OPERATIONAL RESEARCH TOOLS SUPPORTING THE FORCE DEVELOPMENT PROCESS FOR THE CANADIAN FORCES

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Abstract: In June 2005, the Chief of Defence Staff (CDS) of the Canadian Forces (CF) mandated that Capability Based Planning (CBP) be institutionalized as a part of a centrally driven, top-down approach to Force Development (FD) within the Department of National Defence. For the last two years, Operational Research analysts have been instrumental in the development of tools and processes to support all aspects of CBP. In this paper three CBP tools will be described: The CDS Action Team 3 Capability Assessment Methodology (CATCAM), the Capability Discussion Matrix (CapDiM), and the Strategic Costing Model. CATCAM was developed to compare the value of disparate CF capabilities. Presently, the tool determines a priority list of activities (the sub-components of capabilities) by employing a top-down risk assessment of activities against the desired mission effects of a specific FD scenario. CapDiM was developed to prioritize force options by evaluating their contributions against a set of criteria. To display the resultant priority list of force options, CapDiM creates a "Bang for Buck" graph that plots the value of each force option against its corresponding cost. The Strategic Costing Model was created to cost all aspects of the CF force structure. The model costs the total capability demand for the CF including, for example, the capability cost of: personnel; capital; research and development; operations and maintenance; and national procurement. The Strategic Costing Model permitted the first 30-year view of CF demand versus supply.

Keywords: Capability Based Planning, Force Development, Operational Research, Capability Assessment Methodology, Capability Discussion Matrix, Strategic Costing Model.

Introduction

In June 2005, the Chief of Defence Staff (CDS) of the Canadian Forces (CF) mandated that Capability Based Planning (CBP) be institutionalized as a part of a centrally driven, top-down approach to Force Development (FD) within the Department of National Defence (DND). For the last two years, operational research analysts have been instrumental in the development of tools and processes to support all aspects of CBP. In this paper, three tools developed to support the CBP process will be described: the CDS Action Team 3 Capability Assessment Methodology (CATCAM), the Capability Discussion Matrix (CapDiM), and the Strategic Costing Model.

CATCAM

Background

In February of 2005, the CDS stood up four action teams to initiate the implementation of his new vision for the CF, as articulated in the Defence Policy Statement (DPS).[1] Of these four action teams, CDS Action Team 3 (CAT3) was tasked to identify existing and emerging operational capabilities that would enable the CF to meet the demands of the future security environment.[2] In support of the CAT3 mandate, the CATCAM tool, a spreadsheet-based application, was developed to compare the value of disparate CF capabilities.[3] Through the creation of a Strategies-to-Options hierarchy and a risk assessment scoring process, CATCAM linked the value of a force option directly to the CDS' objectives and strategies for the CF. The output of CATCAM was a priority list of tasks, capabilities and force options for a given FD scenario.

During CAT3's tenure, the CDS acknowledged that the task of developing a capability investment/divestment strategy could not be achieved with adequate rigour within the CAT3 timeframe. In the absence of a viable CF FD process it was felt that any recommendations made by CAT3 would be subject to strong criticism. Consequently, the CAT3 work was to serve as the foundation for a comprehensive, robust and enduring CBP process that could be institutionalized across DND/CF.

CATCAM in the CBP Process

A modified version of the original CATCAM tool has been integrated into the end-to-end CBP process currently being developed for the DND/CF. Specifically, CATCAM has become a part of the Capability Planning portion of CBP. In Capability Planning, capability requirements or goals are developed: that is, *what* capabilities are required, rather than *how* capabilities should be produced. Capability Management will determine the best means to deliver capabilities, and the programming (procurement scheduling) of recommended force development options will be carried out in Program Management.[4] The new version of CATCAM supports Capability Planning by facilitating the prioritization of activities (the sub-components of capabilities) through a top-down risk assessment of activities against the desired mission effects of a specific FD scenario.

