counterparts. When asked to gauge the extent of resources spent on this activity, managers gave it a score of 3.8 (see Table 5). Less emphasis is placed on developing prototypes since it is not as important to arrive at a demonstration unit as fast as possible. Rather, importance is placed on arriving at a prototype, and later a product, which adheres to customer standards and specifications.

In fact, when asked to gauge the extent of resources spent on “Developing product specifications based on user needs and wants” and on “Adhering to customer standards and specifications”, managers gave them scores of 5.8 and 6.6, respectively. Defence innovation is primarily RFP driven and as such military standards, specifications, and requirements guide the new product development process.

Table 5 Mean Scores for the Extent of Resources Spent on Performing R&D/Engineering Activities in the Case of Defence Products (N=5)

"Front-End" Activities	Low	High	Mean
Adhering to customer standards and specifications	6	7	6.6
Developing product specifications based on user needs and wants	2	7	5.8
Assessing technical feasibility	4	7	5.8
Selecting final product designs	2	7	4.5
Preparing preliminary sketches and models which demonstrate possible product scenarios	1	6	3.0
Identifying major elements of the production system (facilities, tools and equipment)	1	5	2.8
Estimating laboratory resources needed to obtain results	1	5	2.6
Undertaking tests on competitive products	1	1	1
"Back-End" Activities	Low	High	Mean
Creating the production design release	5	7	5.75
Correcting potential problems prior to full scale development	4	6	5.4
Developing quality strategies	2	6	4.4
Developing maintenance plans	2	6	4.4
Developing prototypes	1	6	3.8
Developing operator training plans	1	6	3.6
Establishing policies on source selection	2	5	3.5
Creating mockups of the system	1	6	2.8

Managers involved with the innovation process of non-defence products spend less resources on “Developing product specifications based on user needs and wants”, and on “Adhering to customer standards and specifications” than their defence colleagues. When asked to gauge the extent of resources spent on these activities, managers gave them scores of 4.0 and 3.8, respectively. In spite of the fact that these activities received lower scores, they nonetheless remain an important part of non-defence innovation. In non-defence innovation, standards and specifications are less stringent than in defence and therefore fewer resources are required to develop them and comply with them.

Overall, no other significant differences between mean scores were found, with the exception of the following activities: “Assessing technical feasibility”, “Developing quality strategies”, and “Developing maintenance plans.”

Managers involved with non-defence innovation gave lower scores to these activities than their defence counterparts. That is, managers involved with the new product development process of non-defence products spend less resources on performing these activities relative to their defence colleagues. The reason being that non-defence activities require less money and time to complete since they are not as heavily documented.

6.2.2 Differences in Variability and Analyzability

Analysis of managerial perceptions about the variability and analyzability of “front-end” and “back-end” R&D/engineering activities revealed certain differences between non-defence and defence innovation activities.

Figure 12 compares mean "technology" scores for "front-end" R&D/engineering non-defence and defence activities. As shown in the figure, mean "technology" scores for non-defence activities are clustered in the non-routine technology quadrant, whereas mean "technology" scores for "front-end" defence activities are clustered in the craft technology quadrant.

Non-defence innovation is new for most sample firms. As such, managers involved in "front-end" non-defence activities regularly encounter a high level of problem variability and have few familiar routines for gaining needed solutions. Managers use trial-and-error procedures and rely on experience, intuition, and technical knowledge to attain solutions.

Explained one manager:

"Our origins are military. Commercial markets are new to us. We have no commercial development process in place. We rely on our experience of basic design methodologies set out by a military organization."

Figure 12 A Comparison of Non-Defence and Defence Mean "Technology" Scores for "Front-End" R&D/Engineering Activities

LEGEND

Activity	N(V,A)	D(V,A)
1. Developing product specifications based on user needs and wants.	(5.6,3.0)	(3.7,1.9)
2. Assessing technical feasibility.	(6.1,2.6)	(4.2,3.0)
3. Estimating laboratory resources needed to obtain results.	(5.5,2.7)	(3.2,2.2)
4. Preparing preliminary sketches and models which demonstrate possible product scenarios.	(5.6,3.7)	(4.2,3.0)
5. Adhering to customer standards and specifications.	(5.6,1.7)	(3.1,1.4)
6. Selecting final product designs.	(5.1,3.3)	(3.8,3.7)
7. Undertaking tests on competitive products.	(6.3,4.3)	N/A
8. Identifying major elements of the production system (facilities, tools and equipment).	(5.1,2.0)	(3.2,1.8)

N: non-defence
D: defence

On the other hand, managers involved in defence innovation activities encounter few exceptional cases to deal with but find that problems stemming from these cases are not subject to standard, familiar solutions. Managers explained that even though their firms have a process in place to ensure that defence development is performed “properly”, managers rely on their experience and technical knowledge to achieve results. As one manager described:

“[Our company] has a manual which describes how you go about carrying out [the development process], the steps to go through, the minimum set of requirements that must be met. Although the company has the same process in place for different products, the implementation, the details of the process are left up to the individual. [The company] relies on the written process and on its personnel to ensure that development is done properly.”

Figure 13 classifies mean “technology” scores for “back-end” R&D/engineering non-defence and defence activities. The figure illustrates significant differences in managerial perceptions about the variability and analyzability of the following activities: “Developing prototypes”, “Developing quality strategies”, and “Establishing policies on source selection.” For non-defence products, these activities are characterized as non-routine technologies, whereas for defence products they are characterized as craft technologies.

Figure 13 A Comparison of Non-Defence and Defence Mean “Technology” Scores for “Back-End” R&D/Engineering Activities

LEGEND

Activity	N(V,A)	D(V,A)
9. Creating mockups of the system.	(6.8,3.7)	(5.3,4.7)
10. Developing prototypes.	(5.8,3.2)	(4.0,3.0)
11. Correcting potential problems prior to full scale development.	(5.1,2.7)	(4.7,3.0)
12. Developing quality strategies.	(5.5,2.1)	(3.3,2.2)
13. Establishing policies on source selection.	(5.7,4.8)	(3.5,2.5)
14. Developing maintenance plans.	(3.8,3.8)	(2.1,1.4)
15. Developing operator training plans.	(3.5,2.7)	(2.3,1.5)
16. Creating the production design release.	(2.9,1.6)	(3.0,1.4)

N: non-defence

D: defence

When performing these activities, managers involved in non-defence innovation regularly encounter difficulties that are not readily analyzed. Since time to market is shorter for non-defence products relative to defence products, managers are often compelled to speed up the development of prototypes. However, managers concede that they often find it difficult to do so without compromising important steps of the innovation process. This is often a complicated balancing act, as this manager's comments illustrate:

"To get prototypes out quickly you have to have good control of your design process but at the same time you can't have the process set up so that you have many gates to get through that you'd never get anything done."

Managers are strongly influenced by standards set out by their firm's traditional business. That is, managers have a tendency to apply military quality standards and components to non-defence products. Developing non-defence products to such standards often raises the cost of the product. Managers often find it difficult to attain a balance between quality and cost. As one manager explained:

"[We] still have to maintain a high level of quality but because it costs money things are changing."

On the other hand, managers involved in defence innovation encounter low variety in performing these activities but find that problems arising from them are not analyzable. Managers explained that even though their firms have a process in place for developing prototypes, quality strategies, and establishing policies on source selection, firms

generally rely on the individual manager's experience to effectively carry out these activities.

6.2.3 Key Differences and Discussion

Up to this point, the results have revealed certain similarities in the way that managers involved with non-defence and defence innovation perform innovation activities. Managers rely on their experience and technical knowledge to achieve results. However, key differences have emerged from the data as to the number of exceptional cases that managers must deal with. That is, managers involved in non-defence innovation must deal with more exceptional cases than their defence counterparts. Since non-defence innovation is new for most sample firms, the workflow involves many unexpected demands.

The task firms face is to increase their understanding of non-defence markets. Increased knowledge of non-defence markets may reduce the number of unexpected demands and thus allow for more analytic techniques to be employed. Managers will thus rely on standard procedures rather than on trial-and-error procedures.

6.3 Manufacturing Activities

This section is divided into three sub-sections. The first sub-section examines differences between the amount of resources managers spend on performing manufacturing innovation activities. The second sub-section examines differences in managerial perceptions about the variability and analyzability of manufacturing innovation activities. The third sub-section describes key differences between the innovation process of non-defence and defence products.

6.3.1 Differences Regarding the Amount of Resources Spent

Table 6 lists mean scores for the amount of resources managers spend on manufacturing activities in the case of non-defence products. This table shows that managers commit a significant sum of money and time to "Delivering production quantities of the product to the distribution system." This activity received a mean score of 6.5.

It is important for managers involved in non-defence innovation to deliver the product to the distribution system in as short a time as possible because time to market is critical. As one manager explained:

"The biggest issue for us is time to market. The demand to get a product out to the customer is aggressive."

Table 6 Mean Scores for the Extent of Resources Spent on Performing Manufacturing Activities in the Case of Non-Defence Products (N=3)

"Front-End" Activities	Low	High	Mean
Acquiring major components of the product	4	7	5.667
Assessing manufacturability of the product	4	7	5.333
Undertaking pre-pilot and pilot production runs	2	7	5.0
Preparing manufacturing equipment and tooling	4	5	4.333
Demonstrating that product and process technology meet customer requirements	1	6	4.333
Estimating manufacturing yield and costs	3	6	4.333
Inspecting test cases	2	5	3.333
Implementing deficiencies and correction plans	1	5	3.333
"Back-End" Activities	Low	High	Mean
Delivering production quantities of product to the distribution system	6	7	6.5
Undertaking full-scale production	5	6	5.667
Monitoring suppliers	3	4	3.667
Conducting quality assurance product audits	3	4	3.333
Placing freeze on standard costs	1	6	3.333
Making available anticipated initial service parts requirements	1	4	2.333
Producing installation checkout kits	1	4	2.333

Managers involved with the innovation process of defence products spend less resources on this activity. When asked to gauge the extent of resources spent on “Delivering production quantities of the product to the distribution system”, managers gave it a score of 4.7 (see Table 7). Less emphasis is placed on this activity since time to market is not as critical. In fact, the literature suggests that the time to market for defence products may exceed 10 years (Kumar and Kumar 1993).