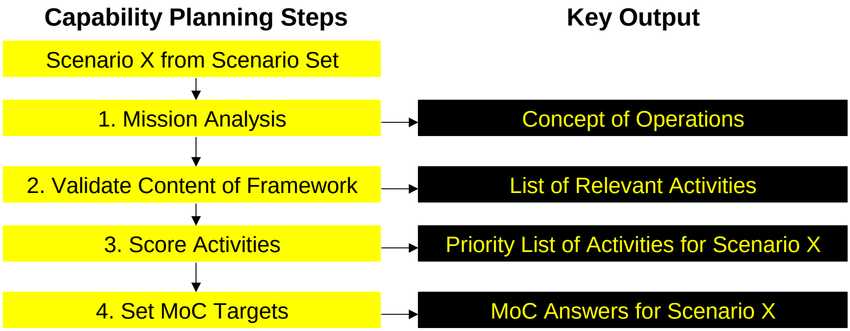

Figure 1: Capability Planning Process Steps.

Capability Planning Process – CATCAM Input Data

The Capability Planning process consists of four steps, as shown in Figure 1. CATCAM has been incorporated into Step 3 (*Scoring Activities*). Steps 1 and 2 (*Mission Analysis* and *Validate Content of Framework*) produce CATCAM's requisite input data. Step 4 (*Set Measures of Capability (MoC) Targets*) is the part in the Capability Planning process where the capability requirements for the chosen scenario are qualified and quantified through a series of capability-specific MoC questions. Steps 1 and 2, and the resulting CATCAM input data, are briefly described below. Step 3 will be described in the next sub-section. Step 4 will not be discussed further in this paper.

In the first Capability Planning process step, mission analysis is carried out on a scenario from the FD scenario set. DND currently has 18 classified real-world FD scenarios that span the spectrum of conflict, ranging from peace-keeping to warfighting operations. Through a modified version of the Operational Planning Process,[5] mission analysis is performed on the chosen scenario to produce multiple CF Courses of Action (COAs) that would address, in varying degrees, the scenario's threat. One CF COA is approved by the Capability Development Board, and consequently becomes the CF's Concept of Operations for the scenario.

In Step 2 of the Capability Planning process, the Concept of Operations is used to validate the content of the capability framework. The capability framework consists of 16 capabilities, which are shown in Figure 2, categorized by capability domain. Each capability in the framework is decomposed into a two-tiered hierarchy of functions and activities. For example, the functions and activities of the Command Support capability are provided in Table 1.

The activities assigned to a capability create an exhaustive list of all the actions required to achieve that capability effect in any scenario in the FD scenario set. Conse-

Command Domain
Command Support
Communications
Joint Effects Targeting

Sense Domain
Intelligence
Surveillance and Reconnaissance

Act Domain
Aerospace Effects Production
Land Effects Production
Maritime Effects Production
Special Ops Effects Production
Non-Kinetic Effects Production

Shield Domain
Force Protection

Sustain Domain
Sustainment
Support Services
Movements
Theatre Activation and Deactivation

Force Generation Domain
Force Generation

Figure 2: Capabilities (by Domain).

quently, not every activity assigned to a capability would be relevant for each FD scenario. To validate the content of the capability framework for the chosen scenario, the activities that would be utilized for the scenario, assuming the Concept of Operations determined in Step 1, are identified. The resultant filtered list of pan-capability activities is required input data for the CATCAM tool.

Prioritization of Activities

In Step 3 of the Capability Planning process, CATCAM facilitates the creation of a priority list of relevant activities for the given FD scenario. Activities are prioritized in CATCAM by first weighting the scenario's mission effects, then scoring the ac-

Table 1: Command Support Capability Functions and Activities.

CAPABILITY	FUNCTIONS	ACTIVITIES
Command Support	Plan	Develop Initial Plans
		Modify Plans
	Direct	Decide Command and Force Structure
		Direct Forces
	Monitor	Understand the Battlespace
		Assess the Ongoing Mission Results
		Analyse Mission Outcomes
	Conduct Liaison	Coordinate with External Entities

			Effect	**Effect**	**Effect**
			Control	Informed Direction	Shield
Capability	**Functions**	**Activities**	hh	hm	ml
Surveillance & Reconnaissance	Wide Area Collection	Collect Strategic Information	eml	elm	
		Survey Areas	emm	hl	ehl
	Focused Collection	Track Targets of Interest		ehh	ell
	Identify	Assess Targets of Interest	emh	hh	

Figure 3: The CATCAM Tool with Sample Data.

tivities against the mission effects to produce an overall numerical score for each activity. The standardized mission effects used in the Capability Planning process are: Control; Shape; Stabilize; Shield; Project and Sustain; and Informed Direction. A portion of the CATCAM tool with sample data is provided in Figure 3.

Mission effects are weighted in CATCAM by first assessing the risk to the success of the scenario mission if the CF could not create the mission effect. A mission effect's risk assessment consists of a frequency and consequence level. The definitions of high (h), medium (m), and low (l) mission effect frequency and consequence are given in Figure 4. In Figure 3, the mission effect risk assessments are highlighted in orange. A risk assessment of *hm* is assigned to the Informed Direction mission effect in the Figure, which means that it is of high frequency and medium consequence to the scenario mission.

Frequency: ***What is the frequency with which this mission effect will be applied within the scenario mission?***

High	This mission effect will be needed **almost always** (>80%) throughout the duration of the scenario mission
Medium	This mission effect will be needed **often** (~20-80%) throughout the duration of the scenario mission.
Low	This mission effect will be **rarely** needed (<20%) throughout the duration of the scenario mission.

Consequence: ***What is the risk of scenario mission failure if the CF cannot achieve this mission effect?***

High	Scenario mission will **fail** if this mission effect cannot be achieved.
Medium	Scenario mission will be **impeded** if this mission effect cannot be achieved.
Low	Scenario mission will suffer **minimal impact** if this mission effect cannot be achieved.

hm **High Frequency Effect**
Medium Consequence Effect

Figure 4: Mission Effect Frequency and Consequence Definitions.

Consequence

Frequency	Low	Medium	High
High	0.5	0.5	1.0
Medium	0.3	0.3	0.75
Low	0.1	0.3	0.75

Figure 5: Frequency/ Consequence Score Matrix.

The mission effect risk assessments are then translated by CATCAM into numerical scores through the frequency / consequence score matrix shown in Figure 5. Using the sample CATCAM data from Figure 3, the *hm* risk assessment assigned to the Informed Direction mission effect would be translated into a numerical score of 0.5. Finally, CATCAM calculates weights with respect to the scenario for each mission effect by normalizing the mission effect numerical scores. The weights of the three mission effects shown in Figure 4 would be: Control (0.55), Informed Direction (0.28), and Shield (0.17).

Once the mission effects have been assigned a weight, the activities are prioritized using a risk assessment of the activities against the mission effects. Since the CATCAM tool displays the information in spreadsheet format, the activities can easily be cross-referenced to the mission effects. When it is determined that an activity is required to achieve a mission effect, either to do or enable the mission effect, a risk assessment is entered in the intersecting box. The risk assessment methodology is

Frequency: ***What is the frequency with which this activity will be applied to produce this mission effect?***

High	This activity will be used **almost always** (>80%) to produce this mission effect.
Medium	This activity will be used **often** (~20-80%) to produce this mission effect.
Low	This activity will be **rarely** used (<20%) to produce this mission effect.

Consequence: ***What is the risk of failing to achieve the mission effect if the CF cannot perform this activity?***

High	Mission effect **cannot be achieved** if this activity is not performed.
Medium	Mission effect **may still be achieved** if this activity is not performed.
Low	This activity has **minimal impact** on the achievement of this mission effect.

ml **Medium Frequency Doer Activity**
Low Consequence Doer Activity

ehm **High Frequency Enabler Activity**
Medium Consequence Enabler Activity

Figure 6: Activity Frequency and Consequence Definitions.