Rather, managers commit a considerable sum of money and time to “Undertaking full-scale production.” When asked to gauge the extent of resources spent on this activity, managers gave it a score of 5.8. One manager described the significance of this activity as follows:

“Undertaking full-scale production is an important activity because it requires capital equipment, that we move things around, that we train people, and that we produce the technical data pack.”

Differences between mean scores of the following activities were also found: “Inspecting test cases”, “Implementing deficiencies and corrections plans”, “Monitoring suppliers”, “Conducting assurance product audits”, and “Making available anticipated initial service parts requirements.”

Table 7 Mean Scores for the Extent of Resources Spent on Performing Manufacturing Activities in the Case of Defence Products (N=5)

"Front-End" Activities	Low	High	Mean
Acquiring major components of the product	4	7	5.6
Undertaking pre-pilot and pilot production runs	2	7	5.6
Assessing manufacturability of the product	2	7	5.0
Preparing manufacturing equipment and tooling	4	6	4.8
Demonstrating that product and process technology meet customer requirements	1	7	4.8
Estimating manufacturing yield and costs	3	6	4.4
Inspecting test cases	2	6	4.2
Implementing deficiencies and correction plans	1	6	4.2
"Back-End" Activities	Low	High	Mean
Undertaking full-scale production	4	7	5.8
Delivering production quantities of product to the distribution system	1	7	4.667
Conducting quality assurance product audits	3	7	4.6
Monitoring suppliers	2	6	4.2
Placing freeze on standard costs	1	6	3.5
Making available anticipated initial service parts requirements	1	7	3.4
Producing installation checkout kits	1	6	3.0

Managers involved with non-defence innovation gave lower scores to "Inspecting test cases", "Implementing deficiencies and corrections plans", "Monitoring suppliers", and "Conducting assurance product audits" than their defence counterparts. Managers spend less resources on these activities since they require less documentation to complete. As one manager explained:

"For military manufacturing there is more QA (quality assurance) required, more documentation, more tracability. More time is spent in general on manufacturing activities because of tracability, that is where the product was manufactured, levels of inspection, tests. For commercial manufacturing, the standard is basically that the product has to work."

As for "Making available anticipated initial service parts requirements", managers involved with non-defence innovation also spend less resources on this activity since non-defence products require fewer initial service parts. Generally, military customers request that a large supply of initial service parts be made available to them upon delivery of the product.

6.3.2 Differences in Variability and Analyzability

Figure 14 compares mean "technology" scores for "front-end" manufacturing non-defence and defence activities and Figure 15 compares mean "technology" scores for "back-end" manufacturing non-defence and defence activities. The figures show that mean "technology" scores for both "front-end" and "back-end" manufacturing non-defence and defence activities are clustered in the craft technology quadrant. No significant difference in the variability and analyzability of these activities is found.

Managers involved with non-defence and those involved with defence innovation activities characterize their work in the same way, i.e. they encounter low variety in performing their work activities but find that problems arising from them are not easily analyzable. Managers explained that even though their firms have a production process in place, firms rely on managers' experience and technical know-how to effectively carry out their work. A manager described this as follows:

“We have a formal development process in place. It is documented. The document describes the steps that are to be undertaken. There are deliverables at each step. The methodology is common among [non-defence and defence] products. However, how someone arrives at a deliverable is different.”

6.3.3 Key Differences and Discussion

Key differences regarding the amount of resources spent on various activities have emerged from the data. Managers involved with non-defence innovation spend more resources in getting products “out” to customers since time to market for non-defence products is critical. On the other hand, time to market is less important in the case of defence products. Since defence innovation activities need to be heavily documented, time to market is generally drawn-out.

Although an analysis of managerial perceptions about the variability and analyzability of manufacturing activities revealed no differences between non-defence and defence innovation activities, qualitative data revealed that firms rely heavily on managers'

intuition and experience to deliver non-defence products. Since non-defence innovation is new for most sample firms, managers still depend on a formal production process put in place for defence products. However, managers are expected to adapt this process to non-defence production requirements. For example, since non-defence manufacturing requires less quality assurance than defence manufacturing, managers are expected to put less emphasis on quality assurance activities.

If firms are to succeed at non-defence product development, managers will have to rely on standard procedures rather than on their experience to discriminate between activities that are to be included and those to be left out. The challenge is to develop more analytic techniques. As managers' knowledge of non-defence manufacturing increases, more reliable procedures must be developed.

Figure 14 A Comparison of Non-Defence and Defence Mean “Technology” Scores for “Front-End” Manufacturing Activities

LEGEND

Activity	N(V,A)	D(V,A)
1. Assessing manufacturability of the product.	(2.5.2.0)	(2.6.2.1)
2. Preparing manufacturing equipment and tooling.	(3.2.2.2)	(3.1.2.1)
3. Acquiring major components of the product.	(1.8.1.5)	(3.5.2.2)
4. Undertaking pre-pilot and pilot production runs.	(2.5.1.7)	(2.9.1.9)
5. Inspecting test cases.	(2.5.1.5)	(4.4.1.7)
6. Implementing deficiencies and correction plans.	(1.5.2.2)	(2.4.1.6)
7. Demonstrating that product and process technology meet customer requirements.	(1.0.1.0)	(2.6.1.5)
8. Estimating manufacturing yield and costs.	(2.8.4.0)	(2.9.3.1)

N: non-defence
D: defence

Figure 15 A Comparison of Non-Defence and Defence Mean “Technology” Scores for “Back-End” Manufacturing Activities

7. CONCLUSION

This study has identified and furnished explanations for differences between activities in the innovation process of non-defence and defence products in the electronic sector of the Canadian defence industry.

The study revealed that business development managers involved with non-defence innovation follow a set of well-defined procedures to assess customer "needs". Managers believe that market-oriented activities such as understanding the customer and the marketplace influence product success and thus have circumscribed procedures in order to improve their assessment. This finding is consistent with the long established importance given to understanding users (Maidique and Zirger 1985).

On the other hand, business development managers involved with defence innovation do not follow ordained procedures. Rather, managers depend on their personal contacts in order to assess customer needs. Market development which typifies the way in which non-defence business development managers carry out their work, is in essence, non-existent in defence innovation.

R&D/engineering non-defence innovation managers do not follow a formal process uniquely geared toward developing non-defence products but rather depend on a formal development process put in place for defence products. Consequently, the workflow

involves many unexpected demands. Managers must deal with more exceptional cases than their defence colleagues.

Non-defence manufacturing managers also depend on a development process put in place for defence products. Managers are expected to adapt this process to non-defence production requirements. Managers rely on trial-and-error procedures in order to perform this task.

If firms are to succeed at non-defence new product development, managers will have to rely on standard procedures rather than on trial-and-error procedures. The challenge firms face is to increase their knowledge of non-defence markets. Greater knowledge of non-defence markets will allow firms to develop more analytic techniques. Firms may allow more knowledge to be gained by increasing the number of clients served, accounts handled, research projects underway and so forth.

8. BENEFITS AND IMPLICATIONS OF THE STUDY

The main thrust of the study and prime benefit is in providing public policy makers, researchers, and managers with information on the differences between the innovation processes of defence and non-defence products. Those activities which are dissimilar between processes were identified and explanations as to why these dissimilarities occur were furnished. Since this research exposes the factors which influence the differences between processes, it provides public policy makers with greater information on which to base policy aimed at facilitating the defence industry's transition to commercial markets, and supplies researchers and managers with information on which to base conversion and/or dual-use strategies.

Any successful conversion and/or dual-use programs will depend on regulatory and cultural changes within the Department of Defence and industry. Regulatory changes must allow easier use of commercial specifications and standards. These changes, however, have must be made in conjunction with broad cultural changes within DoD that allow risk-taking and innovation in the procurement process. Defence firms need to reform business practices that stand in the way of conversion.

Although not exhaustive, the study provides a good foundation for future research in the area of defence conversion, which has been scantily explored, especially, in the Canadian context.

9. LIMITATIONS OF THE STUDY

The main limitation of the study is the generalizability of the prospective findings.

The study involved a sample of seven firms in the electronics sector of the Canadian defence industry. The small sample size and single industry focus may reduce the generalizability of the research. The results may not hold true with other members of the electronics sector of the Canadian defence industry, or with other firms in different sectors of the Canadian defence industry.

Defence conversion is a topic that has been largely neglected in the Canadian context, thereby any attempt to understand the phenomenon was, by definition, exploratory in nature.

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Appendix 1 Work Activities in the Case of Non-Defence Product Development

The following exhaustive list details work activities often carried out within each stage of the Stage-Gate System (based on Cooper and Kleinschmidt 1991):

Idea

- idea submitted

Gate 1 - Initial Screen

- a formal decision is made to spend money on the project and the decision is based largely on qualitative and strategic criteria, such as:
 - ⇒ Is the product strategically important to the firm?
 - ⇒ Does technological synergy exist with the firm's internal resources?
 - ⇒ Can the product be sold through the firm's distribution channels?
 - ⇒ Are competitors likely to respond?
 - ⇒ Estimation of market size?

Stage 1 - Preliminary Assessment

- input sought from major user groups through marketing research
- focus on identification of needs
- determine product need and application
- identify ingredients of a winning product
- define the product's features, advantages and benefits based on the defined concept
- assess technical feasibility via searches inside and outside the division
- identify laboratory resources needed to obtain results
- define project team and leader
- develop team mission statement
- develop project plan
- initiate product and business plan

Gate 2 - Second Screen

- justify the product based on estimates of market size, market need, customer needs and competitive products
- make sure that the product business plan has been initiated
- make sure that divisional ownership has been established
- make sure that the marketing division's participation in the program has been designated and that tradeoff decisions on the product direction have been negotiated

- program group and corporate executives review the items, agreed with the risks involved, and commit preliminary resources

Stage 2 - Definition

- propose product concept which satisfies the defined customer requirements
- complete preliminary sketches, models and finish schemes which demonstrate possible product scenarios
- make sure that technology (product and process) exists or is in final stages of development
- define the production process parameters for cost estimates
- define of the competition in detail
- evaluate the competition
- obtain competitive products and make sure that they are ready for assessment
- undertake extensive market research to clarify the market potential and price
- secure an acceptance from key customers - an indication of intent to purchase
- develop detailed plan identifying development work to be undertaken
- assess resources needed and make sure that they are available
- document team allocation of resources
- make sure that risks are explained and identify fallback alternatives

Gate 3 - Decision on Business Case

- make sure that key customer groups have been identified
- make sure that a marketing plan has been initiated
- make sure that detailed financial and competitively assessed timing plans have been formulated
- make sure that potential revenues and sales volumes have been determined
- make sure that value analysis, cost model and cost targets have been completed
- make sure that investments (R&D, capital, prototypes) have been estimated
- make sure that a business plan has been finalized
- make sure that the project schedule is achievable
- make sure that the risk level is acceptable
- make sure that design and manufacturing is feasible
- make sure that resource requirements vs availability have been determined
- make sure that there is a consensus between Marketing and Engineering
- program group and corporate executives approve and agree to commit the specified resources
- gate decision is taken (Go Kill Hold Recycle)

Stage 3 - Development

- submit an appropriation request
- document layout and develop styling drawings, a prototype plan
- select the final prototype based on market information gathered

2

of/de

2

PM-1 3 1/2" x 4" PHOTOGRAPHIC MICROCOPY TARGET
NBS 1010a ANSI/ISO #2 EQUIVALENT

PRECISIONSM RESOLUTION TARGETS

- translate product definition into an in-house test product
- develop component plan
- complete functional allocation to subsystems
- finalize product specs
- specs become under formal change control
- no changes are allowed unless the following are met: demonstrated improvement to customer, clearly understood risk, design and process validated
- produce a fully operational model to demonstrate styling and packaging intent
- develop functional verification test plan
- identify major elements of production system (facilities, tools, equipment) and formulate strategy to complete these elements
- establish policy on source selection which includes extent of early involvement, approvals, limitations on sources, exclusive sourcing and multiple sourcing
- develop a quality strategy
- develop field trial plans
- develop routing and process plans
- develop workplace layout
- develop labour standards
- develop operator training plan
- develop preliminary launch plan
- undertake tests on competitive products
- record patents
- request patent and copyright clearance
- evaluate legal and business practice

Gate 4 - Post-Development Review

- make sure that sales forecast has been updated
- make sure that product cost and profitability has been updated
- make sure that investment estimates have been updated
- make sure that the prototype products meet all aspects of program goals
- evaluate project on the following items: full design details - form, fit, and function
- make sure that engineering and design of manufacturing and assembly facilities, systems, sub-systems, and tooling have been completed and are ready for release
- program group and corporate executives approve and agree to commit necessary resources
- gate decision (Go/Kill/Hold/Recycle)

Stage 4 - Validation

- prepare manufacturing equipment and tooling
- begin pre-pilot and pilot production runs
- inspect test cases
- report problems
- implement deficiencies and correction plans

- implement final verification test cases
- finalize process operating standards
- demonstrate that product and process technology meet customer requirements
- determine qualification of the process and suppliers
- assess whether or not the product is ready to be released to the first field trial customer for verification testing and manufacturing
- define lead customers and make sure that they are committed
- produce the material for sale in market field evaluation
- determine first ship dates, specifically to first field trial customer
- deliver product samples to marketing for market research work
- execute field tests of the product with customers in which the product is assessed during actual applications
- obtain the necessary confidentiality agreements to protect the patent position
- Evaluate customer responses to the field test
- conduct rapid field tracking and correction
- update market penetration strategy and complete competitive assessment
- develop the final launch plan
- establish advertising and merchandising plans for introduction
- develop all necessary support documentation - unit costs, profit & loss statement, return on investment - for the upcoming decision point
- prepare a five-year forecast based on results from product evaluation testing
- prepare first-year sales estimates in units by month for production control
- update investment requirements
- focus on production forecasts and packaging
- confirm that process capability meets volume requirements
- update orders booked
- determine short term inventory
- finalize sales and service programs
- develop service personnel training plan
- administer the capital from the appropriation request
- develop support materials and operations manuals
- clear all special warranties and product claims/applications with Legal

Gate 5 - Pre-Commercialization Decision

- affirm the validated product
- make sure that key markets and revenue streams have been determined
- make sure that market penetration rate has been estimated
- make sure that life cycle profitability has been determined
- make sure that customer satisfaction index is acceptable
- make sure that manufacturing yield and costs have been determined
- approve distribution and support plan
- make sure that systems have been installed at lead plants and readiness has been demonstrated

- make sure that pilot product, built from production part and assembly tooling, passed quality measurement system and final legal certification
- make sure that lead plants are ready for production acceleration
- approve start of continuous production
- make sure that there is team consensus
- Gate decision (Go/Kill/Hold/Recycle)

Stage 5 - Commercialization

- implement manufacturing plan
- implement marketing, distribution and support plans
- complete service manuals, tools, materials and make them available to dealers
- make new-product announcement
- announce support position
- begin full-scale production
- monitor the process and suppliers
- conduct quality assurance product audit
- make available anticipated initial service parts requirements
- promote product
- launch product in the market
- expand sales training
- deliver production quantities of product to the distribution system
- complete quality assurance reports, supplier performance reports, and fabrication quality reports

Post-Implementation Review

- assess product on continuous basis for further refinement and improvement
- place freeze on standard costs
- conduct post mortem on total development cycle

Appendix 2 Work Activities in the Case of Defence Product Development

The following exhaustive list details work activities often carried out within each stage of the innovation process of defence products (based on Kumar and Kumar 1993):

Phase I - Conceptualization of Projects/Programs

- identify requirements from government policy, operational problem, or need to enhance the capability of an existing system

Phase II - Establishment of Requirements and Issuing of Request for Proposal

- organize a PMO
- develop a SOR in consultation with CRAD
- publicize the RFP

Phase III - Proposal Development by Industry

- estimate preliminary budget and schedule
- assess risk
- conduct a requirements analysis
- develop a preliminary design
- develop a draft of logistics
- develop maintenance plan
- develop manufacturing plan
- develop program management strategies
- develop testing plan
- develop production plan

Phase IV - Contract Award

- examine bid proposals from all interested firms
- award the contract to a single firm or come up with a short list of attractive firms and require them to furnish supplementary information which will be examined before any decision is made to award the contract
- grant the contract

Phase V - Final Negotiation

- engage in a series of meetings with the PMO to determine the complete and definitive requirements of the product before engineering development commences
- ensure that the design team is aware and understands the specific design requirements before it starts developing the design
- produce a complete list of contractually imposed military standards and specifications

- agree upon the measures that will be taken to ensure compliance
- finalize budget and schedule estimates
- finalize program development monitoring
- finalize test plans
- finalize system elements acquisition

Phase VI - Design Development

- continually update design analyses through empirical testing
- identify and correct potential problems prior to full scale development
- ensure that adequate reliability and performance margins are achieved
- assess engineering concepts and design approaches
- measure design analyses against appropriate specifications, objectives, and standards
- produce engineering drawings
- create a mockup of the system
- develop software component integration
- produce a preliminary list of tools and special equipment
- develop test specifications
- create the production design release

Phase VII - System Preproduction Implementation and Integration Testing

- produce the first model of the system
- test the first model of the system
- validate the first model of the system
- develop required documentation
- release product design

Phase VIII - System Elements Acquisition

- acquire major components of the product
- acquire special equipment
- acquire fabricating tools
- update product baseline documentation and source/specification control drawings
- finalize manufacturing processes and procedures

Phase IX - Production

- undertake full scale production
- update the design package
- update the product baseline documentation
- update the configuration inspection
- fabricate hardware equipment
- perform qualification tests
- produce installation checkout kits

Phase X - Integration and Qualification

- accomplish engineering qualification and integration tests
- produce tests reports
- update all necessary documentation
- deliver or install product

Appendix 3 Grouping of Non-Defence and Defence Work Activities by Functional Departments of the Firm

The following list groups work activities within the innovation processes of defence and non-defence products, and categorizes them by functional departments of the firm.