			Effect	Effect	Effect	
			Control	Informed Direction	Shield	
Capability	Function	Activity	0.55	0.28	0.17	
			x	x	x	
Surveillance & Reconnaissance	Identify	Assess Targets of Interest	0.75	1	0	
			0.41 +	0.28 +	0	= 0.69

Figure 7: Activity Score Calculation.

very similar to that described above for mission effects. The definitions of high (h),medium (m), and low (l) activity frequency and consequence are given in Figure 6.

In Figure 3, the Survey Areas activity is given an *hl* (high frequency, low consequence) risk assessment against the Informed Direction mission effect. The square is colored dark purple to indicate the Survey Areas activity is directly involved in achieving the Informed Direction mission effect. A box is colored light purple and an *e* is placed in front of the risk assessment when the activity enables the achievement of the mission effect. The activity risk assessments are then translated by CATCAM into numerical scores through the frequency / consequence score matrix (Figure 5). Finally, CATCAM calculates an activity's overall score by taking the weighted sum of its numerical scores with the mission effect weights. For example, the calculation of the overall score for the Assess Targets of Interest activity is illustrated in Figure 7.

Listing the activities in descending order of their overall scores creates the priority list of activities for the chosen scenario.

Activity Prioritization across all FD Scenarios

The result of the Capability Planning process (Figure 1) is a set of 16 capability goals for the chosen scenario. A capability goal includes the CATCAM-calculated priority list of activities and the answers to the MoC questions (Step 4 in Figure 1). The Capability Planning process will be carried out for all 18 scenarios in the FD scenario set. Once complete, the scenario-specific priority lists of activities will be aggregated to produce an overall priority list of activities. This overall priority list, and an aggregation of the answers to the MoC questions, will then be handed over to Capability Management, where they will conduct a gap analysis of these aggregated capability goals (referred to as force goals) with the current CF force structure.

CapDiM

Background

Concurrent to the development of a CBP process for FD, the Chief of Force Development was tasked by the CDS to create a Defence Capability Plan (DCP): a document to articulate the capability investment and divestment strategy for the CF. In the absence of an institutionalized CBP process, a decision aid was required in the interim to help objectively orient the DCP discussions towards a policy-oriented priority of CF capabilities. In September 2005, a spreadsheet toolset called the Capability Discussion Matrix (CapDiM) was developed as an interim shortcut to the CBP process to facilitate the writing of the DCP.[6]

CapDiM has been utilized three times. In the first instance CF senior leadership used the tool to help determine their force option priorities for the DCP. Shortly after this CapDiM exercise, the attention of the senior leadership quickly shifted towards the alignment of DND with the newly-elected government. In the second instance, CapDiM was used with Level 1 representatives to build consensus regarding the impact of the new government's initiatives on the CF, and consequently modify the draft DCP document. Finally, in early September 2006, the three Environmental Chiefs of Staff used CapDiM as a launch point for discussions in the final deliberations of the DCP, which was renamed the Canada First Defence Strategy.

CapDiM Overview

CapDiM prioritizes force options through a set of criteria felt to reflect key aspects of either policy or CF strategic goals. CapDiM first captures the subject matter expert's (SME's) sense of priority of the criteria. It then records the SME's opinion of how each key force option rates against each criterion. After all assessments have been made, CapDiM then produces a priority list of force options. To display the resultant priority list of force options, CapDiM creates a "Bang for Buck" graph that plots the priority of each force option against its corresponding cost. A CapDiM spreadsheet with sample data is shown in Figure 8. In the following sub-sections, the steps of CapDiM will be explained in greater detail.

Criteria Assessments

The CapDiM criteria are grouped into three separate categories: Domestic/Continental, International, and General Military Attributes (GMA). In Figure 8, the criteria from the Domestic/Continental category appear in the left-most column. There are three spreadsheets in the CapDiM tool identical to that shown in Figure 8, one for each of the criteria categories.