Part 1 Activities undertaken by Business Development/Sales

- idea for new product submitted to business development sales
- identify new product requirements from government policy, operational problem, or need to enhance the capability of an existing system
- informed about a RFP
- business development sales requests that a formal decision be made to spend money on the project - the decision is based largely on qualitative and strategic criteria, such as:
 - ⇒ Is the product strategically important to the firm?
 - ⇒ Does technological synergy exist with the firm's internal resources?
 - ⇒ Can the product be sold through the firm's distribution channels?
 - ⇒ Are competitors likely to respond?
 - ⇒ Estimation of market size?
- input is sought from major user groups through marketing research
- focus on identification of needs
- determine product need and application
- identify ingredients of a winning product
- define the product's features, advantages and benefits based on the defined concept
- define project team and leader
- develop team mission statement
- develop project plan
- initiate product and business plan
- develop proposal
- justify the product based on estimates of market size, market need, customer needs and competitive products
- make sure that the product business plan has been initiated
- develop program management strategies
- make sure that divisional ownership has been established
- make sure that the marketing division's participation in the program has been designated and that tradeoff decisions on the product direction have been negotiated
- finalize program development monitoring
- program group and corporate executives review the items, agreed with the risks involved, and commit preliminary resources
- propose product concept which satisfies the defined customer requirements

- define of the competition in detail
- evaluate the competition
- obtain competitive products and make sure that they are ready for assessment
- undertake extensive market research to clarify the market potential and price
- secure an acceptance from key customers - an indication of intent to purchase
- develop detailed plan identifying development work to be undertaken
- assess resources needed and make sure that they are available
- document team allocation of resources
- assess risk
- make sure that risks are explained and identify fallback alternatives
- make sure that key customer groups have been identified
- make sure that a marketing plan has been initiated
- make sure that detailed financial and competitively assessed timing plans have been formulated
- make sure that potential revenues and sales volumes have been determined
- make sure that value analysis, cost model and cost targets have been completed
- make sure that investments (R&D, capital, prototypes) have been estimated
- make sure that a business plan has been finalized
- make sure that the project schedule is achievable
- make sure that the risk level is acceptable
- make sure that resource requirements vs availability have been determined
- make sure that there is a consensus between Marketing and Engineering
- program group and corporate executives approve and agree to commit the specified resources
- develop field trial plans
- develop preliminary launch plan
- make sure that sales forecast has been updated
- make sure that product cost and profitability has been updated
- make sure that investment estimates have been updated
- assess whether or not the product is ready to be released to the first field trial customer for verification testing and manufacturing
- define lead customers and make sure that they are committed
- produce the material for sale in market field evaluation
- determine first ship dates, specifically to first field trial customer
- deliver product samples to marketing for market research work
- execute field tests of the product with customers in which the product is assessed during actual applications
- obtain the necessary confidentiality agreements to protect the patent position
- Evaluate customer responses to the field test
- conduct rapid field tracking and correction
- update market penetration strategy and complete competitive assessment
- develop the final launch plan
- establish advertising and merchandising plans for introduction

- develop all necessary support documentation - unit costs, profit & loss statement, return on investment
- prepare a five-year forecast based on results from product evaluation testing
- prepare first-year sales estimates in units by month for production control
- update investment requirements
- focus on production forecasts and packaging
- confirm that process capability meets volume requirements
- update orders booked
- determine short term inventory
- finalize sales and service programs
- develop service personnel training plan
- administer the capital from the appropriation request
- make sure that key markets and revenue streams have been determined
- make sure that market penetration rate has been estimated
- make sure that life cycle profitability has been determined
- make sure that customer satisfaction index is acceptable
- make sure that distribution and support plan have been approved
- implement marketing, distribution and support plans
- complete service manuals, tools, materials and make them available to dealers
- make new-product announcement
- announce support position
- promote product
- launch product in the market
- expand sales training
- deliver or install product
- assess product on continuous basis for further refinement and improvement
- conduct post mortem on total development cycle

Part 2 Activities undertaken by R&D/Engineering

- engage in a series of meetings with the PMO to determine the complete and definitive requirements of the product before engineering development commences
- ensure that the design team is aware and understands the specific design requirements before it starts developing the design
- produce a complete list of contractually imposed military standards and specifications
- agree upon the measures that will be taken to ensure compliance
- assess technical feasibility via searches inside and outside the division
- identify laboratory resources needed to obtain results
- develop a set of specifications together with more detailed program plans
- complete preliminary sketches, models and finish schemes which demonstrate possible product scenarios
- make sure that technology (product and process) exists or is in final stages of development

- develop a draft of logistics
- develop software component integration
- define the production process parameters for cost estimates
- continually update design analyses through empirical testing
- make sure that design is feasible
- submit an appropriation request
- assess engineering concepts and design approaches
- measure design analyses against appropriate specifications, objectives, and standards
- document layout
- develop styling drawings
- produce engineering drawings
- develop a prototype plan
- select the final prototype based on market information gathered
- translate product definition into an in-house test product
- develop component plan
- complete functional allocation to subsystems
- identify and correct potential problems prior to full scale development
- finalize product specs
- specs become under formal change control
- no changes are allowed unless the following are met: demonstrated improvement to customer, clearly understood risk, design and process validated
- produce a fully operational model to demonstrate styling and packaging intent
- develop functional verification test plan
- develop maintenance plan
- identify major elements of production system (facilities, tools, equipment) and formulate strategy to complete these elements
- establish policy on source selection which includes extent of early involvement, approvals, limitations on sources, exclusive sourcing and multiple sourcing
- develop a quality strategy
- develop routing and process plans
- develop workplace layout
- develop labour standards
- develop operator training plan
- undertake tests on competitive products
- record patents
- request patent and copyright clearance
- evaluate legal and business practice
- make sure that the prototype products meet all aspects of program goals
- accomplish engineering qualification and integration tests
- ensure that adequate reliability and performance margins are achieved
- evaluate project on the following items: full design details - form, fit, and function
- make sure that engineering and design of manufacturing and assembly facilities, systems, sub-systems, and tooling have been completed and are ready for release
- create a mockup of the system

- create the production design release
- develop support materials and operations manuals
- clear all special warranties and product claims applications with Legal

Part 3 Activities undertaken by Manufacturing

- make sure that manufacturability is feasible
- prepare manufacturing equipment and tooling
- acquire major components of the product
- begin pre-pilot and pilot production runs
- inspect test cases
- produce tests reports
- report problems
- implement deficiencies and correction plans
- implement final verification test cases
- finalize process operating standards
- demonstrate that product and process technology meet customer requirements
- determine qualification of the process and suppliers
- make sure that manufacturing yield and costs have been determined
- make sure that systems have been installed at lead plants and readiness has been demonstrated
- make sure that pilot product, built from production part and assembly tooling, passed quality measurement system and final legal certification
- make sure that lead plants are ready for production acceleration
- start of continuous production has been approved
- update the configuration inspection
- make sure that there is team consensus
- implement manufacturing plan
- begin full-scale production
- monitor the process and suppliers
- conduct quality assurance product audit
- perform qualification tests
- make available anticipated initial service parts requirements
- produce installation checkout kits
- deliver production quantities of product to the distribution system
- complete quality assurance reports, supplier performance reports, and fabrication quality reports
- place freeze on standard costs

Appendix 4 Request Letter Provided to Respondents Prior to the Interview

Attn:

Dear Sir or Madam

Re: Research of the innovation processes of defence and non-defence products

Mr. Stephane Silber, one of our graduate students, is conducting a research study of the innovation processes of defence and non-defence products in the Canadian electronic industry in fulfilment of his master's thesis requirement under my supervision. This study has two objectives: the first is to identify the differences between activities in the innovation process of defence and non-defence products; the second is to provide some explanation for these differences. As your firm is one of the leading innovating firms, your participation in this study would be greatly appreciated.

We will be asking you for an interview which will last no more than one hour. This session will include open ended questions where you will be asked to describe your department's contribution to the new product development process of a non-defence (defence) product. You will also be asked to complete a questionnaire after the interview session. The questionnaire takes approximately twenty minutes to complete.

All interview and questionnaires responses will be kept strictly confidential. If desired, a summary report will be made available.

I appreciate your assistance as your help is essential to conduct this study.

Yours Sincerely,

Vinod Kumar, Ph.D., P.Eng
Professor of Technology Management and
Director, School of Business

Appendix 5 Interview Guide

PART 1 - SECTION 1

Question 1

- a) Company name _____
- b) Respondent's name _____
- c) Respondent's department _____
- d) Respondent's position _____

Question 2

Many firms follow a series of steps during the innovation process. Please describe your department's contribution to the new product development process of a non-defence product.

THE INTERVIEWER WILL MAKE IT CLEAR TO THE INTERVIEWEE THAT THE WORDS "INNOVATION PROCESS" AND "NEW PRODUCT DEVELOPMENT PROCESS" ARE USED SYNONYMOUSLY.

Probes

- a) What was the starting phase of the innovation process?

THIS PROBE WILL INDICATE WHETHER THE NEW PRODUCT IDEA WAS OBTAINED FROM THE USER OR FROM A SOURCE OTHER THAN THE USER.

- b) Did you conduct market research?

THIS PROBE WILL INDICATE WHETHER A MARKET ANALYSIS WAS UNDERTAKEN TO DEFINE THE CUSTOMER AND WHETHER INPUT WAS SOUGHT FROM MAJOR USER GROUPS.

- c) Were financial estimates assessed?

THIS PROBE WILL INDICATE WHETHER POTENTIAL REVENUES AND SALES VOLUMES WERE DETERMINED.

- d) To what extent is there a clearly defined body of knowledge which can guide you in performing these activities?

THIS PROBE WILL MEASURE THE EXTENT OF ANALYZABILITY OF ACTIVITIES.

- e) How often can you confidently predict the results of performing these activities?

THIS PROBE WILL MEASURE THE EXTENT OF ANALYZABILITY OF ACTIVITIES.

- f) To what extent are these activities the same for different products?

THIS PROBE WILL MEASURE THE EXTENT OF VARIABILITY OF ACTIVITIES.

- g) To what extent different ways or approaches are used to perform these activities?

THIS PROBE WILL MEASURE THE EXTENT OF VARIABILITY OF ACTIVITIES.

THE INTERVIEWER WILL ASK THE INTERVIEWEE TO COMPLETE THE QUESTIONNAIRE. ONCE COMPLETED THE INTERVIEWER WILL ASK THE INTERVIEWEE THE FOLLOWING QUESTION:

- h) Please describe the reasons why [activities which obtain a score of 6 or 7 in section 1A of the questionnaire] have a substantial amount of resources (money or time) spent on them.