POLICY EMPHASIS
No Fail: 10
More: 5
Same: 3
Less: 1

CONTRIBUTION SCORE
Provide Capability: 3 Points
Enabling Capabilities Only: 1 Point
Provides No Capability: 0 points

		AIR				
		ACT	COMMAND	SENSE		SUSTAIN
Domestic / Continental:		**Opt1**	**Opt2**	**Opt3**	**Opt4**	**Opt5**
Surveillance of Airspace	3	3	0	1	3	0
Control of Airspace	5	3	0	1	3	0
Surveillance of Territorial waters	3	3	0	3	1	1
Control of Territorial Waters	3	3	0	3	1	3
Search & Rescue	1	3	0	1	1	0
Disaster Relief	1	3	3	3	1	1
Consequence Management	1	3	3	3	1	3
Counter Terrorism Operations	10	3	0	1	0	3
Law Enforcement Crisis	10	3	0	3	1	3
G-8 / Olympics	10	3	0	3	1	3
Northern Incursion / presence	3	3	0	3	1	3
Security / Defence Cooperation with US	3	3	0	3	1	3
	SUB-TOTAL (out of 6399)	6399	6	4777	1833	5864
	Scaled (out of 100)	100	0	75	29	92

Figure 8: CapDiM Spreadsheet with Sample Data.

Table 2: Criteria Assessment Table.

ANSWER	SCORE
No Fail	**10**
More Emphasis	**5**
Same Emphasis	**3**
Less Emphasis	**1**

To assess each criterion within the Domestic/Continental category, the following question is asked: "According to policy, what is the emphasis that you would place on the following Domestic/Continental criteria?" The SME then gives an assessment corresponding to the table of standardized responses, as given in Table 2. For example, in Figure 8, the SME felt that defence policy clearly articulates domestic counter-terrorism operations as a no-fail activity, since the 8th criteria listed has been given an assessment value of 10. Assessments for the International and GMA criteria are determined in the same fashion.

Force Option Assessments

Once the criteria have been assessed, the next stage in CapDiM is to evaluate how each force option rates against each criterion. For both the Domestic/Continental and International categories, the force options are evaluated by asking: "How do the following force options contribute to the following criteria?" The SME then gives an assessment corresponding to the table of standardized responses, shown in Table 3.

The governing question for force option assessment for the GMA category is different. Here, the SME is asked: "Please rate the following force option against the General Military Attributes," using the scores indicated in Table 4.

After the criteria and force option assessments have been entered into the CapDiM spreadsheets for each criteria category, the value of each force options is calculated, as described in the next sub-section.

Table 3: Force Option Assessment Table (Domestic/Continental and International Categories).

ANSWER	SCORE
Directly provides a capability	**3**
Provides an enabling capability	**1**
Provides no capability	**0**

Table 4: Force Option Assessment Table (GMA Category).

ANSWER	SCORE
Good	**3**
OK	**1**
Poor	**0**

Force Option Value Calculation

Within each criteria category, the value of a force option is determined in CapDiM by taking a weighted sum of its force option assessments against the criteria weights. The criteria assessments (Table 2) were originally taken as the criteria weights, but this weighting scheme was found to be too subjective. For instance, it implied that a criterion assessed as *More Emphasis* (5) was half as important as one assessed as *No Fail* (10). A new criteria-weighting scheme was derived to ensure that, for example, a force option that at best was assessed against a *More Emphasis* criterion would never exceed the value of a force option assessed against one or more *No Fail* criteria. In other words, the weight assigned to a criterion must always be greater than the maximum score of a force option assessed against *all* lower level criteria. The basic assumption is that a force option that satisfies a higher criterion should always score higher than a force option that only satisfies *all* lower criteria. The algebraic derivation of the criteria weighting scheme is provided in a publication by Billyard, Blakeney, and Parker.[7]

To briefly demonstrate the criteria weighting scheme, consider the sample set of CapDiM assessments and criteria weights provided in Table 5. A weight of 1 was arbitrarily assigned to the *Less Emphasis* criteria. Consequently, the value score assigned to Option 5 is 12 [3(1) + 3(1) + 3(1) + 3(1) = 3(4)], which is the maximum value score an option assessed only against *Less Emphasis* criteria can receive. To ensure that Option 3, assessed only against the single *Same Emphasis* criterion, has a value score higher than Option 5, a weight of 13 [1 + (12=maximum value score of an option assessed only against the *Less Emphasis* criteria)] is assigned to Criteria 4 (*Same Emphasis* criterion). As a result, the value score of Option 3 is 13 [13(1)]. Similar logic is used to determine the weights for the *More Emphasis* and *No Fail* criteria (see Weight Calculation column of Table 5). The maximum value score of an option assessed against only *Same Emphasis* criteria and lower is 51 [3(4) + 3(13)], so a weight of 52 [1 + (51)] is assigned to Criteria 2 and 3 (*More Emphasis* criteria). The maximum value score of an option assessed against only *More Emphasis* criteria and lower is 363 [3(4) + 3(13) + 6 (52)], so a weight of 364 [1 + (363)] is assigned to

Table 5: Sample CapDiM Data to Illustrate Criteria Weighting Scheme.

	Criteria Assessment	Criteria Weight	Criteria Weight Calculation	Opt 1	Opt 2	Opt 3	Opt 4	Opt 5
Criteria 1	**10**	**364**	**[1+3(4)+3(13)+6(52)]**	**3**				
Criteria 2	**5**	**52**	**[1+3(4)+3(13)]**		**3**		**1**	
Criteria 3	**5**	**52**			**3**		**1**	
Criteria 4	**3**	**13**	**[1+3(4)]**		**1**	**1**		
Criteria 5	**1**	**1**	**1**		**1**		**3**	**3**
Criteria 6	**1**	**1**	**1**				**1**	**3**
Criteria 7	**1**	**1**	**1**					**3**
Criteria 8	**1**	**1**	**1**					**3**

Criteria 1 (*No Fail* criterion). The overall priority of force options in Table 5 is: Option 1 (1092) > Option 2 (326) > Option 4 (108) > Option 3 (13) > Option 5 (12).

Since there are three categories of criteria, three value scores are determined for each force option. CapDiM calculates one overall value score for a force option by taking a weighted sum of its three value scores with the normalized weights of the criteria categories. Criteria category weights are entered into CapDiM by the SME.

"Bang for Buck" Graph

To display the force option overall value scores, CapDiM produces a "Bang for Buck" graph: a scatter plot with the value score on the y-axis and the cost of the force options on the x-axis. The cost corresponding to each force option was produced by the Strategic Costing Model, which is described in the next section. A sample Bang vs. Buck graph is depicted in Figure 9.

Strategic Costing Model

Introduction

An important component of actualizing the CBP approach to defence resource planning is to relate the value of what is expected to be delivered, operationally and strategically, against its cost. This ultimately requires a supportable mechanism to facilitate balance of investment decision-making. With such a mechanism in place, national departments of defence could apply optimization techniques to define programs of defence capability acquisition that would best meet national requirements within specified budgetary constraints.