THIS PROBE WILL PROVIDE EXPLANATIONS AS TO WHY CERTAIN ACTIVITIES HAVE A SUBSTANTIAL AMOUNT OF RESOURCES SPENT ON THEM.

PART 1 - SECTION 2**Question 1**

- a) Company name _____
- b) Respondent's name _____
- c) Respondent's department _____
- d) Respondent's position _____

Question 2

Many firms follow a series of steps during the innovation process. Please describe your department's contribution to the new product development process of a defence product.

THE INTERVIEWER WILL MAKE IT CLEAR TO THE INTERVIEWEE THAT THE WORDS "INNOVATION PROCESS" AND "NEW PRODUCT DEVELOPMENT PROCESS" ARE USED SYNONYMOUSLY.

Probes

- a) What was the starting phase of the innovation process?

THIS PROBE WILL INDICATE WHETHER THE NEW PRODUCT IDEA WAS OBTAINED FROM A RFP OR FROM A SOURCE OTHER THAN THE GOVERNMENT.

- b) Did you conduct any market research?

THIS PROBE WILL DETERMINE THE FOCUS OF MARKETING RESEARCH IN THE INNOVATION PROCESS OF DEFENCE PRODUCTS (I.E. IS THE FOCUS PLACED ON THE CUSTOMER, COMPETITORS, OR BOTH).

- c) Were financial estimates assessed?

THIS PROBE WILL INDICATE WHETHER POTENTIAL REVENUES AND SALES VOLUMES AND WERE DETERMINED.

- d) To what extent is there a clearly defined body of knowledge which can guide you in performing these activities?

THIS PROBE WILL MEASURE THE EXTENT OF ANALYZABILITY OF ACTIVITIES.

- e) How often can you confidently predict the results of performing these activities?**

THIS PROBE WILL MEASURE THE EXTENT OF ANALYZABILITY OF ACTIVITIES.

- f) To what extent are these activities the same for different products?**

THIS PROBE WILL MEASURE THE EXTENT OF VARIABILITY OF ACTIVITIES.

- g) To what extent different ways or approaches are used to perform these activities?**

THIS PROBE WILL MEASURE THE EXTENT OF VARIABILITY OF ACTIVITIES.

THE INTERVIEWER WILL ASK THE INTERVIEWEE TO COMPLETE THE QUESTIONNAIRE. ONCE COMPLETED THE INTERVIEWER WILL ASK THE INTERVIEWEE THE FOLLOWING QUESTION:

- h) Please describe the reasons why [activities which obtain a score of 6 or 7 in section 2A of the questionnaire] have a substantial amount of resources (money or time) spent on them.**

THIS PROBE WILL PROVIDE EXPLANATIONS AS TO WHY CERTAIN ACTIVITIES HAVE A SUBSTANTIAL AMOUNT OF RESOURCES SPENT ON THEM.

PART 2 - SECTION 1**Question 1**

- a) Company name _____
- b) Respondent's name _____
- c) Respondent's department _____
- d) Respondent's position _____

Question 2

Many firms follow a series of steps during the innovation process. Please describe your department's contribution to the new product development process of a non-defence product.

THE INTERVIEWER WILL MAKE IT CLEAR TO THE INTERVIEWEE THAT THE WORDS "INNOVATION PROCESS" AND "NEW PRODUCT DEVELOPMENT PROCESS" ARE USED SYNONYMOUSLY.

Probes

- a) Were new product specifications based on user needs and wants?

THIS PROBE WILL INDICATE WHETHER PRODUCT SPECIFICATIONS ARE DEVELOPED IN CONSULTATION WITH THE CUSTOMER.

- b) Did you adhere to any type of standards?

THIS PROBE WILL INDICATE THE IMPORTANCE OF STANDARDS WITHIN THE INNOVATION PROCESS OF NON-DEFENCE PRODUCTS.

- c) To what extent is there a clearly defined body of knowledge which can guide you in performing these activities?

THIS PROBE WILL MEASURE THE EXTENT OF ANALYZABILITY OF ACTIVITIES.

- d) How often can you confidently predict the results of performing these activities?

THIS PROBE WILL MEASURE THE EXTENT OF ANALYZABILITY OF ACTIVITIES.

- e) To what extent are these activities the same for different products?

THIS PROBE WILL MEASURE THE EXTENT OF VARIABILITY OF ACTIVITIES.

- f) To what extent different ways or approaches are used to perform these activities?

THIS PROBE WILL MEASURE THE EXTENT OF VARIABILITY OF ACTIVITIES.

THE INTERVIEWER WILL ASK THE INTERVIEWEE TO COMPLETE THE QUESTIONNAIRE. ONCE COMPLETED THE INTERVIEWER WILL ASK THE INTERVIEWEE THE FOLLOWING QUESTION:

- g) Please describe the reasons why [activities which obtain a score of 6 or 7 in section 1A of the questionnaire] have a substantial amount of resources (money or time) spent on them.

THIS PROBE WILL PROVIDE EXPLANATIONS AS TO WHY CERTAIN ACTIVITIES HAVE A SUBSTANTIAL AMOUNT OF RESOURCES SPENT ON THEM.

PART 2 - SECTION 2**Question 1**

- a) Company name _____
- b) Respondent's name _____
- c) Respondent's department _____
- d) Respondent's position _____

Question 2

Many firms follow a series of steps during the innovation process. Please describe your department's contribution to the new product development process of a defence product.

THE INTERVIEWER WILL MAKE IT CLEAR TO THE INTERVIEWEE THAT THE WORDS "INNOVATION PROCESS" AND "NEW PRODUCT DEVELOPMENT PROCESS" ARE USED SYNONYMOUSLY.

Probes

- a) Were new product specifications based on user needs and wants?

THIS PROBE WILL INDICATE THE IMPORTANCE OF INTERACTIONS BETWEEN THE FIRM AND MILITARY DEPARTMENTS.

- b) Did you adhere to any type of standards?

THIS PROBE WILL INDICATE THE IMPORTANCE OF MILITARY STANDARDS WITHIN THE INNOVATION PROCESS OF DEFENCE PRODUCTS.

- c) To what extent is there a clearly defined body of knowledge which can guide you in performing these activities?

THIS PROBE WILL MEASURE THE EXTENT OF ANALYZABILITY OF ACTIVITIES.

- d) How often can you confidently predict the results of performing these activities?

THIS PROBE WILL MEASURE THE EXTENT OF ANALYZABILITY OF ACTIVITIES.

- e) To what extent are these activities the same for different products?

THIS PROBE WILL MEASURE THE EXTENT OF VARIABILITY OF ACTIVITIES.

- f) To what extent different ways or approaches are used to perform these activities?

THIS PROBE WILL MEASURE THE EXTENT OF VARIABILITY OF ACTIVITIES.

THE INTERVIEWER WILL ASK THE INTERVIEWEE TO COMPLETE THE QUESTIONNAIRE. ONCE COMPLETED THE INTERVIEWER WILL ASK THE INTERVIEWEE THE FOLLOWING QUESTION:

- g) Please describe the reasons why [activities which obtain a score of 6 or 7 in section 2A of the questionnaire] have a substantial amount of resources (money or time) spent on them.

THIS PROBE WILL PROVIDE EXPLANATIONS AS TO WHY CERTAIN ACTIVITIES HAVE A SUBSTANTIAL AMOUNT OF RESOURCES SPENT ON THEM.

PART 3 - SECTION 1**Question 1**

- a) Company name _____
- b) Respondent's name _____
- c) Respondent's department _____
- d) Respondent's position _____

Question 2

Many firms follow a series of steps during the innovation process. Please describe your department's contribution to the new product development process of a non-defence product.

THE INTERVIEWER WILL MAKE IT CLEAR TO THE INTERVIEWEE THAT THE WORDS "INNOVATION PROCESS" AND "NEW PRODUCT DEVELOPMENT PROCESS" ARE USED SYNONYMOUSLY.

Probes

- a) Is the manufacturability of new products determined early-on in the development process?

THIS PROBE WILL INDICATE WHETHER MANUFACTURING WAS INVOLVED IN THE INNOVATION PROCESS FROM AN EARLY STAGE.

- b) To what extent is there a clearly defined body of knowledge which can guide you in performing these activities?

THIS PROBE WILL MEASURE THE EXTENT OF ANALYZABILITY OF ACTIVITIES.

- c) How often can you confidently predict the results of performing these activities?

THIS PROBE WILL MEASURE THE EXTENT OF ANALYZABILITY OF ACTIVITIES.

- d) To what extent are these activities the same for different products?

THIS PROBE WILL MEASURE THE EXTENT OF VARIABILITY OF ACTIVITIES.

- e) To what extent different ways or approaches are used to perform these activities?**

THIS PROBE WILL MEASURE THE EXTENT OF VARIABILITY OF ACTIVITIES.

THE INTERVIEWER WILL ASK THE INTERVIEWEE TO COMPLETE THE QUESTIONNAIRE. ONCE COMPLETED THE INTERVIEWER WILL ASK THE INTERVIEWEE THE FOLLOWING QUESTION:

- f) Please describe the reasons why [activities which obtain a score of 6 or 7 in section 1A of the questionnaire] have a substantial amount of resources (money or time) spent on them.**

THIS PROBE WILL PROVIDE EXPLANATIONS AS TO WHY CERTAIN ACTIVITIES HAVE A SUBSTANTIAL AMOUNT OF RESOURCES SPENT ON THEM.

PART 3 - SECTION 2**Question 1**

- a) Company name _____
- b) Respondent's name _____
- c) Respondent's department _____
- d) Respondent's position _____

Question 2

Many firms follow a series of steps during the innovation process. Please describe your department's contribution to the new product development process of a defence product.

THE INTERVIEWER WILL MAKE IT CLEAR TO THE INTERVIEWEE THAT THE WORDS "INNOVATION PROCESS" AND "NEW PRODUCT DEVELOPMENT PROCESS" ARE USED SYNONYMOUSLY.

Probes

- a) Is the manufacturability of new products determined early-on in the development process?

THIS PROBE WILL INDICATE WHETHER MANUFACTURING WAS INVOLVED IN THE INNOVATION PROCESS FROM AN EARLY STAGE.

- b) To what extent is there a clearly defined body of knowledge which can guide you in performing these activities?

THIS PROBE WILL MEASURE THE EXTENT OF ANALYZABILITY OF ACTIVITIES.

- c) How often can you confidently predict the results of performing these activities?

THIS PROBE WILL MEASURE THE EXTENT OF ANALYZABILITY OF ACTIVITIES.

- d) To what extent are these activities the same for different products?

THIS PROBE WILL MEASURE THE EXTENT OF VARIABILITY OF ACTIVITIES.

- e) To what extent different ways or approaches are used to perform these activities?

THIS PROBE WILL MEASURE THE EXTENT OF VARIABILITY OF ACTIVITIES.

THE INTERVIEWER WILL ASK THE INTERVIEWEE TO COMPLETE THE QUESTIONNAIRE. ONCE COMPLETED THE INTERVIEWER WILL ASK THE INTERVIEWEE THE FOLLOWING QUESTION:

- f) Please describe the reasons why [activities which obtain a score of 6 or 7 in section 2A of the questionnaire] have a substantial amount of resources (money or time) spent on them.

THIS PROBE WILL PROVIDE EXPLANATIONS AS TO WHY CERTAIN ACTIVITIES HAVE A SUBSTANTIAL AMOUNT OF RESOURCES SPENT ON THEM.

Appendix 6 Questionnaire Key

PART 1 - SECTION 1A

Activities described in Appendix 3 Part 1 are tested.

Information is sought on the extent of resources (money or time) spent on performing these activities.

Questions are directed towards a manager involved with the new product development process of non-defence products.

PART 1 - SECTION 1B

Activities described in Appendix 3 Part 1 are again tested. However, this time information is sought on:

1. the extent of a clearly defined body of knowledge which can guide managers in performing these activities;
2. how often managers can confidently predict the results of performing these activities;
3. to what extent these activities are the same for different products;
4. and, to what extent are different ways or approaches used to perform these activities.

Measures 1 and 2 gauge the extent of analyzability of activities while measures 3 and 4 gauge the extent of variability of activities.

Questions are directed towards the same respondent as in part 1 - section 1A.

PART 1 - SECTION 2A

Activities described in Appendix 3 Part 1 are tested.

Information is sought on the extent of resources (money or time) spent on performing these activities.

Questions are directed towards a manager involved with the new product development process of defence products.

PART 1 - SECTION 2B

Activities described in Appendix 3 Part 1 are again tested. However, this time information is sought on:

1. the extent of a clearly defined body of knowledge which can guide managers in performing these activities;
2. how often managers can confidently predict the results of performing these activities;
3. to what extent these activities are the same for different products;
4. and, to what extent are different ways or approaches used to perform these activities.

Measures 1 and 2 gauge the extent of analyzability of activities while measures 3 and 4 gauge the extent of variability of activities.

Questions are directed towards the same respondent as in part 1 - section 2A.

PART 2 - SECTION 1A

Activities described in Appendix 3 Part 2 are tested.

Information is sought on the extent of resources (money or time) spent on performing these activities.

Questions are directed towards a manager involved with the new product development process of non-defence products.

PART 2 - SECTION 1B

Activities described in Appendix 3 Part 2 are again tested. However, this time information is sought on:

1. the extent of a clearly defined body of knowledge which can guide managers in performing these activities;
2. how often managers can confidently predict the results of performing these activities;
3. to what extent these activities are the same for different products;
4. and, to what extent are different ways or approaches used to perform these activities.

Measures 1 and 2 gauge the extent of analyzability of activities while measures 3 and 4 gauge the extent of variability of activities.

Questions are directed towards the same respondent as in part 2 - section 1A.

PART 2 - SECTION 2A

Activities described in Appendix 3 Part 2 are tested.

Information is sought on the extent of resources (money or time) spent on performing these activities.

Questions are directed towards a manager involved with the new product development process of defence products.

PART 2 - SECTION 2B

Activities described in Appendix 3 Part 2 are again tested. However, this time information is sought on:

1. the extent of a clearly defined body of knowledge which can guide managers in performing these activities;
2. how often managers can confidently predict the results of performing these activities;
3. to what extent these activities are the same for different products;
4. and, to what extent are different ways or approaches used to perform these activities.

Measures 1 and 2 gauge the extent of analyzability of activities while measures 3 and 4 gauge the extent of variability of activities.

Questions are directed towards the same respondent as in part 2 - section 2A.

PART 3 - SECTION 1A

Activities described in Appendix 3 Part 3 are tested.

Information is sought on the extent of resources (money or time) spent on performing these activities.

Questions are directed towards a manager involved with the new product development process of non-defence products.

PART 3 - SECTION 1B

Activities described in Appendix 3 Part 3 are again tested. However, this time information is sought on:

1. the extent of a clearly defined body of knowledge which can guide managers in performing these activities;
2. how often managers can confidently predict the results of performing these activities;
3. to what extent these activities are the same for different products;
4. and, to what extent are different ways or approaches used to perform these activities.

Measures 1 and 2 gauge the extent of analyzability of activities while measures 3 and 4 gauge the extent of variability of activities.

Questions are directed towards the same respondent as in part 3 - section 1A.

PART 3 - SECTION 2A

Activities described in Appendix 3 Part 3 are tested.

Information is sought on the extent of resources (money or time) spent on performing these activities.

Questions are directed towards a manager involved with the new product development process of defence products.

PART 3 - SECTION 2B

Activities described in Appendix 3 Part 3 are again tested. However, this time information is sought on:

1. the extent of a clearly defined body of knowledge which can guide managers in performing these activities;
2. how often managers can confidently predict the results of performing these activities;
3. to what extent these activities are the same for different products;
4. and, to what extent are different ways or approaches used to perform these activities.

Measures 1 and 2 gauge the extent of analyzability of activities while measures 3 and 4 gauge the extent of variability of activities.

Questions are directed towards the same respondent as in part 3 - section 2A.

Appendix 7 Questionnaire**QUESTIONNAIRE**

This questionnaire is designed to identify the differences between the innovation processes of defence and non-defence products. The questionnaire will take a maximum of 30 minutes of your time. Your responses will help me understand the differences between activities in the new product development process of defence and non-defence products more completely than possible by reading the available literature. There is no right or wrong answer. Rather, your experience will provide valuable insight. Your confidentiality is guaranteed. Only aggregated results will be published, neither you nor your company will be identified in any document. Your help is greatly appreciated.

Company name:

Company sales:

Your department:

Your position:

PART 1 - SECTION 1A

The following is a list of activities that may occur within the new product development process of non-defence products. For each activity listed, you will be asked to gauge the extent of resources (money or time) spent on performing the activity.

Please weigh each activity on a scale of 1-7, where 1 represents very little resources (money or time) spent on performing the activity within the new product development process of non-defence products, and 7 signifies substantial resources (money or time) spent on performing the activity within the new product development process of non-defence products. Please circle the appropriate response.

Before proceeding, please think of non-defence projects which you are involved with and use these projects as a frame of reference when responding.

1. Obtaining product ideas from the user.	1	2	3	4	5	6	7
2. Obtaining product ideas from a source other than the user.	1	2	3	4	5	6	7
3. Responding to a Request for Proposal (RFP).	1	2	3	4	5	6	7
4. Developing a product concept which satisfies customer requirements.	1	2	3	4	5	6	7
5. Estimating potential revenues and sales volumes.	1	2	3	4	5	6	7
6. Estimating required investments (R&D, capital, prototypes).	1	2	3	4	5	6	7
7. Assessing technical risks.	1	2	3	4	5	6	7

8. Identifying and evaluating the competition.	1	2	3	4	5	6	7
9. Developing project management strategies.	1	2	3	4	5	6	7
10. Designing fallback alternatives.	1	2	3	4	5	6	7
11. Developing marketing plans.	1	2	3	4	5	6	7
12. Assessing competitive products.	1	2	3	4	5	6	7
13. Committing lead customers.	1	2	3	4	5	6	7
14. Administering field tests.	1	2	3	4	5	6	7
15. Obtaining feedback from users to confirm acceptance.	1	2	3	4	5	6	7
16. Conducting field tracking and correction.	1	2	3	4	5	6	7
17. Confirming that process capability meets volume requirements.	1	2	3	4	5	6	7
18. Developing sales programs for the product.	1	2	3	4	5	6	7
19. Making service related material available to dealers.	1	2	3	4	5	6	7
20. Installing the product.	1	2	3	4	5	6	7
21. Assessing the product on a continuous basis for further refinement.	1	2	3	4	5	6	7
22. Conducting a review of the total development cycle.	1	2	3	4	5	6	7

PART 1 - SECTION 1B

The following is a list of activities that may occur within the new product development process of non-defence products. For each activity listed, you will be asked to:

1. identify the extent of a clearly defined body of knowledge to guide you in performing the activity;
2. identify how often you can confidently predict the results of performing the activity;
3. identify to what extent the activity is much the same for different products;
4. and, identify to what extent different ways or approaches are used to perform the activity.

Please circle the appropriate response.