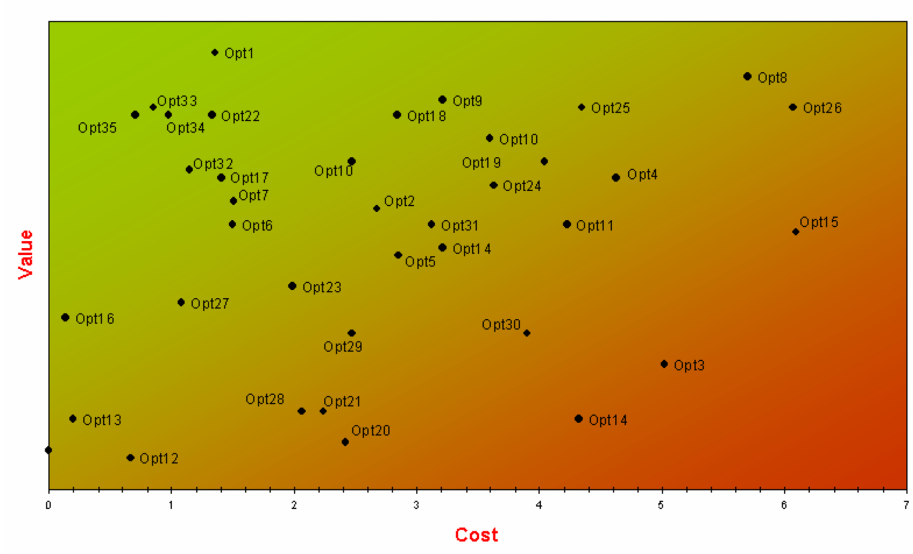

Figure 9: "Bang for Buck" Graph.

While there are many hurdles yet to be overcome before such a mechanism is institutionalized, Canada has developed the Strategic Costing Model – a costing architecture that produces high-level visualizations of what it costs to develop and operate current and prospective operational capabilities.[8] The model was originally built to estimate and analyze the cost of the DPS.

Strategic Costing Model Data

The ability to construct the costing architecture is a consequence of Canada's move to unify its Armed Services in the mid 1960's.[9] While not all of its objectives were met, services unification did produce a common support structure that enforced fairly centralized resource management across Canada's military. With this in place and with the advent of enterprise-wide financial data management software, DND is able to capture detailed organization, operations and support costs over the past few years, as well as current and anticipated capital costs (equipment and infrastructure) in a consistent, applicable format.

The raw departmental costing information could not be used without aggregation. It was estimated that the data sources captured was in the vicinity of 10,000 line items per year; a level of resolution too fine for the kind of cost visualization required. To arrive at a manageable data set of the correct resolution, DND activities were classified into a series of direct and indirect categories. For example, as shown in Table 6, the direct costs of Canada's Surface Ship fleet would be: capital; operations and

Table 6: Surface Ship Sample Direct and Indirect Cost Categories.

Direct	Capital	Frigate Life Extension
	Personnel	Surface Ship – Military Pay
	Operations and Maintenance	Frigate Sustainability
Indirect	Infrastructure & Fixed Support	Fleet Maintenance Facility
		Acoustic Data Analysis Centres
		CF METR
		Maritime Equipment Support
		Common Equipment Support
		Naval Base Support
	R&D	Maritime Effects R&D
		Joint & Common Effects R&D
	Training	Naval Training
		Common Training

maintenance; and personnel. The indirect costs would include such elements as the cost of fleet maintenance facilities, and common as well as service-specific training.

Indirect cost categories in their turn consist of subordinate direct and indirect cost categories. For example, the indirect costs of a fleet maintenance facility would include naval base support and naval training. When these categories were decomposed to the most indirect levels of support, a comprehensive taxonomy of DND cost elements, organized by groups of related activities, was generated. Consequently, the quantity of data in the raw cost representation was reduced to approximately 1500 elements per year.

Calculation of Force Structure Cost

With a working set of cost data defined, the next phase in the creation of the Strategic Costing Model was to determine the full cost of force structure ownership. This was accomplished in two steps: the attribution of indirect costs and the consolidation of indirect costs by type to force structure elements (systems). These steps are briefly described below.

Indirect Cost Attribution

The specific mechanism for assigning the cost of an enabling (indirect) activity to its immediate beneficiaries was through a four-stage process. First, each benefiting ac-

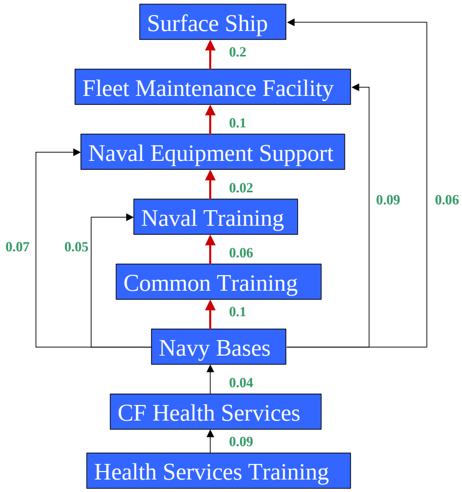

Figure 10: Sample Network between Surface Ship and Enabling Activities.

tivity was assigned a normalized weight (a fraction between 0 and 1) reflecting its draw of resources on the considered enabling activity. To better illustrate, consider the fleet maintenance facility and its immediate beneficiaries (surface ship, joint support ship and submarine). The weights assigned to the beneficiaries of the fleet maintenance facility were proportional to their equipment operating costs. Second, the total cost of the enabling activity was calculated: the sum of its direct and indirect costs. Thirdly, the portion of the enabling activity's total cost attributed to a beneficiary was determined by multiplying the enabling activity's total cost by the benefiting activity's fractional weight. Finally, the resultant attributed cost was explicitly included among the (indirect) cost components of the benefiting activity.

Consolidation of Enabling Costs to Force Structure Elements

The successive attribution of costs through the hierarchy of intermediate enabling entities established a series of tree-like networks of paths from the direct cost of enabling activities identified in the consolidated cost database to the model's defined force structure elements. A possible network between the Surface Ship force element and a sample of its enabling entities is shown, for illustrative purposes, in Figure 10. In the figure, notional weights assigned between benefiting and enabling activities are provided. For example, in Figure 10, the fraction of the cost of naval training assigned to naval equipment support is 0.02.

Each path in the network that linked together an enabling entity with the destination force element was assigned a score (product of all weights along the path), which indicated the ratio of enabling activity cost attributed to its destination force element. In

Figure 10, the most direct path between navy bases and the Surface Ship, highlighted with red arrows, would be assigned a score of $2.4*10^{-6}$ [0.1*0.06*0.02*0.1*0.2].

When the scores were summed over all possible paths between an enabling entity and an operational force element, the result described the complete cost impact of the enabling system. For example, the impact of navy bases on Surface Ships would be 0.079 [(0.07*0.1*0.2)+(0.05*0.02*0.1*0.2)+(0.1*0.06*0.02*0.1*0.2)+(0.09*0.2)+(0.06)]. When applied to all combinations of enablers to operational force elements, this provides an input/output visualization of DND activities.

Outcomes

The most significant outcome of the Strategic Costing Model initiative is that it was the first defensible effort at comprehensive operational force structure costing. Through attribution relations, contributions from infrastructure, equipment support, research and development, and training can be estimated for existing systems and these can be related to their direct costs. These latter relations can be applied in turn to provide first order estimates of the respective support overheads for replacement systems. Moreover, personnel intensive land and support systems can be contrasted with capital intensive maritime and air systems within this common costing framework.

The model can also serve as a reference to estimate life cycle costs for major equipment fleets. When tied in with anticipated hours of operation, information held in the model can be used to assess service delivery costs per asset.

Concluding Remarks

The three tools described in this paper have been well received by the Department and the military, and in the case of CATCAM and the Strategic Costing model, are being incorporated into the CBP process that will be institutionalized within DND/CF. CATCAM continues to be modified to fit the evolving Capability Planning process. While there is still much to be achieved before the sought-after balance of investment component of CBP is realized, what has been achieved thus far with the Strategic Costing Model marks the way towards building a credible and supportable defence capability analysis system. CapDiM served its purpose as a shortcut to the CBP process. With the CBP process still in the process of being established, CapDiM stands ready to be called upon again in the near future to support senior leadership with difficult capability investment/divestment decisions.

Notes:

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