*Before proceeding, please think of **non-defence projects** which you are involved with and use these projects as a frame of reference when responding to the following questions.*

THE FOLLOWING QUESTIONS WERE ASKED OF ALL OF THE ACTIVITIES LISTED BELOW

To what extent is there a clearly defined body of knowledge to guide you in this activity?

ill-defined body 1 2 3 4 5 6 7 8 9 10 well-defined body

How often can you confidently predict the results of this activity?

never 1 2 3 4 5 6 7 8 9 10 always

To what extent is this activity much the same for different products?

same 1 2 3 4 5 6 7 8 9 10 different

To what extent different ways or approaches are used to perform this activity?

same 1 2 3 4 5 6 7 8 9 10 different

1. Obtaining product ideas from the user.
2. Obtaining product ideas from a source other than the user.
3. Responding to a Request for Proposal (RFP).
4. Developing a product concept which satisfies customer requirements.
5. Estimating potential revenues and sales volumes.
6. Estimating required investments (R&D, capital, prototypes).
7. Assessing technical risks.
8. Identifying and evaluating the competition.
9. Developing project management strategies.
10. Designing fallback alternatives.
11. Developing marketing plans.
12. Assessing competitive products.
13. Committing lead customers.
14. Administering field tests.
15. Obtaining feedback from users to confirm acceptance.
16. Conducting field tracking and correction.
17. Confirming that process capability meets volume requirements.
18. Developing sales programs for the product.
19. Making service related materials available to dealers.
20. Installing the product.
21. Assessing the product on a continuous basis for further refinement.
22. Conducting a review of the total development cycle.

Thank you very much for your time and effort.

PART 1 - SECTION 2A

The following is a list of activities that may occur within the new product development process of defence products. For each activity listed, you will be asked to gauge the extent of resources (money or time) spent on performing the activity.

Please weigh each activity on a scale of 1-7, where 1 represents very little resources (money or time) spent on performing the activity within the new product development process of defence products, and 7 signifies substantial resources (money or time) spent on performing the activity within the new product development process of defence products. Please circle the appropriate response.

*Before proceeding, please think of **defence projects** which you are involved with and use these projects as a frame of reference when responding.*

1. Obtaining product ideas from the user.	1	2	3	4	5	6	7
2. Obtaining product ideas from a source other than the user.	1	2	3	4	5	6	7
3. Responding to a Request for Proposal (RFP).	1	2	3	4	5	6	7
4. Developing a product concept which satisfies customer requirements.	1	2	3	4	5	6	7
5. Estimating potential revenues and sales volumes.	1	2	3	4	5	6	7
6. Estimating required investments (R&D, capital, prototypes).	1	2	3	4	5	6	7
7. Assessing technical risks.	1	2	3	4	5	6	7

8. Identifying and evaluating the competition.	1	2	3	4	5	6	7
9. Developing project management strategies.	1	2	3	4	5	6	7
10. Designing fallback alternatives.	1	2	3	4	5	6	7
11. Developing marketing plans.	1	2	3	4	5	6	7
12. Assessing competitive products.	1	2	3	4	5	6	7
13. Committing lead customers.	1	2	3	4	5	6	7
14. Administering field tests.	1	2	3	4	5	6	7
15. Obtaining feedback from users to confirm acceptance.	1	2	3	4	5	6	7
16. Conducting field tracking and correction.	1	2	3	4	5	6	7
17. Confirming that process capability meets volume requirements.	1	2	3	4	5	6	7
18. Developing sales programs for the product.	1	2	3	4	5	6	7
19. Making service related material available to dealers.	1	2	3	4	5	6	7
20. Installing the product.	1	2	3	4	5	6	7
21. Assessing the product on a continuous basis for further refinement.	1	2	3	4	5	6	7
22. Conducting a review of the total development cycle.	1	2	3	4	5	6	7

PART 1 - SECTION 2B

The following is a list of activities that may occur within the new product development process of defence products. For each activity listed, you will be asked to:

1. identify the extent of a clearly defined body of knowledge to guide you in performing the activity;
2. identify how often you can confidently predict the results of performing the activity;
3. identify to what extent the activity is much the same for different products;
4. and, identify to what extent different ways or approaches are used to perform the activity.

Please circle the appropriate response.

*Before proceeding, please think of **defence projects** which you are involved with and use these projects as a frame of reference when responding to the following questions.*

THE FOLLOWING QUESTIONS WERE ASKED OF ALL OF THE ACTIVITIES LISTED BELOW

To what extent is there a clearly defined body of knowledge to guide you in this activity?

ill-defined body 1 2 3 4 5 6 7 8 9 10 well-defined body

How often can you confidently predict the results of this activity?

never 1 2 3 4 5 6 7 8 9 10 always

To what extent is this activity much the same for different products?

same 1 2 3 4 5 6 7 8 9 10 different

To what extent different ways or approaches are used to perform this activity?

same 1 2 3 4 5 6 7 8 9 10 different

1. Obtaining product ideas from the user.
2. Obtaining product ideas from a source other than the user.
3. Responding to a Request for Proposal (RFP).
4. Developing a product concept which satisfies customer requirements.
5. Estimating potential revenues and sales volumes.
6. Estimating required investments (R&D, capital, prototypes).
7. Assessing technical risks.
8. Identifying and evaluating the competition.
9. Developing project management strategies.
10. Designing fallback alternatives.
11. Developing marketing plans.
12. Assessing competitive products.
13. Committing lead customers.
14. Administering field tests.
15. Obtaining feedback from users to confirm acceptance.
16. Conducting field tracking and correction.
17. Confirming that process capability meets volume requirements.
18. Developing sales programs for the product.
19. Making service related materials available to dealers.
20. Installing the product.
21. Assessing the product on a continuous basis for further refinement.
22. Conducting a review of the total development cycle.

Thank you very much for your time and effort.

PART 2 - SECTION 1A

The following is a list of activities that may occur within the new product development process of non-defence products. For each activity listed, you will be asked to gauge the extent of resources (money or time) spent on performing the activity.

Please weigh each activity on a scale of 1-7, where 1 represents very little resources (money or time) spent on performing the activity within the new product development process of non-defence products, and 7 signifies substantial resources (money or time) spent on performing the activity within the new product development process of non-defence products. Please circle the appropriate response.

*Before proceeding, please think of **non-defence projects** which you are involved with and use these projects as a frame of reference when responding.*

1. Developing product specifications based on user needs and wants.	1	2	3	4	5	6	7
2. Assessing technical feasibility.	1	2	3	4	5	6	7
3. Estimating laboratory resources needed to obtain results.	1	2	3	4	5	6	7
4. Preparing preliminary sketches and models which demonstrate possible product scenarios.	1	2	3	4	5	6	7
5. Adhering to customer standards and specifications.	1	2	3	4	5	6	7
6. Selecting final product designs.	1	2	3	4	5	6	7
7. Undertaking tests on competitive products.	1	2	3	4	5	6	7

8. Identifying major elements of the production system (facilities, tools and equipment).	1	2	3	4	5	6	7
9. Creating mockups of the system.	1	2	3	4	5	6	7
10. Developing prototypes.	1	2	3	4	5	6	7
11. Correcting potential problems prior to full scale development.	1	2	3	4	5	6	7
12. Developing quality strategies.	1	2	3	4	5	6	7
13. Establishing policies on source selection.	1	2	3	4	5	6	7
14. Developing maintenance plans.	1	2	3	4	5	6	7
15. Developing operator training plans.	1	2	3	4	5	6	7
16. Creating the production design release.	1	2	3	4	5	6	7

PART 2 - SECTION 1B

The following is a list of activities that may occur within the new product development process of non-defence products. For each activity listed, you will be asked to:

1. identify the extent of a clearly defined body of knowledge to guide you in performing the activity;
2. identify how often you can confidently predict the results of performing the activity;
3. identify to what extent the activity is much the same for different products;
4. and, identify to what extent different ways or approaches are used to perform the activity.

Please circle the appropriate response.

*Before proceeding, please think of **non-defence projects** which you are involved with and use these projects as a frame of reference when responding to the following questions.*

THE FOLLOWING QUESTIONS WERE ASKED OF ALL OF THE ACTIVITIES LISTED BELOW

To what extent is there a clearly defined body of knowledge to guide you in this activity?

ill-defined body 1 2 3 4 5 6 7 8 9 10 well-defined body

How often can you confidently predict the results of this activity?

never 1 2 3 4 5 6 7 8 9 10 always

To what extent is this activity much the same for different products?

same 1 2 3 4 5 6 7 8 9 10 different

To what extent different ways or approaches are used to perform this activity?

same 1 2 3 4 5 6 7 8 9 10 different

1. Developing product specifications based on user needs and wants.
2. Assessing technical feasibility.
3. Estimating laboratory resources needed to obtain results.
4. Preparing preliminary sketches and models which demonstrate possible product scenarios.
5. Adhering to customer standards and specifications.
6. Selecting final product designs.
7. Undertaking tests on competitive products.
8. Identifying major elements of the production system (facilities, tools and equipment).
9. Creating mockups of the system.
10. Developing prototypes.
11. Correcting potential problems prior to full scale development.
12. Developing quality strategies.
13. Establishing policies on source selection.
14. Developing maintenance plans.
15. Developing operator training plans.
16. Creating the production design release.

Thank you very much for your time and effort.

PART 2 - SECTION 2A

The following is a list of activities that may occur within the new product development process of defence products. For each activity listed, you will be asked to gauge the extent of resources (money or time) spent on performing the activity.

Please weigh each activity on a scale of 1-7, where 1 represents very little resources (money or time) spent on performing the activity within the new product development process of defence products, and 7 signifies substantial resources (money or time) spent on performing the activity within the new product development process of defence products. Please circle the appropriate response.

*Before proceeding, please think of **defence projects** which you are involved with and use these projects as a frame of reference when responding.*

1. Developing product specifications based on user needs and wants.	1	2	3	4	5	6	7
2. Assessing technical feasibility.	1	2	3	4	5	6	7
3. Estimating laboratory resources needed to obtain results.	1	2	3	4	5	6	7
4. Preparing preliminary sketches and models which demonstrate possible product scenarios.	1	2	3	4	5	6	7
5. Adhering to customer standards and specifications.	1	2	3	4	5	6	7
6. Selecting final product designs.	1	2	3	4	5	6	7
7. Undertaking tests on competitive products.	1	2	3	4	5	6	7

8. Identifying major elements of the production system (facilities, tools and equipment).	1	2	3	4	5	6	7
9. Creating mockups of the system.	1	2	3	4	5	6	7
10. Developing prototypes.	1	2	3	4	5	6	7
11. Correcting potential problems prior to full scale development.	1	2	3	4	5	6	7
12. Developing quality strategies.	1	2	3	4	5	6	7
13. Establishing policies on source selection.	1	2	3	4	5	6	7
14. Developing maintenance plans.	1	2	3	4	5	6	7
15. Developing operator training plans.	1	2	3	4	5	6	7
16. Creating the production design release.	1	2	3	4	5	6	7

PART 2 - SECTION 2B

The following is a list of activities that may occur within the new product development process of defence products. For each activity listed, you will be asked to:

1. identify the extent of a clearly defined body of knowledge to guide you in performing the activity;
2. identify how often you can confidently predict the results of performing the activity;
3. identify to what extent the activity is much the same for different products;
4. and, identify to what extent different ways or approaches are used to perform the activity.

Please circle the appropriate response.

*Before proceeding, please think of **defence projects** which you are involved with and use these projects as a frame of reference when responding to the following questions.*

THE FOLLOWING QUESTIONS WERE ASKED OF ALL OF THE ACTIVITIES LISTED BELOW

To what extent is there a clearly defined body of knowledge to guide you in this activity?

ill-defined body 1 2 3 4 5 6 7 8 9 10 well-defined body

How often can you confidently predict the results of this activity?

never 1 2 3 4 5 6 7 8 9 10 always

To what extent is this activity much the same for different products?

same 1 2 3 4 5 6 7 8 9 10 different

To what extent different ways or approaches are used to perform this activity?

same 1 2 3 4 5 6 7 8 9 10 different

1. Developing product specifications based on user needs and wants.
2. Assessing technical feasibility.
3. Estimating laboratory resources needed to obtain results.
4. Preparing preliminary sketches and models which demonstrate possible product scenarios.
5. Adhering to customer standards and specifications.
6. Selecting final product designs.
7. Undertaking tests on competitive products.
8. Identifying major elements of the production system (facilities, tools and equipment).
9. Creating mockups of the system.
10. Developing prototypes.
11. Correcting potential problems prior to full scale development.
12. Developing quality strategies.
13. Establishing policies on source selection.
14. Developing maintenance plans.
15. Developing operator training plans.
16. Creating the production design release.

Thank you very much for your time and effort.

PART 3 - SECTION 1A

The following is a list of activities that may occur within the new product development process of non-defence products. For each activity listed, you will be asked to gauge the extent of resources (money or time) spent on performing the activity.

Please weigh each activity on a scale of 1-7, where 1 represents very little resources (money or time) spent on performing the activity within the new product development process of non-defence products, and 7 signifies substantial resources (money or time) spent on performing the activity within the new product development process of non-defence products. Please circle the appropriate response.

*Before proceeding, please think of **non-defence projects** which you are involved with and use these projects as a frame of reference when responding.*

1. Assessing manufacturability of the product.	1	2	3	4	5	6	7
2. Preparing manufacturing equipment and tooling.	1	2	3	4	5	6	7
3. Acquiring major components of the product.	1	2	3	4	5	6	7
4. Undertaking pre-pilot and pilot production runs.	1	2	3	4	5	6	7
5. Inspecting test cases.	1	2	3	4	5	6	7
6. Implementing deficiencies and correction plans.	1	2	3	4	5	6	7
7. Demonstrating that product and process technology meet customer requirements.	1	2	3	4	5	6	7

8. Estimating manufacturing yield and costs.	1	2	3	4	5	6	7
9. Undertaking full-scale production.	1	2	3	4	5	6	7
10. Monitoring suppliers.	1	2	3	4	5	6	7
11. Conducting quality assurance product audits.	1	2	3	4	5	6	7
12. Making available anticipated initial service parts requirements.	1	2	3	4	5	6	7
13. Producing installation checkout kits.	1	2	3	4	5	6	7
14. Delivering production quantities of product to the distribution system.	1	2	3	4	5	6	7
15. Placing freeze on standard costs.	1	2	3	4	5	6	7

PART 3 - SECTION 1B

The following is a list of activities that may occur within the new product development process of non-defence products. For each activity listed, you will be asked to:

1. identify the extent of a clearly defined body of knowledge to guide you in performing the activity;
2. identify how often you can confidently predict the results of performing the activity;
3. identify to what extent the activity is much the same for different products;
4. and, identify to what extent different ways or approaches are used to perform the activity.

Please circle the appropriate response.

*Before proceeding, please think of **non-defence projects** which you are involved with and use these projects as a frame of reference when responding to the following questions.*

THE FOLLOWING QUESTIONS WERE ASKED OF ALL OF THE ACTIVITIES LISTED BELOW

To what extent is there a clearly defined body of knowledge to guide you in this activity?

ill-defined body 1 2 3 4 5 6 7 8 9 10 well-defined body

How often can you confidently predict the results of this activity?

never 1 2 3 4 5 6 7 8 9 10 always

To what extent is this activity much the same for different products?

same 1 2 3 4 5 6 7 8 9 10 different

To what extent different ways or approaches are used to perform this activity?

same 1 2 3 4 5 6 7 8 9 10 different

1. Assessing manufacturability of the product.
2. Preparing manufacturing equipment and tooling.
3. Acquiring major components of the product.
4. Undertaking pre-pilot and pilot production runs.
5. Inspecting test cases.
6. Implementing deficiencies and correction plans.
7. Demonstrating that product and process technology meet customer requirements.
8. Estimating manufacturing yield and costs.
9. Undertaking full-scale production.
10. Monitoring suppliers.
11. Conducting quality assurance product audits.
12. Making available anticipated initial service parts requirements.
13. Producing installation checkout kits.
14. Delivering production quantities of product to the distribution system.
15. Placing freeze on standard costs.

Thank you very much for your time and effort.

PART 3 - SECTION 2A

The following is a list of activities that may occur within the new product development process of defence products. For each activity listed, you will be asked to gauge the extent of resources (money or time) spent on performing the activity.

Please weigh each activity on a scale of 1-7, where 1 represents very little resources (money or time) spent on performing the activity within the new product development process of defence products, and 7 signifies substantial resources (money or time) spent on performing the activity within the new product development process of defence products. Please circle the appropriate response.

*Before proceeding, please think of **defence projects** which you are involved with and use these projects as a frame of reference when responding.*

1. Assessing manufacturability of the product.	1	2	3	4	5	6	7
2. Preparing manufacturing equipment and tooling.	1	2	3	4	5	6	7
3. Acquiring major components of the product.	1	2	3	4	5	6	7
4. Undertaking pre-pilot and pilot production runs.	1	2	3	4	5	6	7
5. Inspecting test cases.	1	2	3	4	5	6	7
6. Implementing deficiencies and correction plans.	1	2	3	4	5	6	7
7. Demonstrating that product and process technology meet customer requirements.	1	2	3	4	5	6	7

8. Estimating manufacturing yield and costs.	1	2	3	4	5	6	7
9. Undertaking full-scale production.	1	2	3	4	5	6	7
10. Monitoring suppliers.	1	2	3	4	5	6	7
11. Conducting quality assurance product audits.	1	2	3	4	5	6	7
12. Making available anticipated initial service parts requirements.	1	2	3	4	5	6	7
13. Producing installation checkout kits.	1	2	3	4	5	6	7
14. Delivering production quantities of product to the distribution system.	1	2	3	4	5	6	7
15. Placing freeze on standard costs.	1	2	3	4	5	6	7

PART 3 - SECTION 2B

The following is a list of activities that may occur within the new product development process of defence products. For each activity listed, you will be asked to:

1. identify the extent of a clearly defined body of knowledge to guide you in performing the activity;
2. identify how often you can confidently predict the results of performing the activity;
3. identify to what extent the activity is much the same for different products;
4. and, identify to what extent different ways or approaches are used to perform the activity.

Please circle the appropriate response.

*Before proceeding, please think of **defence projects** which you are involved with and use these projects as a frame of reference when responding to the following questions.*

THE FOLLOWING QUESTIONS WERE ASKED OF ALL OF THE ACTIVITIES LISTED BELOW

To what extent is there a clearly defined body of knowledge to guide you in this activity?

ill-defined body 1 2 3 4 5 6 7 8 9 10 well-defined body

How often can you confidently predict the results of this activity?

never 1 2 3 4 5 6 7 8 9 10 always

To what extent is this activity much the same for different products?

same 1 2 3 4 5 6 7 8 9 10 different

To what extent different ways or approaches are used to perform this activity?

same 1 2 3 4 5 6 7 8 9 10 different

1. Assessing manufacturability of the product.
2. Preparing manufacturing equipment and tooling.
3. Acquiring major components of the product.
4. Undertaking pre-pilot and pilot production runs.
5. Inspecting test cases.
6. Implementing deficiencies and correction plans.
7. Demonstrating that product and process technology meet customer requirements.
8. Estimating manufacturing yield and costs.
9. Undertaking full-scale production.
10. Monitoring suppliers.
11. Conducting quality assurance product audits.
12. Making available anticipated initial service parts requirements.
13. Producing installation checkout kits.
14. Delivering production quantities of product to the distribution system.
15. Placing freeze on standard costs.

Thank you very much for your time and effort.

END

2 4 - 0 6 - 9 | 7

FIN